AOSIS

Johann W.N. Tempelhoff

South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context

South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context

AOSIS

Published by AOSIS (Pty) Ltd, 15 Oxford Street, Durbanville 7550, Cape Town, South Africa
Postnet Suite #110, Private Bag X19, Durbanville 7551, South Africa
Tel: +27 21 975 2602
Fax: +27 21 975 4635
Email: info@aosis.co.za
Website: https://www.aosis.co.za

Published in 2018
Impression: 1

ISBN: 978-1-928396-72-7 (print)
ISBN: 978-1-928396-73-4 (epub)
ISBN: 978-1-928396-74-1 (pdf)
DOI: https://doi.org/10.4102/aosis.2018.BK75
How to cite this work: Tempelhoff, J.W.N., 2018, 'South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context,' pp. i-626, AOSIS, Cape Town.

Printed and bound in South Africa.

Listed in OAPEN (http://www.oapen.org), DOAB (http://www.doabooks.org/) and indexed by Google Scholar.

South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context

Johann W.N. Tempelhoff

AOSIS

Peer review declaration

The publisher (AOSIS) endorses the South African 'National Scholarly Book Publishers Forum Best Practice for Peer Review of Scholarly Books.' The manuscript was subjected to rigorous two-step peer review prior to publication, with the identities of the reviewers not revealed to the author(s). The reviewers were independent of the publisher and/or authors in question. The reviewers commented positively on the scholarly merits of the manuscript and recommended that the manuscript be published. Where the reviewers recommended revision and/or improvements to the manuscript, the authors responded adequately to such recommendations.

Research Justification

Geologists, physicists and ecologists currently promote the idea of a post-Holocene epoch, the Anthropocene. As a result of constant innovation and modernisation in the fields of engineering, natural science, management studies and environmental studies there has been a growing awareness of the intrinsic interaction between humankind and the environment. Humankind has become part of the environmental dynamics, to the extent that they are literally able to change ecosystems. Nowhere is the impact more evident than in the anthropogenic engagement with the hydrosphere – from the smallest pool of water to the earth's atmosphere. Comprehensive infrastructure development in water and sanitation, the growing trend to seek additional resources in the form of groundwater, desalinated seawater, and recycled wastewater, as well as special attention being given to capturing and preserving rainwater, bear evidence of a timely response to climate change, population growth and rapid development in many water-stressed regions of the world. The purpose of the book is to provide a historical overview of the manner in which South Africa's water resources have been governed from a time when the Union of South Africa was formed, in 1910, up to 2008, a time of a growing global awareness of the potential impact that climate change may have on water resources in a key region of southern Africa, notable for increasingly higher levels of aridity and more erratic rainfall patterns. This focus on the history of water affairs in South Africa makes it possible for scholars to comprehend the contemporary transitions made in the country's water governance system since the establishment in 2014 of the Department of Water and Sanitation. The focus is on the Water–Energy–Food nexus, a strategy which holistically contemplates the governance and use of water from the perspective of the interconnection between water, energy and food as resources. Research has been based on transdisciplinary methods, complemented with the classical interpretive historical narrative methodology. The target audience is specialists in the academy. No part of this book has been plagiarised.

Johann W.N. Tempelhoff, Professor of History, North-West University, South Africa.

Contents

Section C: Onset of a social ecological hydraulic mission

Abbreviations, Figures and Tables appearing in the Text and Notes

List of Abbreviatons

ACRU	Agricultural Catchments' Research Unit
AMD	Acidic Mine Water Drainage
ANC	African National Congress
B	B Collection in SAWHAR's Waterlit Collection (WLC)
BCM	Black Consciousness Movement
BoTT	Build–Operate–Train–Transfer
C	C Collection in SAWHAR's Waterlit Collection (WLC)
CMA	Catchment Management Agencies
CMIP	Consolidated Municipal Infrastructure Programme
COSATU	Congress of South African Trade Unions
CSIR	Council for Scientific and Industrial Research
CWSS	Community Water Supply and Sanitation
DBSA	Development Bank of Southern Africa
DDG	Deputy Directors-general
DG	Director-general
DPLG	Department of Provincial and Local Government
DOA	Department of Agriculture
DOI	Department of Irrigation
DPLG	Department of Provincial and Local Government
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
FSC	Full Supply Capacity
GDP	Gross Domestic Product
GIS	Geographical Information Systems
GNP	Gross National Product
HRI	Hydrological Research Institute
ICOLD	International Commission on Large Dams
IDC	Industrial Development Corporation
IDT	Independent Development Trust
ISWIP	Implementing a Sustainable Water Services Institution Programme
IT	Information Technologies
IWHA	International Water History Association

IWRM	Integrated Water Resource Management
JPTC	Joint Permanent Technical Commission
KOBWA	Komati Basin Water Authority
KT	Kagiso Trust
LHDA	Lesotho Highlands Development Authority
LHWC	Lesotho Highlands Water Commission
LHWP	Lesotho Highlands Water Project
LP	Labour Party
MAP	Mean Annual Precipitation
MAR	Mean Annual Rainfall
MBC	Meteor-burst Communications
MCM	Million Cubic Metres
MDM	Mass Democratic Movement
MIG	Municipal Infrastructure Grant
MIIU	Municipal Infrastructure Investment Unit
MINMEC	Ministers and Members of Executive Councils Meeting
MIT	Massachusetts Institute of Technology
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organisations
NIWR	National Institute of Water Research
NP	National Party
NPDP	National Physical Development Plan
NRDC	Natural Resources Development Council
NRF	National Research Foundation
NSTT	National Sanitation Task Team
NWA	National Water Act
NWRS	National Water Resource Strategy
NWU	North-West University
OFS	Orange Free State
ORDP	Orange River Development Project
OVTS	Orange–Vaal Transfer Scheme
PDG	Palmer Development Group
PITT	Policy Implementation Task Team
PWV	Pretoria–Witwatersrand–Vereeniging
RDP	Reconstruction and Development Programme
ReDR	Registered Engineers of Disaster Relief
RP	Departmental Report of the Republic of South Africa
SABC	South African Broadcasting Corporation
SABS	South African Bureau of Standards
SACP	South African Communist Party
SADC	Southern African Development Community

SAICE	South African Institution of Civil Engineers
SALGA	South African Local Government Association
SANCO	South African National Civic Organisation
SANCOLD	South African Commission on Large Dams
SANNC	South African National Native Congress
SAP	South African Party
SAWHAR	South African Water History Archival Repository
SCO	SCOWSAS Archive in SAWHAR
SCOWSAS	Standing Committee on Water Supply and Sanitation. Also Abbreviation for the Archive in SAWHAR
SOAS	School of Oriental and African Studies
SPROCAS	Study Project on Christianity in an Apartheid Society
SWA	South West Africa
TBVC	Transkei, Bophuthatswana, Venda and Ciskei
TCTA	Trans-Caledon Tunnel Authority
TOA	Tempelhoff Oral Archive
TPA	Tempelhoff Personal Archive
TR	Technical Report of the Department
TSO	Trigonometrical Survey Office
UDF	Union Defence Force
UG	Departmental Report of the Government of the Union of South Africa
UN	United Nations
UNCED	UN Conference on Environment and Development
UNDP	United Nations Development Programme
UP	Unionist Party
US	United States
USAID	US Agency for International Development
WAR	Water Allocation Reform
WARMS	Water Use and Authorisation Management System
WEF	Water–Energy–Food
WEHAB	Water, Energy, Health, Agriculture and Biodiversity
WfW	Working for Water
WHO	World Health Organisation
WISA	Water Institute of South Africa
WLC	Waterlit Collection
WP	Parliamentary White Paper
WQM	Water Quality Monitoring
WRC	Water Research Commission
WSDP	Water Services Development Plans
WSSD	World Summit on Sustainable Development
yBP	Years Before the Present

List of Figures

List of Tables

Biographical Note

Professor Johann Tempelhoff is a South African water historian who has been conducting research on the history of natural resources since the 1980s. Following an almost decade-long nationwide drought, he began to focus in particular on the interaction between societal development and water resources. In the 1990s, based at the North-West University Vanderbijlpark campus, he started researching historical aspects of civil awareness of water scarcity. His real-time laboratory was the Vaal River, beside which the campus is situated, and he later completed a history of the Vaal River Barrage, for many years a prime source of water supply to Gauteng, South Africa's economic and industrial hub.

In the 2000s Professor Tempelhoff started the research niche for the Cultural Dynamics of Water (CuDyWat) at North-West University. Postgraduate students, academics and external researchers participated in several transdisciplinary research projects aimed at understanding the way in which people in a variety of social ecological settings engage with water. He has also been involved in researching mining-related water problems and their impact on urban communities.

Prof. Tempelhoff is a former president and council member of the International Water History Association (IWHA). In 2012 he started the digitised South African Water History Archival Repository (SAWHAR) at North-West University with a grant from South Africa's Water Research Commission (WRC).

He is the author of 11 books and 66 accredited journal articles, as well as the founding editor of *TD: The Journal for Transdisciplinary Research in Southern Africa*. Although Professor Tempelhoff is now retired, he is still actively involved in research and postgraduate guidance in water studies.

This publication was funded by South Africa's National Research Foundation (NRF) and North-West University's research management.

The author can be contacted at johann.tempelhoff@nwu.ac.za and ORCID: https://orcid.org/0000-0002-6849-4938 for further information.

Acknowledgements

South Africa's NRF and North-West University's research management funded this book project. I am grateful for their support. The contents of this document reflect the views of the author, who is responsible for the facts and accuracy of the information. The contents do not reflect the views of the National Research Foundation, or North-West University.

The project was made possible by an NRF grant (CSUR 90310) in 2014. The first edition of the manuscript was completed in March 2017. Many people and institutions have played an important supporting role in bringing the project to fruition. They deserve mention.

My thanks to the WRC for donating the Waterlit Collection (WLC) to North-West University. This is an important collection of secondary source materials on water studies. It was started at the National Institute of Water Research (NIWR) at the Council for Scientific and Industrial Research (CSIR) in the 1970s. The comprehensive corpus of source materials enabled us, at the research niche for the Cultural Dynamics of Water (CuDyWat) at North-West University (NWU), to set up the South African Water History Archival Repository (SAWHAR). The WLC remains the nucleus of an information database that is in the process of becoming a comprehensive digital kaleidoscope of local and international primary and secondary source materials related to water studies in South Africa.

The management of North-West University's Vaal Triangle campus created an enabling environment for us to start working with students and outside researchers towards the development of a system that would hopefully be of service to water sector workers, researchers, and managers in future.

My thanks go to Dr Bridget Theron-Bushell for her unstinting support and valued services as language editor, having walked the way with me for many years as a fellow historian and language adviser. I am deeply indebted to her for the sterling support and advice on dealing with the text. A number of water experts have also been through the drafts. I am grateful to the external peer reviewers for their reading, their recommendations and valuable advice. Thanks to Martin Ginster, a senior research associate of CuDyWat and trusted friend, Dr Paul Roberts, a former senior management official in the Department of Water and Sanitation, Dr Marika van der Walt, a legal scholar and water researcher, as well as Isa Thompson, until recently a senior manager at the Department of Water and Sanitation. These readers critically commented on the manuscript, shared their expertise with me, and provided valuable comments and advice. Isa was most helpful in bringing me into contact with South Africa's Water Alumni – the silverbacks of the country's water sector who are custodians of lots of mature water wisdom. My thanks to all the alumni for sharing views and many valued recollections on their encounters with water.

The SAWHAR team of Willem Lemmer, Nadine Smit, Hilda Jaka, Louraine Ndweni and Lucky Maleketu have all been part of the process of creating inventories and digitising many of the valuable sources on South African and international water studies used in this study. Thanks also to Ms Suzaan Laubscher of NWU's Centre for Teaching and Learning who drew two key maps that provide the reader with a better orientation of early water governance regions in the country.

Dr Anelda van der Walt of the NWU information technology division provided support and expert advice on the creation of an operational digital archival repository. The administrative officials, Debbie Mocke and Lebo Serobane, along with the research management of North-West University, provided important services. I am grateful for their support and advice.

In 2017 Dr Pierre de Villiers, CEO of AOSIS Publishers responded favourably to my request to consider the manuscript. Subsequently, he and other AOSIS staffers, headed by Trudie Retief and Prof. Andries van Aarde, formed a nuclear team responsible for a comprehensive international peer review process and extensive negotiations with the funding authorities at North-West University. Subsequently, AOSIS staffers actively worked on all the processes leading up to the publication of this work. I am most grateful for their dedicated support in bringing this project to fruition.

Finally, this study is dedicated to my wife, Elise, for her unstinting support, patience and companionship in the long haul of writing on South Africa's water history.

Preface

This study covers the period from the early 20th century, after the formation of the Union of South Africa in 1910, to the early 21st century. It explains how a central government department shouldered the responsibility of ensuring that adequate water storage facilities and the necessary infrastructure were created to supply sufficient water to farming operations, industrial activities in the mining sector and the growing conurbations throughout the country. The process that has unfolded since the early 1900s is nothing short of a modern miracle. As a result of constant innovation and modernisation in the fields of engineering, natural science, management studies and environmental studies, there has been a growing awareness of the intrinsic interaction between humankind and the environment. Deep thinking geologists, physicists and ecologists, currently promote the idea of a post-Holocene epoch – the Anthropocene. The way we respond to the call for greater societal responsibility, is not confined to dealing with emissions of greenhouse gases and carbon emissions into the atmosphere. Human societies in all parts of the globe have an even greater responsibility to take care of our finite freshwater resources.

The aim of this book is to inform the reader on some water-related governance processes that have played themselves out in South Africa since the early 20th century. The period under discussion is confined to 1910 to 2008. At the end of the Thabo Mbeki presidency (1999–2008) the social, economic and political landscape of South Africa was subject to significant change. Seen against the backdrop of the Water–Energy–Food (WEF) nexus theory that features prominently in this study, the countrywide electricity outages in the first half of 2008, was a seminal manifestation of emergent 'panarchy' states of creative destruction and recovery in the infrastructural system feeding into the nexus of water, energy and food. By focusing on the WEF nexus it is possible to assess to what extent the country (contemplated as a social ecological system) has been able to adapt resiliently to challenges and opportunities, specifically in matters related to the available water resources.

There are in the text a few references to post-2008 developments in South Africa's water history. But they are limited. South Africa's post-2008 water history will hopefully come up in future research work. We are currently living in an era of rapid and sometimes tumultuous change. It is difficult to distinguish clutter from meaningful adaptation trends. The interpretation of long-term developments on a comprehensive and deep-seated theme, such as South Africa's water history, requires distance in time for the interpretive

How to cite: Tempelhoff, J.W.N., 2018, 'Preface', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. xxix–xxx, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.0P

distillation of emergent long-term trends. It is to be hoped that opportunity will soon present itself.

In the development of this text a concerted effort was made to integrate the information used into the digital storage system of North-West University's South African Water History Archival Repository (SAWHAR). This study was part of an experiment to determine how to make the emergent digital archival repository user-friendly for current and future researchers in and beyond South Africa who increasingly rely on software systems for using and storing data.

All references in the text are listed in a separate bibliography at the end of each chapter. The current Endnote X8© software and its (improvised) Chicago 16th footnote system was used for referencing. For publication purposes, the conventional historical referencing system has been changed to limit repetitive bibliographical detail. The system required considerable variations in reference codes. It tended to be somewhat unkind when detailed archival materials were subject to extensive referencing. In writing this manuscript a concerted effort was made to develop a tailor-made referencing system to correspond properly with the unique nature of the specific research project and the growing field of sophisticated commercial cloud-based software referencing systems. Good software has to be responsive to the eccentric systems of referencing used by historians – especially in the field of primary source materials. Apart from the Waterlit Collection (WLC), SAWHAR's archives of individual water sector specialists, such as Will Alexander (WAC, Version1.1), Alan Conley (AHCA), the Standing Committee on Water Supply and Sanitation (SCOWSAS) archive (SCO, Version 1.2) as well as the author's personal archives (TPA/TOA), developed over an extensive period of time. They form part of the primary source referencing in the text. There has been a concerted effort to make the referencing accurate and as clear as possible for the reader.

Future prospects are excellent for software support to researchers, especially those working in the field of the history of mentalities and contemporary history. The continued growth of internet-based primary and secondary source materials, especially in the field of social media and open access record databases of private and public institutions, will continue to expand the research horizon for innovative academic research. The future prospects are bright for scholars interested in exploring new methods and sources in a variety of research activities in all disciplines.

Introduction

Water has a long history as a notoriously scarce resource in the greater part of southern Africa. This fact registered clearly in the Spring of 2017 when the authorities at Cape Town harbour were unable to give assurance of unrestricted supplies of fresh water to vessels docking at the world famous Tavern of the Seas.[1] The reason? The Western Cape was caught in the grip of what climate scientists described as a one–in–325-year drought. Calculated over two years (2016 and 2017) preliminary data analysis suggested the densely populated Western Cape metropolitan area was caught up in a one–in–1150-year drought.[2]

The annual winter rains were well below par, leaving the city's water supplies at 37% of capacity until the next rainy season in the winter of 2018. Although the countrywide drought that started in about 2011 seemed to subside in many parts of South Africa, the Western Cape continued to suffer under conditions of extreme natural drought.

Cape Town, founded in 1652 primarily because of its favourable environment and the copious water supplies which flowed from streams and aquifers nestled in the Table Mountain system, remained dry. The Cape has a long history of meeting the demand for refreshment; it is one of the earliest Western-style urban settlements at the southern tip of the African continent. But as the Western Cape prepared for the annual December inflow of holidaymakers in 2017 a costly and comprehensive set of contingency plans was put in place to provide precious water. Measures included stringent water restrictions, additional boreholes for more groundwater plants, desalination plants and the reclamation of wastewater.[3]

The Republic of South Africa, one of the leading economies on the African continent, relies largely on surface water resources for its supplies. Rainfall, as is the case in most parts of the continent, is an important water provider. But the country's annual rainfall of about 440 mm/a is well below the average for other countries. Therefore, it is true to say that drought – in an unassuming way – has been instrumental in shaping the social ecological course of the country's history. Because drought and flood conditions are natural phenomena, they form part of an invisible history that seldom features prominently in popular memory. This is partly the result of significant

How to cite: Tempelhoff, J.W.N., 2018, 'Introduction', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 1-24, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.00

1. Jordaan (2017:12).

2. Vermeulen pers. comm., 03 March 2017; Wolski (2017).

3. NEWS24WIRE (2017).

anthropogenic interventions since the 19th century in creating a comprehensive infrastructure of substantial water storage and distribution facilities, with a view to supplying ever-increasing water supplies to a rapidly developing country. Accordingly, an increasingly urban society appears to have developed selective amnesia about the effects of modernity and technological innovation on a scarce natural resource; as a result of long-term planning, traditionally droughts were believed only really to affect communities on the fringes of growing metropolitan areas.

In the 20th century there were a number of drought events that followed in cycles of roughly seven to 11 years that led to guidelines for planning appropriate mitigation strategies in the form of comprehensive infrastructure programmes.

The South African government authorities, from the local to the national level, have always been sensitive to the need for sufficient water resources. In the civil, public and private domains there has always been an enabling environment for introducing technologies to allay the threat of water insecurity. Much of the country's modern history testifies to continuous and innovative strategies of water procurement and distribution. An elaborate system of sophisticated networks of pumping and storage infrastructure in all parts of the country testify to impressive infrastructure planning.

In recent decades there has been a growing awareness that global climate change, caused by the excessive release into the atmosphere of greenhouse gases, has had a marked influence on human settlements in all parts of the globe. Migration trends make it difficult to predict secure and sufficient water and sanitation services for human settlements in many parts of the country. Sub-Saharan Africa is currently one of the fastest urbanising regions in the world. With an estimated 12% of populations in some regions on the continent migrating annually to urban settlements, it is barely possible to keep abreast of the growing demand for water supply and sanitation services. Rapid urbanisation continues to pose problems for the water sector; it calls for intricate planning to make predictions and allowances for future growth.[4] Southern Africa is not precluded from this regional trend. With the uncertainty about the consequences of climate change and the political, economic, social and environmental issues that inevitably follow in their wake, authorities need to meet the growing need for sufficient water and sanitation infrastructure.[5]

This study, essentially a water history of South Africa, is a narrative aimed at creating a discourse on the development of water governance and services in South Africa since the beginning of the 20th century. What is presented is a historical monograph touching on a number of salient areas and periods in the

4. Bloch (2011).

5. Pieterse, Parnell and Haysom (2015:21–27).

history of South Africa to create an awareness of the intrinsic significance of water and the way in which it has shaped the nation's society over a period of about a century.

The task of the historian is not to predict the future. Instead, history implies a subjective narrative of the past that contributes towards comprehending the present. The historical narrative to follow is interspersed with a number of terms, theories and concepts that may be unfamiliar to the reader. However, because the protagonist of the story – water – is firmly situated in the realm of natural history, a number of science theories have been incorporated in a transdisciplinary context to shed light on a complex system of etiological thinking based on historical facts. Our understanding and use of hermeneutics in transdisciplinary studies is gaining traction in academic research.[6] It is becoming a valuable vehicle for understanding epistemological views about culture in nature in more holistic ways. Therefore, the use of theory in this study is not an attempt to defy the idiographic characteristics of historical discourse. Instead, the aim is to create an awareness of concepts and theories for the reader to explore creatively; to interpret and contextualise from evidence presented in the narrative.

For the purposes of this study, the institutional water history of South Africa for the period 1912 to 2008 has been divided into three distinct phases. Each marks a period in the way water has been governed by the state for the benefit of the country and its inhabitants.

■ Defining the 'hydraulic mission'

The term 'hydraulic mission', derives from the work of K.A. Wittfogel (1896–1988), a German-American historian and sinologist who advanced a comprehensive theory on hydraulic societies, and has a special status among theorists in the field of water studies. In his famous study, *Oriental Despotism,*[7] he used a variety of terms related to the anthropogenic activities that have a bearing on interacting with water in the fields of agriculture and governance. As anthropologist, historian and sinologist of note, and a former communist who later 'converted' to capitalism, Wittfogel was considered a controversial academic in some quarters. His grand theory about irrigation governance systems spontaneously feeding into the formation of authoritarian societies, did not go down well with world historians and the grand theorists of his day.

Arnold Toynbee, for example, criticised Wittfogel for using 'hydraulic' out of context. The term, as Toynbee correctly pointed out, had a specific significance in the language of science and engineering related to the accurate measuring

6. Dieleman (2017:170–199).

7. Wittfogel (1957).

of water and infrastructure. Toynbee also felt that Wittfogel's general theories on 'irrigation societies' were not universal in their application.[8] Even the philosopher Eisenstadt criticised Wittfogel for not fitting his grand view of things universally and logically into valid theoretical categories.[9] Fortunately, Wittfogel was not castigated by all contemporary theorists for his quaint turn of phrase and his creativity. Some authors participating in the debates on the merits of Wittfogel's work had accolades for his sound historical scholarship and his creative anthropology on water governance and society's interactions with the hydrosphere in political ecological contexts.[10]

For six decades the debates have continued. In many cases theorists have become more favourably disposed towards Wittfogel's appraisals of aquatic governance systems and the cultural dynamics of water. To be sure, some debates have been ongoing,[11] but the discussion has branched off into a multitude of fields of rich intellectual exploration of ideas related to water studies. Political scientists, anthropologists, sociologists, ethnologists, archaeologists and geographers, as well as historians, have derived considerable value from what was once considered to be crude and overtly political abstract theorisation on Chinese history by a one-time communist who later relocated to the United States (US) – the land of the free.

Wittfogel's terminology gained substantial traction in the late 1970s in Waterbury's exploration of hydraulic culture in modern African states competing for access to the waters of the River Nile.[12] By 1999, Swyngedouw[13] at Oxford, used the term 'hydraulic mission' to describe the way the evolving system by which the Spanish state, in the period 1890 to 1930, was influenced by the so-called 'Regenerist' movement, and began to secure water resources for the country's industrial, farming and domestic consumers. The security of Spain's national water and food supply became synonymous with a hybrid approach to dealing with the management of the resource.[14]

Shortly afterwards, Tony Allan at London University's School of Oriental and African Studies (SOAS), in his work on virtual water, incorporated the concept.[15] The appeal of the hydraulic mission concept was the result of a growing awareness in the field of water studies of the need to incorporate

8. Toynbee (1958:195–198).

9. Eisenstadt (1958).

10. Venturi (1963).

11. Price (1994:187–204); Hunt et al. (1976); Hunt (1988).

12. Cooley (1984:3–26); Waterbury (1979; 2002); Turton pers. comm., 25 September 2016.

13. Swyngedouw (1999:443–465).

14. Allouche (2010:).

15. Allan (1999a:1–11; 1999b).

trending ideas in hydropolitical environmental activism,[16] environmental history,[17] political ecology[18] and postmodernist philosophy.[19] At the time Allan was working on his theory of virtual water.[20] It interfaced directly with the 'new hydraulic mission'[21] that significantly differed from what Wallingford at the time described as the 'old hydraulic mission'.[22]

As will be explained below, at SOAS in 1999, South Africa featured prominently in talks and research on the hydraulic mission. The South African political scientist and water expert, Anthony Turton, had close ties at the time with SOAS and transferred a number of current theoretical terms, such as hydropolitics and hydraulic mission into the political and governance discourse on African water. Turton concentrated extensively on theories of water politics.[23] In much of his work the theoretical underpinnings of the hydraulic mission were present.[24] It formed part of a comprehensive theoretical reference framework in which he focused on hydropolitics and transboundary water resource governance, to fit in with the discourse on water governance in South Africa from the advent of European colonialism in the 17th century. Apart from Turton's statements on the 1960s and 1970s, when the state was said to take a more assertive stand on water control and management,[25] there has thus far not been a sensible historical categorisation of the evolution of South Africa's hydraulic mission in the 20th century. Therefore, in this study the objective is to work towards a reasonable understanding of the comprehensive evolution of the hydraulic mission as it evolved in the South African state.

On occasion Turton argued that the hydraulic mission began in the period 1867 to 1886, at the time of the major mineral discoveries of diamonds and gold at Kimberley and Johannesburg respectively.[26] In his PhD thesis he also made an extensive theoretical exploration of the concept of the hydraulic mission in the institutional development of South Africa's water sector and transboundary

16. Reisner (1993; 1994:1–12).

17. Worster (1985).

18. M'Gonigle (1999:11–26); Bryant and Goodman (2008).

19. Reuss (*c*. 2003/2004:1–20); Baghel (2014:61–92).

20. Anonymous (n.d.e).

21. Allan (1999b).

22. Wallingford and Wallingford (1999).

23. Lichtenthaeler and Turton (1999); Turton (1999).

24. For the purposes of this, attention is only given to the works up to 2002. Turton (2000); Turton (2001); Turton and Meissner (2002); Turton and Warner (2002); Turton and Henwood (2002).

25. Turton, Patrick and Rascher (2008:324).

26. Turton et al. (2004:ii).

international relations.[27] It seems reasonable to suggest, therefore, that a frontier-type hydraulic mission evolved in southern Africa in the 19th century.

Up until the 20th century, southern Africa consisted of a number of independent African states, locally developed European-styled republics and colonies, many of them British, Portuguese or German colonies or protectorates. At most, indications of a hydraulic mission would have been local, self-styled and often driven by market forces in the private sector. Up to the present we still know very little about the indigenous communities' water management strategies. What presents itself in the 19th century is a fragmented image of informal water management systems that is unfamiliar to our current understanding of the South African past. Even in the case of the British colonies there is no comprehensive cohesion in matters of water governance in the 19th century.

It appears that if there were to have been an emergent hydraulic mission, even in the 1870s Cape Colony, it was most probably driven largely by market forces. The colonial authority asserted marginal control and had limited long-term objectives of where it wanted to take the water governance system of the colony. However, in terms of local governance, a localised hydraulic mission of securing supply and establishing sanitary systems did present itself in early European-type urban areas such as Cape Town, Grahamstown, Bloemfontein, Johannesburg and Durban.[28] London set the pace and example. It was the premier metropolitan colonial capital city in Europe. As a result of imperial influence in many parts of the world, London set the trend on how water resources would be used in regions where there was a dominant British presence. Not only was London's water managed, but the need for proper sanitation was also borne in mind. The city of London set an example for many cities in Europe and especially the United States of America, where the 'sanitary revolution' had a profound impact on urban water governance and infrastructure development after the take-off in the 19th century of the Second Industrial Revolution (*c*. 1870–1914)[29] and forms part of the current global discourse on the Fourth Industrial Revolution.[30]

The colonies were essentially there for the benefit of the colonial power. It is true that in terms of colonial government there were localised strategies for water governance, but these could not easily be applied to all the British colonies on the subcontinent. Of a cohesive management plan – a hydraulic

27. Turton (2003).

28. SAWHAR WLC PAM2293 (1951:3–4); Van Schoor and Oberholster (1960:169–178); Swanson (1977:387–410); Mäki (2008).

29. Jevons 1931.

30. Halliday (2001); Sedlack (2014); Smith (2013). Schwab (2017).

mission – the first proper planning in South Africa only began after the formation of the Union in 1910.

The application of the hydraulic mission, as a theoretical term, fits comfortably into the 20th century. In 2007, Turton saw the hydraulic mission of South Africa as emergent at the time of the so-called 'total onslaught' in the 1970s.[31] For him South Africa's remarkable hydraulic mission had its origins in the 1970 Commission of Enquiry into Water Matters that identified the resource as being of the highest strategic importance. It meant, he points out, that more than 60% of the country's mean annual run-off was captured in large dams.[32]

After 2000, South Africa's water management was in a long phase of development and many views on the sector appeared to be messy and confused. For example, Jonker, in 2007, berated the fact that water resources management merely had a bearing on issues of municipal and domestic water users. It appeared to him as if the Department of Water Affairs completely withdrew from integrated water resources management as a water regime, compliant with the principle of the hydraulic regime.[33] To all intents and purposes, in his view, there was no visible hydraulic mission.

Swatuk, in turn, makes much of outlining South Africa's hydraulic mission in the apartheid era, but does not define it. Instead, he suggests, what will be required is a 'modified hydraulic mission' involving significantly new infrastructure and potentially an inter-basin transfer from beyond South Africa's borders.[34] Van Koppen's response to the term, by 2008, was to define a 'white [water] hydraulic mission' that between 1917 and 1994 was notable for government ensuring that the Department of Water Affairs provided soft loans or grants to white farmers.[35] Van Koppen, in line with Lévite, speaks of a race-based hydraulic mission.[36] In their collaborative work Schreiner and Van Koppen have focused on what was subsequently described as an 'apartheid hydraulic mission'.[37] Sojamo's more recent view on South Africa's hydraulic mission suggests that the country's objective with large-scale infrastructure was to ensure water security. However, as a result of the deterioration of water quality, that mission seemed to him to have been compromised.[38]

31. Turton and Funke (2008).

32. Turton (2010:142).

33. Jonker (2007:1260).

34. Swatuk (2010:521).

35. Van Koppen (2008:433).

36. Merrey, Levite and Van Koppen (2009:52–53).

37. Van Koppen and Schreiner (2014:547).

38. Sojamo (2015:6900).

■ Affordance and SA's hydraulic mission in the WEF nexus

The environment, a term introduced by Jakob von Uexküll (1864–1944), was instrumental in J.J. Gibson's ecological and psychological development of the concept of 'affordance'.[39] Both Ingold[40] and Dennet provide valuable insights into anthropological philosophy, cognitive psychology and ecological studies for our understanding of affordance in the development of infrastructure and how water resources were made available in the aquatic hydrosphere for human use in South Africa in the past century. In a recent discussion of the evolution of understanding consciousness, Daniel Dennet gives an account of the significance of design by animals and the agency of affordances of environments in which they find themselves.[41] Comprehending environmental affordance in the context of infrastructure, the product of human creativity and foresight, makes it possible to interpret the significance of water in the social ecological development of South Africa.

For the purposes of this study the WEF nexus is perceived as the product of a number of affordances stemming from the use of water and the way the natural resources have been put to use by humans in the South African context. Essentially three actions of affordances are identified, irrigation, industrial development, and securing the affordance for universal human domestic access to water. For example, the infrastructure to secure sufficient supplies for the country's population was an outstanding accomplishment. What becomes evident is that increasingly the affordance of water through infrastructural innovation contributed cognitively, to the creation of an awareness of the need for a social ecological understanding of the hydrosphere within which we live and thrive.

In this study, South Africa's national water resource management and infrastructure development process in the 20th century is classified into three distinct periods of hydraulic mission. The phases coincide with three sets of basic water legislation introduced in 1912, 1956 and 1997 to 1998.[42]

In 1910 four British colonies, the Cape of Good Hope, Natal, Transvaal and the Orange River Colony, were consolidated into a unitary state. In terms of water resource management, it meant that the national Department of Irrigation, as it came to be known in 1912, was responsible for ensuring that sufficient irrigation infrastructure was available for the 'conservation' of water, that is, water storage infrastructure. The conservation of water, from an

39. Gibson (1977a; 1977b).

40. Ingold (2011).

41. Dennett (2017).

42. Kearns (2014).

environmental perspective, also promoted the growth and protection of moist forest lands that could be used for the natural conservation of water-rich mountain catchment areas.[43] The *Irrigation and Conservation of Water Act* of 1912 determined the evolution of a hydraulic mission that was not only influenced by the British tradition of colonial irrigation in India,[44] the Nile,[45] and Australia, but also by developments in the United States of America.[46] To all intents and purposes, after Union in 1910 South Africa was a typical modern young state in the process of developing its water infrastructure, aspiring to the pursuit of a typical modernist hydraulic mission.

From 1912 to about 1947 the governance of water and the construction of South Africa's water infrastructure focused primarily on the realisation of a food–agricultural hydraulic mission. It was all about developing the country's water resources primarily for the farming sector – specifically the irrigation farming sector – to provide food supplies for local consumption and export.

The second phase was the energy–industrial hydraulic mission, from *c*. 1947 to 1994. It was a period in which the state gave its full support to the development of the country's industries by securing sufficient water supplies and also by the generation of electricity. It was a period notable for the deterministic style of engineering and technology that flourished at an exceptional rate, with significant scientific breakthroughs. For the greater part of the period (especially 1960 to 1990) South Africa was politically isolated from the international community and the key water sector developments commonly trending internationally.

With the exception of South Africa becoming a member of the International Commission on Large Dams (ICOLD) in 1965, the country was largely excluded from many of the latest developments in the water sector. In hindsight the period was intellectually fruitful for some creative home-grown engineering work and state-of-the-art infrastructure development. South Africa's water sector by the 1970s emerged as one of the world's leading nodes for water purification and reclamation and the development of an impressive – but highly modernist and almost unsustainable – intricate network of water transfer systems in a water-stressed country. By the 1990s it would become evident how vulnerable the sophisticated system actually was.

One of the negative spin-offs of South Africa's international isolation in the apartheid era was that new trends, such as an emergent global environmental awareness, did not feature prominently in most plans for the construction of water schemes and water systems management. However, after the 1966 to

43. Agricultural Journal of the Union of South Africa (1911); Kanthack (1908:194–204; 1910:537–538).

44. Bozzoli (1997:96).

45. Plug (2016).

46. Lewis (1915).

1969 Commission of Enquiry into Water Matters, and the subsequent implementation of its recommendations, there are indications that a number of strategies were introduced to become more environmentally friendly in the planning and governance of water infrastructure systems.[47]

The third phase, a social ecological hydraulic mission, began in *c*. 1992 and is currently (2018) still in a phase of maturation. The dominant social- ecological mindset of the 1990s was the creation of a non-racial democracy in South Africa. Along with a new environmental awareness came a greater awareness of government's social responsibility to secure good drinking water and proper sanitation for all the people resident in the state. From 1994, this frame of mind paved the way for a greater governmental concern for ordinary people, especially those who had been previously disadvantaged by the apartheid era policies of the state. The principle of sustainability ensured that environmental awareness would form part of the legislation related to the country's water resources and governance.

The era marked South Africa's reintroduction, after almost 40 years of political isolation, into the international community and its water sector, where the United Nations' (UN) decade of water supply and sanitation (1980–1990) informed much of the international water sector's thinking on planning for the UN Conference on Environment and Development (UNCED), also known as the Rio Earth Summit (Rio) in 1992. In the post-Cold War era (after 1989) Integrated Water Resource Management (IWRM), deliberated at the International Conference on Water and Sustainable Development in Dublin and issued as 'The Dublin Statement' in January 1992, informed water talks at the Rio summit later that year. IWRM outlined general guidelines for a more integrated, inclusive, systematic and sustainable approach to water governance. The developing countries of the world, of which South Africa now formed part, were taken into consideration in planning the new system of governance.

However, over the long-term, IWRM appeared to have been far too complex and excluded many countries of the world. There were developmentally challenged countries that grappled with poverty, underdevelopment and the absence of sufficient potable water supplies and basic sanitation. As will be discussed below, issues of water privatisation and neo-liberal economic policies asserted an influence on IWRM. The principle of sustainable development served as a guiding theoretical light in respect of the environment and humankind's responsible use of resources. The concept of sustainable development in the water sector would reach its peak at the time of the UN's World Summit on Sustainable Development (WSSD) held in South Africa in 2002.[48]

At present there seems to be a growing awareness in the water sector of a newly emergent hydraulic mission: the WEF nexus. In Western thought the concept

47. Van Vuuren (2013:51–80).

48. Turton (2003:130); Alexander (2002).

of 'nexus' dates back to classical Greek Stoic philosophy, but its use by A.N. Whitehead in his process philosophy of the 1920s, pointed to the nexus as the description of how minds and material structures can be understood in collections of actual occasions in time.[49] In effect, nexus speaks to our understanding of observable material changes taking place over time. In water sector governance the term is used to foreground dynamic broad spectrum thinking on material values, security and climate change.[50] Water is an intrinsic link that keeps a great variety of resources together. In fact, its responsible management provides an enabling environment for vital resources to be used in typical social ecological settings.[51]

The nexus has been foregrounded as part of a rethink on IWRM in the international water sector.[52] The preliminary strategy came under discussion in the international water sector in the early 2010s. In preparation for the UN's 2012 Conference on Environment and Development (UNCED) in Brazil – also known as Rio+20 – the WEF nexus was discussed the Bonn 2011 Conference: The Water Energy and Food Security Nexus – Solutions for the Green Economy. It marked a new international approach to water governance.

Notable in the plans were definitions of new challenges and new solutions for water management.[53] These included a greater emphasis on resilience, while still maintaining the basic tenets of sustainable development, in contemplating water in social ecological contexts. After the 2012 Brazil summit the international water sector came to a consensus that in the process of planning and deciding on investment landscapes and the concomitant risk management, three stages required attention. In the first stage, in an assessment of the WEF security system, three sub-sections of importance were singled out, of which the second is important for this discussion. Subsection two is a focus on past stresses and adaptations, where there is an acknowledgement for the need to put our understanding of history to good use, because:

> [*A*] broader historical analysis is necessary to understand the regional landscape with respect to how it has changed over time, as well as why and how stakeholders have adapted to change – and were drivers of change themselves – in the context of water, energy and food security issues [*as well as other significant issues*].[54]

It appears as if there are water sector groups with a keen interest to learn from the past. It is heartening to note that in fields such as the natural sciences and technology studies, there is an interest in and demand for the dusty information

49. Senchuk (1999:971–974).

50. Schmidt (2017); Allan (2011).

51. Swatuk and Cash (2018).

52. Muller (2015:675–694).

53. Bizikova et al. (2013:5).

54. Bizikova et al. (2013:16).

historians extract from archives and almost forgotten repositories that became redundant after the Information Technology (IT) and computer revolution that began in the 1960s.

This study takes cognisance of the WEF nexus, specifically in the period 1910 to 2008. Therefore the hydraulic mission concept is linked up with traces of the WEF nexus that manifests at numerous points over more than a century of South African water governance. There is no doubt that a more comprehensive and longer trajectory of potentially 3.2 million years before the present (yBP) should ideally be taken into consideration for our long-term understanding of the historical dynamics playing out in southern Africa, in order to shape the ideal local, regional and national hydraulic mission. Aspects of the discourse have been explored,[55] but they need to be integrated into the bigger picture.

Resilience and panarchy[56]

As a rule, historians tend to refrain from excessive theorisation, preferring to interpret the past in qualitative contexts, without forcing a corset of analytical thinking on the reader's personal interpretation of what transpired in the past. However, the author has been working extensively in transdisciplinary water-related research since the mid-2000s. Consequently, an attempt is made at incorporating some natural science ideas into this study. It is of relevance in respect of our understanding of resilience and the historical implications of what some scientists prefer to describe as the phenomenon of emergence.

Central to the understanding of resilience theory in this study is the concept of panarchy – outlined in a pioneering study of Gunderson and Holling and other researchers in the early 2000s.[57] Panarchy is defined in a variety of ways. According to Holling it is intended to 'capture the way living systems persist and yet innovate'. It is a concept that by working in various scales of size, shows how ecosystems, through evolution, can change. At the same time it shows how events and processes can 'transform humans and their societies through learning of the chance of learning'.[58]

The roots of panarchy can be traced back to the 19th century, a time when in Europe the concept of anarchy was fashionable. Emille de Puydt (1810–1891), a Belgian botanist and philosopher, published an article in *Revue Trimestrielle* in which he applied panarchy theory to social and political relationships. It was for him a descriptor of space for economic competition. It is a space with choices and decisions that determine how people function typically in society.[59]

55. Tempelhoff (2016b:121–159).

56. For a more comprehensive overview see Tempelhoff (2016a: 91–112).

57. Gunderson and Holling (2002).

58. Holling (2004).

59. De Pruydt (1860).

The biological thinking that informed panarchy has resonated well in seeking ways of understanding human society. There is acceptance for the diversity of ecological systems and multiple systems of order and disorder that can exist side by side in nature and also in society. Moreover, it becomes evident that panarchy is not exclusively a result of the workings of humankind. There is also a dynamic ecology within which humans form part of a rich cultural biodiversity.

Panarchy brings into play the infinite characteristics of constant change that are evident in nature. There is little equilibrium and frequent change takes place over short or extended periods of time. A 'flip' in the natural cycle can restore a former ecological state, or it can abruptly change it, leading to a state of collapse. Ultimately the objective of environmental scientists is to comprehend the complex processes contributing to states of increased activity, productivity, conservation, collapse, and restart, followed by an upwards trend in the consumption of the available resources in an ecological system. An appealing feature of panarchy is that it becomes possible for historians to consider the dynamics of fast and slow and cross-scale interactions as well as the interdependency of social ecological systems.[60]

In short, there is space for innovative idiographic thinking that has the potential to override nomothetic thinking in processes of interpretation and analysis.[61] Interdisciplinary theorists single out the strength of panarchy as a tool for studying social and ecological systems and finding the opportunity to understand a historical event 'more organically'.[62] From the outset it is accepted that cycles take place on different scales and at different times. Furthermore, there is no distinct or predictable outcome at all times. Too many external and internal dynamics have a profound influence on the way change takes place.

In a panarchy cycle there are essentially four phases (further represented in Figure I.1.):

1. exploitation (Γ)
2. conservation (K)
3. release/creative destruction (Ω)
4. reorganisation (α).

The cycle is key to understanding the process of adaptation.

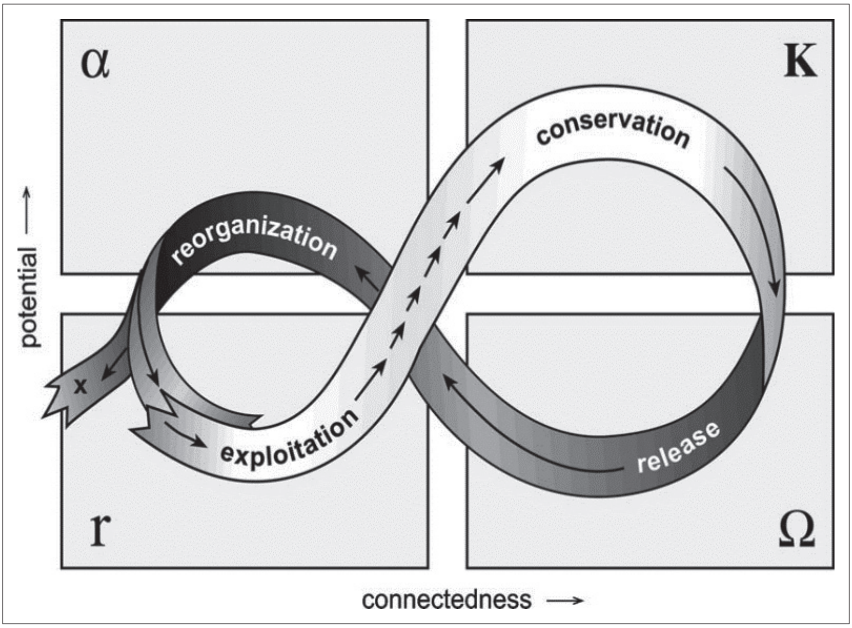
In panarchy, ecological and social ecological systems tend to form nested sets of adaptive cycles as demonstrated in Figure I.2. The larger cycles are slower and constrain the faster ones. They also tend to maintain integrity, whereas the faster cycles become unpredictable and trigger off responses that may give rise to revolt.[63]

60. Folke (2006:258).

61. Krohn (2010:33–34).

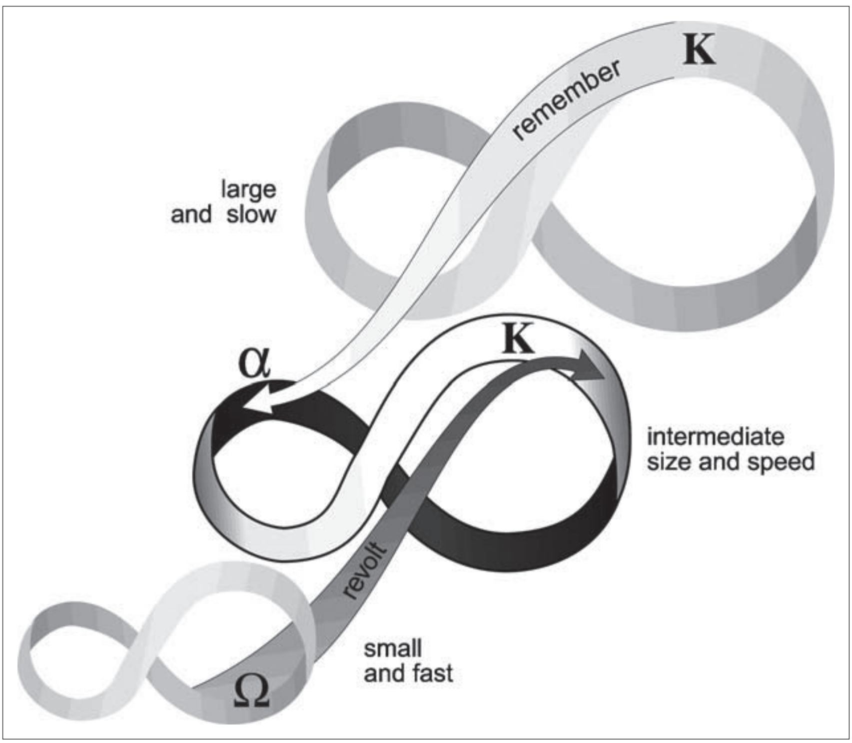
62. Weeks, Rodriguez and Blakeslee (2004).

63. Gotts (2007).



Source: Based on Gunderson and Holling (2002) and Gary (2011:49).

FIGURE I.1: The basic infinite set of phases in the panarchy cycle.



Source: Based on De Pruydt (n.d.). Reproduced with permission from Island Press, Washington D.C.

FIGURE I.2: Holling's panarchical connections.

For historians, panarchy is reminiscent of modern cyclical historical theories that have relied on ancient myths and mythology discourses, [64] and, since the 17th century, on comprehensive systems outlined in the works of Giambattista Vico,[65] Benedetto Croce,[66] Oswald Spengler,[67] Pitirim Sorokin[68] and Arnold Toynbee.[69]

Cyclical theory that ends in discourses of collapse has featured prominently in recent times, especially in the field of end-time environmental thought and why states fail.[70] However, there has been a significant critique of conceptions of ecological collapse thinking in deterministic historical discourses. Jarred Diamond's *Collapse: How societies choose to fail or succeed* is perhaps one of the most popular environmental historical interpretations of collapse.[71] It also attracted considerable criticism. In contrast, taken at face value, panarchy[72] tends to shift from a survivalist discourse of collapse,[73] to resilience – which is far more useful.

Previously the historian would have made a concerted effort to steer clear of zero-sum game theory in the history of events – especially over the long term. In resilience thinking it makes sense to understand continuity. Panarchy, integrated with resilience, has the potential to open up areas of exploration for long-term thinking.[74] On the whole panarchy is a forward-thinking theory. Yet there is nothing preventing the absorption of historical thinking in the process of responding to the need for adaptation in the present time. Perhaps the important redeeming element of panarchy is the fact that it is by no means prescriptive. It merely provides a framework for comprehending singular and collective events in given contexts.

Up to the 1990s, environmental managers, as a rule, worked on the deterministic theoretical foundations of resource management. Many used sigmoid curve theory.[75] This approach strengthened the focus on an outcome

64. Kelley (2013:82–83).

65. Hutton (1972:359–367).

66. See Kracauer (1966:75–76).

67. Spengler (1922–1923).

68. Sorokin (1927:28–40).

69. Toynbee (1959:205–210).

70. Cline (2014); Acemoglu and Robinson (2012).

71. Diamond (2005).

72. Wuetrich (2002).

73. Butzer (2012:3632–3639).

74. Brand et al. (2013); Slaughter (1996:75–86).

75. Berges and Folke (2002:2654).

of 'collapse'. In panarchy the linkage between cycles featured in the front and back loops becomes what futurists describe as the 'two-stroke model of punctuated equilibrium [or equilibria]',[76] the latter being a theory of evolutionary biology that takes note of stasis in genetic evolution over geological time spans.[77] In many respects determinism and the compulsion to seek equilibrium becomes more pragmatic and sensitive to unique processes of change that never quite repeat themselves in the same way.

Front and back loop transitions offer attractive thinking paradigms for historians, especially when the driving forces suggest 'memory' and 'revolt'. It is here that change in time and space is manifest and there are distinct trends that contribute towards a better understanding of the way nature and culture interact. In the analysis of front loops it is possible to make predictions.[78] The constant forward-moving trend tends to capture stability in the process of exploitation.[79] If there is prudence in resource harvesting, the conservation K-phase can last over an extended period of time providing there are no events on the fringes causing debilitating disturbances.

If there are endogenous agents of change, the way in which influential agents in the dominant social ecology adapt and remain absorbed in the downward phase, determines whether it becomes a process of 'creative destruction'. Creative destruction, a term coined by Marx[80] and outlined by the economist, Joseph Schumpeter (1883–1950), suggests that change, in a social ecological system, for example, is never static. Economic life merely goes on in a social and natural environment, but in the process there are changes in the shape of the economic actions taking place. The changes are often the result of wars, revolutions, anthropogenically stimulated pandemics – and also natural phenomena, such as droughts, floods and earthquakes. But they are not prime movers.

The real game changers are frequently the new consumers, goods, new methods of production, transportation and/or communication, new markets, new forms of industrial production and the type of organisation created by economic enterprise.[81] Moreover, they are seldom central to most dynamic activities. The major changes often occur on the periphery of the core system. In July 2017, Bozzoli, a former neo-Marxist academic who subsequently entered politics, drew interesting comparisons between the way the mature Karl Marx

76. Gary (2011:49).

77. Eldredge and Gould (1972:85–112).

78. Holling (2004:6–7).

79. Gary (2011:49).

80. Elliott (1978–1979:148–169).

81. Schumpeter (1975:82).

interpreted creative destruction and the manner in which South African Marxists in the in the 2010s interpreted the concept. Bozzoli is of the view that Marx had seen the benefits of capitalism's production and the vital role it had to play in economic revival after times of collapse.[82] This discourse will come under scrutiny in the discussion of the period in South Africa's water history after 2009.

It stands to reason that institutions of knowledge are created where there are appropriate management strategies. In the context of this study, these are management strategies, for example, for the use of the water supply. This implies that ecological factors, such as the functional availability of water resources, shaped governance and management strategies. Polities, states and empires were shaped by emergent urban formations that were also directly informed by governance strategies in a variety of social ecological settings.

Panarchy cycle theory posits that the transition in the back loop is more unpredictable. It is where changes take place in a most marked manner.[83] When growth is halted, deep uncertainty explodes. At this juncture, several alternative futures come to the fore. The variety of circumstances in the back loop represent conditions of crisis. At the same time, they hold potential opportunity. Holling explains:

> During a back loop, unexpected interactions can occur among previously separate properties that can then nucleate an inherently novel and unexpected focus for future good or ill in the next cycle.[84]

Unpredictability becomes master of the process. There is always the potential for small externalities to have major consequences. At the same time major events can have a minimal influence on change. Futurist thinkers on the environment suggest the back loop creates fertile ground for radical social innovation.[85] For the discipline of history, back loop thinking can broaden perspectives on deep historical trends. Historians primarily think in the past, but are increasingly becoming sensitive to the need for understanding the present and the future. For example, a focused and orderly approach to conserving the environment in terms of governance is a fairly recent innovation. It is said to have been as a consequence of the 18th century Industrial Revolution that by the 20th century created concerns about the state of the natural environment. This led to the realisation that environmental degradation might jeopardise sustainability.[86] Currently there is an acknowledgement that globally,

82. Bozzoli (2017).

83. Holling (2004:6–7).

84. Holling (2004:10).

85. Biggs, Westley and Carpenter (2010).

86. Haq and Paul (2012).

human societies have been instrumental in the process of a new geological epoch – the Anthropocene.[87] In more recent time there is a tendency to accept resilience thinking instead of conventional value-laden sustainability. The change in accent could lead to greater spontaneous social ecological awareness.[88] A focus on panarchy's back loop from a resilience perspective, provides valuable opportunities for understanding how uncertainty shapes social ecological systems under circumstances of radical change.

Adaptive management is the responsibility of institutions that have codified rules, laws and legitimacy within a social ecological system. They prescribe how society should function and what decisions should be taken.[89] At the same time adaptive management is notable for its inherent flexibility in method and conceptualisation. It begins with a simple 'learning by doing' and then progresses to rigorous systems with sound planning and experimental design, with a systematic evaluation process that makes it possible to monitor management. Adaptive management strategies are by no means 'new' approaches. In fact, in the 1990s pioneers of social ecological resilience research, many of whom helped in the formulation and development of panarchy theory, worked from strategies of local indigenous knowledge and the way customs shaped human thinking. At the heart of the system was an understanding of how to take care of ecological systems. For panarchy researchers it was evident that there were practices in conventional resource management, similar to those in traditional societies; practices that had been abandoned in conventional resource management but still formed part of traditional societies' thinking; and those that were both in conventional and traditional societies, but were no longer being observed in conventional management strategies.[90]

Naturally then, when ecologists refer to management and governance institutions, social ecological terms feature prominently. These, in turn, are steeped in laws, traditions, customs and codes of behaviour. In short, we have history and mnemonic consciousness. In fact, as social ecological systems thinking began to gain momentum in the early 1990s it was evident to Scoones that there was an increasing accent on people and places in analyses. There was acknowledgement of the role that history had to play in understanding change in time and space. Dynamic processes were seen at work in nonlinear interactions across hierarchies in systems analysis.[91] At the same time, greater significance was attached to temporal dynamics, on current patterns and

87. Waters et al. (2016).

88. Elmqvist (2015).

89. Resilience Alliance (2010:8).

90. Berkes, Colding and Folke (2000:1253).

91. Scoones (1999:483).

processes that provided better insight into paleoecology, evolutionary ecology and environmental history. Social mechanisms in traditional practices take care of local resources. They depend on local mechanisms that function in hierarchical patterns where knowledge flows from social institutions to mechanisms for cultural internalisation. In the process these interactions contribute to the development of worldviews.[92] These are clearly the result of historically evolved institutions where memory is directed towards management of the resources in the conservation K-phase. They are also informed by the knowledge acquired in the process of phases of creative destruction. Reorganisation in the back loop then provides new and novel approaches to finding solutions and optimising governance of the social ecological system.[93] The responsibility for nurturing the appropriate resources for effective use is then understandably the domain of the traditional leaders, who have acquired a historical consciousness of the way resources can be used effectively.[94] It is within this space that panarchical theorists conceive the seat of 'memory'.

Berkes and Folke see institutional memory in relation to resource use essentially as the memory of experience that provides a sense of context for the modification of the way resources are used.[95] Institutional knowledge also incorporates local or traditional knowledge. In addition they suggest that 'ecological knowledge' is a prerequisite 'for the management and sustainable use of resources, biological diversity and ecosystems'. By implication ecological knowledge seems to be seated in some type of memory. Thus, in view of the fact that they point to aspects of management, it implies that there has to be a sense of humanness about comprehending precisely what ecological knowledge is. They go on to explain that institutional memory (also related to resource use) has a bearing on the 'memory of experience' that provides strategies for the potential modification of resource use rules and regimes. We need the same type of thinking when we contemplate water and its intrinsic use.[96]

Although the elements of panarchy and resilience outlined above are not explicitly discussed in the narrative discourse of the study, they are by implication relevant to the reader when interpreting the historical narrative.

■ Outline of chapters

This study follows a conventional chronological narrative of events and developments. In some parts chronology becomes integrated with events

92. Berkes, Colding and Folke (2000).

93. Berkes, Colding and Folke (2000:1256).

94. Berkes, Colding and Folke (2000:1258).

95. Berges and Folke (2002:2610–2613).

96. Berges and Folke (2002:2610–2613).

preceding or following in sections still to come. However, a concerted effort was made to keep to a basic chronology in the meta-text and in the sub-thematic discourses interspersed in the text.

Chapter 1 deals with the period 1910 to 1924, notable for the merging of the four provinces into the Union of South Africa and the way the Department of Irrigation came into existence. The food–agricultural hydraulic mission was paramount in the government's planning and put the country's water resources to work in the interests of the country and its people. Attention is given to progress made in the Department of Irrigation and its operations, early forays into scientific research and surveys, and advances in the technology of modern irrigation. However, it was still an era when political discord between British and Afrikaner communities was responsible for creating a divided South Africa, with white ethnic cultural preferences overshadowing the status and empowerment of the country's indigenous peoples.

In Chapter 2 the focus is on drought and flood conditions as natural disasters, and attempts at finding solutions to the problem of 'aridity' – a line of thinking that dated back to a colonial discourse of the 1860s. Poverty was evident in many sectors of society. 'Poor whites' and Africans were marginalised following the colonial appropriation of land and mineral resources by entrepreneurial settler groupings, while indigenous peoples were estranged from the land on which they had lived and had been making a living for centuries. The technology of modern irrigation, most prevalent in the Cape Province, started making headway in the provinces of the Transvaal, Orange Free State and Natal. Although the government was a major investor in irrigation by making loans available to farmers on the irrigation schemes it set up, there were also significant private sector operations, whereby crop production was boosted and profits could be made.

In the mid-1920s as the 'Pact government' – a blend between proponents of Afrikaner nationalism and white working class interests – took over, the new government gave significant attention to uplifting the poor by drawing them into irrigation projects. Chapter 3 deals with the new government's Irrigation Commission and the way it informed political decision makers on the state of affairs in the country's agricultural sector. Government was aware of the need to address the problem of the so-called 'poor whites' in South Africa's rural areas. To gain better insight into dealing with the problem it applied the findings from research on poor whitism in South Africa that had been sponsored by an American philanthropic institution. Parallels were drawn with F.D. Roosevelt's New Deal in the US when, as a result of the worldwide economic depression, indigent labour was used for the construction of water infrastructure. Others were settled on land in the government's irrigation farming projects. The outbreak of the Second World War in 1939 brought significant changes, and by the early 1940s plans were afoot for promoting a hydraulic mission that supported industrial development.

Institutional changes in water sector governance followed after the unexpected election victory of the National Party in 1948. These are discussed in Chapter 4. Apart from introducing new water legislation for South Africa in 1956, the government embarked on a controversial policy of separate development (apartheid) that had major repercussions on South African society as of the mid-1950s.

In the 1960s, a time when the majority of European colonies on the African continent became independent, South Africa embarked on comprehensive water schemes to secure water in central South Africa. Chapter 5 explains how a new era began in dam construction. Despite South Africa's political isolation in reaction to its racial policies, it was possible for the water sector to make headway, with international partnerships bringing the country up to speed on the latest developments in water infrastructure construction and hydropower. The first inter-basin transfer systems started operations and South African water sector engineers conducted significant research.

Chapter 6 explores the 1960s against the backdrop of the devastating effects of drought. Although the greater part of the period was notable for typical natural disaster conditions, there is also evidence that the drought was caused partly by an extensive period of unsustainable development that had its origins in the 1950s. By this time industrialisation and urbanisation had the effect of polluting the country's water resources. In an era when the hydraulic mission was notable for promoting industrial development and energy (electricity) generation, government had to take measures to ensure that water supplies did not drop to dangerously low levels. Acting on the recommendations of a commission of enquiry into water matters in 1969, the government embarked on comprehensive innovations and expansion activities in the 1970s. Government became more centralised. The country's economy was buoyant, and government could afford to make investments that favoured the functioning of a productive and resilient WEF nexus.

Despite growing international opposition to the policy of apartheid, government persisted in its regional development plans to create 'homelands' for the various ethnic groupings in the country. Chapter 7 sheds light on how the Helsinki rules on interstate relations and water governance were employed to shape South Africa's relations with its local and international neighbours. Attention is also focused on the imminent development of computer technology and the way it began to transform the human landscape of work and planning in the Department of Water Affairs.

As South Africa became increasingly industrialised, partly as a result of a comprehensive electricity grid extending to all parts of the country, the demand for energy was of paramount importance. The energy crisis of the early 1970s, sparked by the Yom Kippur War of 1973 when the Arabic states of the Middle East began imposing embargoes on fuel supplies to many countries of the world, there was a new demand for locally produced liquid fuel (energy) from the state-initiated Sasol oil-from-coal industry in the eastern Transvaal. South Africa's water governance sector was able to avert the challenges posed by drought conditions and the industrial demand for a consistent and assured flow of water supplies. These issues are discussed in Chapter 8. In addition, attention is given to the introduction of pollution control, environmental awareness and growing pressure on consumers to accept reclamation of water resources as a future development path for South Africa. A notable feature of the 1970s and early 1980s in the water sector was the use of unconventional strategies in realising its industrial–energy hydraulic mission. Politically the government had to contend with the Soweto uprisings and the aftermath of the most serious major statement of African nationalism in South Africa since the early 1960s.

Chapter 9 explores the absorption of the Department of Water Affairs into a single department with the Departments of Environmental Affairs and Forestry. It was a short-term trend; one not favoured by the hard core of water sector workers, but it proved to be a valuable opportunity for the emergence of institutional environmental awareness in South Africa. In the mid-1980s government concluded an agreement with the government of Lesotho for the development of the Lesotho Highlands Water Project – one of the largest projects of its kind in Africa up to that time. While the department's operations were still firmly anchored in a well-structured and deterministic understanding of hydrology and civil engineering, there was significant growth in planning and research. A new system of state governance in pursuit of apartheid era goals proved inappropriate in the context of society's growing socio-economic and political demands both inside South Africa and beyond its borders. The department maintained its autonomy in the mid-1980s and its officials were able to continue their ground-breaking research despite South Africa's increasing political isolation.

By 1989, as the East-West ideological divide came to an end, white South Africa was well positioned to make a transition towards racial tolerance, and public statements were made on the transition to a new all-inclusive governance system, free of racial prejudice. Chapter 10 outlines the consequences of the economic downswing South Africa experienced from the early 1980s and the impact this had on the development of the country's water infrastructure. It is suggested in Chapter 10 that it was a matter of business as usual for departmental operations and planning. However, without a doubt the exogenous political landscape was changing rapidly.

The major driver for change in water governance in South Africa in the early 1990s was a serious drought that affected the rural areas of the country. For the first time attention was dedicated to previously disadvantaged communities who, in many cases, were provided with proper communal water supplies for the first time. These interventions were largely as a result of the deliberations that began between the government and the anti-apartheid organisations, as well as – notably – the leadership of the previously banned African National Congress (ANC). At the same time a comprehensive informal collaboration initiative, a SCOWSAS began its endeavours. The planning of the committee paved the way for a strategy to accommodate the growing need for water and sanitation services to all South Africans in a multiracial society. This is discussed in Chapter 11, along with the first steps towards integrating the emergent new South Africa's water governance sector with discourses in the international water sector.

Chapter 12 features an outline of the development of a social ecological hydraulic mission in which all South Africans would have the right of access to water. Greater attention was given to a more focused concentration in legislation and governance on the status of water in the country's ecological system. The chapter discusses how a growing sense of human rights influenced the formulation of ground-breaking water legislation for South Africa. Attention is given to the comprehensive changes in the Department of Water Affairs and Forestry and how a massive staff component of more than 30 000 officials had to be downscaled to operate within a financially viable context. It was also a period when South Africa's transboundary water partnerships blossomed. The Lesotho Highlands Water Project was under construction and agreements were made with Swaziland and other neighbouring states on the use and development of water resources. These developments paved the way for sound relations in a post-apartheid southern Africa.

South Africa's Department of Water Affairs and Forestry meanwhile also had to transform itself to function in a new and more transparent dispensation. Democracy was now the order of the day and the voice of stakeholders at grassroots level was heard when they spoke about their water and sanitation requirements. Government did what it could to respond to their call. Chapter 13 explains how, in the aftermath of the post-apartheid 'Mandela honeymoon' era (1990–1998) the businesslike approach of the new president, Thabo Mbeki, made the call for effective management and free market principles. However, this approach was unpopular with sectors of his own government and civil society organisations concerned with overcoming South Africa's historical inequities.

Chapter 14 foregrounds the voice and influence of civil society in the new democratic South Africa. It deals with matters ranging from a critique of large dams to the realisation of providing free water for the needy. It also looks at the issue of the early water and sanitation service delivery protests that emerged in a pronounced manner in the rural areas of South Africa. The country also made its mark in the international community by hosting the UN Summit on Sustainable Development in Johannesburg in 2002. The role water played in the deliberations and the way civil society shared its views with the representatives of governance, serves to map the way towards a different understanding of issues of water and sanitation.

In the final chapter, there is an attempt to interpret some theoretical themes and draw some pertinent conclusions on development trends in a transformed 21st century South Africa.

Section A

The origins of an irrigation–food hydraulic mission

Chapter 1

State consolidation and the conservation of irrigation water (1910–1924)

Introduction

The formation of the Union of South Africa in 1910 was a marriage of convenience for the British authorities who, after 1902, had a presence not only in the former colonies of the Cape and Natal, and the protectorates of Bechuanaland, Basutoland and Swaziland, but also in the former Afrikaner republics of the Transvaal and the Orange Free State. For the political leadership in the portion of southern Africa that was now part of the Union of South Africa, the consolidation meant the creation of a uniform system of governance.

The Union government resembled the British Westminster system, with a parliamentary legislative assembly, an upper house, an independent judiciary and an executive authority. The executive was headed by the prime minister and his cabinet and was responsible for the political oversight of government departments such as education, lands, agriculture and irrigation. The country consisted of four provincial authorities with reasonable executive autonomy at the regional and municipal governance level. The governor general was the

How to cite: Tempelhoff, J.W.N., 2018, 'State consolidation and the conservation of irrigation water (1910–1924)', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 27-61, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.01

titular representative in South Africa of the British Crown and worked in close collaboration with officials at Westminster.

In the discussion to follow, attention is given to the political dynamics of the Union of South Africa at the time of union in 1910, and the political and economic conditions – both within South Africa and beyond its confines – that shaped the emergence of a new state at the southern tip of the African continent. Developments in the water governance sector were closely linked to the politics of the day.

South Africa's water governance resided under the centralised Department of Irrigation. At the provincial level water governance increasingly came under the supervision of administrative 'circles' of governance and service delivery. The circles, discussed extensively below, were partly extensions of ecological river systems that crossed provincial and national boundaries, and required of provincial and local authorities – operating in river and irrigation boards – to respect the principle of sharing early 20th century conceptions of river catchments. The department acknowledged provincial and local government authorities, but relied on the legislative assembly to approve legislation on how the water resources of the country should be used. It was the legislation passed by parliament that defined how the Department of Irrigation and its subdivisions in the various provinces would operate in developing irrigation farming opportunities, while also controlling the development of water conservation infrastructure.

Union, in economic terms, meant that the abundance of natural resources of the country, along with innovative human enterprise, would in future generate sufficient tax revenue for the state to support the development of human settlements where industry could flourish and where there would be the necessary infrastructure in the form of roads, railways, energy and water resources.[97] Although mining was the rising star,[98] farming remained the prime role- player in the national economy, especially after unification, when the former interstate restrictions on trade in agricultural products started falling by the wayside.[99]

The prospects were good for the provinces to become beneficiaries of the country's mineral wealth. Mining created opportunities for commercial, financial, secondary industrial and urban development. But farming – producing food for local consumption and to export – was there for sustaining the economy in the early years of the Union. The rivers of the country that previously marked the boundaries between states and colonies, were now identified as

97. Department of Water Affairs and Forestry (1986a).

98. Solomon (1911:428).

99. Du Toit (1910:692).

the collective purveyors of valuable water resources in the new Union and new opportunities opened up.

In many respects, the largely semi-arid South Africa, destined to become one of the wealthiest countries on the African continent in the course of the 20th century, faced a significant challenge. It had to overcome substantial threats to water security. Part of South Africa's exceptionalism was the ability to address the ever-increasing demand for more water in one of the world's 30 driest regions.

In the second half of the 20th century, economic geographers determined that the 50 poorest countries in the world were situated in semi-arid regions.[100] Mining and industry in the world's semi-arid countries tended to compete for water supplies, while the value attached to the resource remained at a premium. For the greater part of the 20th century, these areas of competition became the creative spaces for sectors destined to drive South Africa's development into the future. It was the responsibility of the new Union government to provide opportunities for growth and development by securing copious supplies and governing this liquid wealth in a responsible manner.

■ The political dynamics of the Union and its water governance

The main political parties at the time of Union represented specific interests. The South African Party (SAP), led by General Louis Botha, came to power in 1910. It stood for introducing a cultural economy of British colonial and ethnic Afrikaner interests, seeking collaboration and mutual understanding in the interest of creating a prosperous unitary state. The opposition Unionist Party was inclined towards colonial sentiments and called for promoting strong relations between the Union of South Africa and the rest of the British Empire. Unionists tended to put their British identity first and then to relate their responses to government in the Union of South Africa, on strong, almost sentimental principles of British governance.

The early Union of South Africa was marred by controversial issues of white language and cultural rights. Botha excluded former Boer general J.B.M. Hertzog from his cabinet because of his outspoken statements against English-speaking South Africans and the strong exogenous capitalist drive for profit from the mines. The result was that Botha's SAP government lost significant support, and a growing number of Afrikaners shifted their support to Hertzog's National Party (NP), formed in 1914. As of that time, Afrikaners in most provinces of South Africa supported the NP and the party had a strong rural bias.

100. Grove et al. (1977:468).

In the urban areas the Labour Party (LP) tended to have significant support, primarily from working class British-born people who emigrated to South Africa to work in the country's mining sector and related industries. The stronghold of the LP was in the urban areas of the Witwatersrand in what was then the Transvaal Province. Among the political leadership of the country there was also a group of independents, who tended to be like the emergent ratepayers in municipal politics – seeking their personal interests as consumers of certain infrastructure services (water, sanitation, waste removal and power supplies) and making sure that they received value for the rates and taxes they paid to local authorities.

The South African National Native Congress (SANNC), founded in Bloemfontein in 1912, focused on securing African support by contesting the *Natives Land Act* of 1913, fearing that it signified their economic marginalisation. In line with the policy of segregation introduced in 1905 by the British authorities and applied throughout the Union by 1910, under the Act, Africans were technically unable to secure more farming land in areas controlled by the country's white residents, who were by far the minority of the population.[101]

The SANNC's membership consisted largely of intellectuals who had been exposed to Christian mission education and were engaged in economic activities that enabled them to gain the right to vote in the provinces of the Cape and Natal. Another party representing South Africans of colour was Dr Abdullah Abdurahman's African Political (later People's) Organisation, which drew its support from coloured people in the Cape and gave its support to all parties prepared to promote the interests of people of colour in the country's legislative, judicial and executive sectors of governance.[102]

At the time of the founding of the Union of South Africa, European-based capital interests in South Africa were pronounced. It was in the mining industrial sector that the economic growth of the country was seated. Farming interests were important, especially in the provinces of the Cape and Natal, but from the 1920s it was the mining industrial sector that increasingly shaped the political economy of South Africa.

In the urban areas of the Witwatersrand, the mineworkers who, prior to 1910, had been responsible for significant unrest, were strengthened by the LP under F.H.P. Creswell and Wilfred Wybergh. Working class Afrikaners, in the absence of a party to see to their interests, also gave their support to the LP and joined the extensive labour strikes in 1913.[103]

101. Beinart and Delius (2015:667–688).

102. Spies (1993:72–78).

103. Oakes (1995:298).

By 1914, the Afrikaners, both the rural communities and some of their urban brethren, united against Botha's SAP government. They questioned the government's authority to take South Africa into the First World War. This led to an unsuccessful uprising – the Rebellion of 1914 – by Afrikaners from the rural areas of the country. Having put down this rebellion, the government actively supported participation in the war.[104]

Politics and water governance

The politics of the Union's first decade shaped water governance. The state relied heavily on the farming sector. At the national level, in 1910 the irrigation department operated initially under the Ministry of Lands and Irrigation. Its first minister, Abraham Fischer, was a former premier of the Orange River Colony and supporter of Hertzog.[105] After Hertzog and Botha fell out there was a cabinet shuffle, with Hendrik Schalk Theron becoming the responsible minister for water matters. Theron was an Orange Free State mining engineer who had graduated at the University of Stellenbosch and later qualified at the School of Mines in London.

As Minister of Irrigation, Theron was responsible for steering the *Hartebeestpoort Irrigation Scheme (Crocodile River) Act*, 32 of 1914 through parliament.[106] It made provision for the largest dam and irrigation scheme in the interior of South Africa, specifically with the intention of uplifting so-called 'poor whites', mostly Afrikaners. For the Botha government the project, marred by a number of political issues, did not garner much support. As Hertzog's NP and its support of the nationalist cause grew in popularity, Theron, as was the case with many SAP politicians, fell by the wayside. He was not re-elected to parliament in 1915 or in 1920.[107]

In 1915, Hendrik Mentz, a legal practitioner and republican veteran of the South African War, who later served with distinction in the Union Defence Force in the South West Africa campaign of the First World War, was appointed as Minister of Lands and Irrigation. A staunch SAP supporter, in 1914 Mentz was at the forefront of rounding up Hertzog's rebellious supporters in the northern Transvaal who were opposed to South Africa's participation in the war.[108]

104. Tempelhoff (2006:4–5).

105. UG26/1911 (1911).

106. Union of South Africa (1952).

107. Krüger (1981:685).

108. Ploeger (1977:615–616).

In the water sector, Mentz is remembered for his key role in the first 'golden age' of dam construction in South Africa.[109] Of particular importance was an amendment he made to the *Irrigation Act* of 1916.[110] Despite tight financial conditions in the control of government spending, in 1917 Mentz was able to steer through parliament the *Irrigation Works (special loans) Act*. It made provision for loans to be extended to the irrigation boards of Kamanassie and Sunday's River in the Cape Province, a stronghold of support for the Botha government.[111] Meanwhile the Union's director of irrigation, who returned to the Department of Irrigation in 1917, immediately stepped in to oversee the improvements of the Cape's irrigation schemes.[112]

Mentz was also active in promoting water resource developments in the north. He was responsible for the amendment of the legislation of the Hartbeespoort Dam water scheme in the Transvaal. The new legislation (*Hartebeespoort Irrigation Scheme [Crocodile River] Act*, 32 of 1914, as amended by *Act 23 of 1918*) made provision for the construction of more irrigation works on the Crocodile River in the districts of Pretoria and Rustenburg.[113] However, the Botha government was unable to drive the completion of the Hartbeespoort scheme.

Botha died in 1919 and was succeeded by J.C. Smuts. Apart from playing an important role in British imperial politics, Smuts – a militarist and intellectual of note – had to deal with a post-war economic depression, increasing dissent in parliamentary politics, and a move away from seeking consensus on matters of South Africa's national interests. In 1920 and 1921 Smuts' SAP contested two tough elections to hold on to power. Ultimately the SAP and Unionist Party had to cooperate to retain control in parliament. The NP and the LP, especially after the Rand Strike of discontented mineworkers in 1922, gained significant support from the white miners. The workers stymied all attempts by the government and mining houses to prevent widespread strikes in the gold mining sector. The hard line approach taken by Smuts to deal with the strike later counted against him; the Afrikaans cultural establishment especially remained critical of Smuts.[114]

In 1920 the Smuts government tried hard to secure a popular politician to take charge of the water ministry. The Unionist Party's prime candidate was Deneys Reitz, son of a former Free State republican president, F.W. Reitz.

109. Hobbs and Phélines (1987:33).

110. *Irrigation and conservation of waters Act* 1912 and *Amendment Act*, 26 of 1916 (in Murray et al. 1952:415–417).

111. Union of South Africa (1952).

112. Isaacson (1977:473–474).

113. Murray et al. (1952:623–625).

114. Ludi (2016).

The younger Reitz was a veteran of the South African War who had served under Smuts in the Cape Colony, and later in the First World War. When he entered politics the atmosphere in South Africa was toxic. The Afrikaners in the Orange Free State and Transvaal resented what they considered to be a middle-of-the-road government. Reitz only took charge of the new Ministry of Irrigation and Agriculture in 1921. His route to the cabinet had been anything but easy.

After being ousted as representative for Bloemfontein South in parliament, in 1922 Reitz was elected as MP for Port Elizabeth – a pro-SAP stronghold. At the time, the number of water schemes under construction by the Department of Irrigation was by far the largest since the formation of Union, largely as a result of the preparatory work done by the former minister, Mentz.[115] In July 1923, the Department of Irrigation was re-integrated into the Department of Lands, an area in which Reitz was most knowledgeable and also influential.[116]

It is generally accepted that the 'first golden era' of dam construction came to an end between 1922 and 1923.[117] Political factors played a significant role in shaping the policies for the development of water storage facilities. In the early years, governance tended to restrain the development of the Union's water storage facilities. The persistent incorporation of the Department of Irrigation into different departments under various ministries, a common trend in the political governance of the country, required adjustments in the department's core focus. To some extent the shifts were the result of short-term expediency, but they were primarily the result of small cabinets and government's limited funding for creating more departments.

From 1922 South Africa drifted increasingly towards a conservative Afrikaner nationalist and white labour dispensation. Reitz remained Minister of Lands and Irrigation until in 1924 when the Smuts government was ousted by the National and LP 'Pact government' under Hertzog and Colonel F.H.P. Creswell.

The African population of South Africa

Although the African people of South Africa formed two thirds of the population, they did not play any significant role in the governance of the country. At the time of the 1921 census South Africa's population was recorded as being 6.9 million, with people of European descent representing only 21.9% of the population. About 56% of the white population was resident in the country's urban areas, where they were primarily active in commerce (104 000) and industry (102 000). Numerically, whites were far outnumbered by Africans in

115. UG8/1923 (1923:1).

116. UG14/1925 (1925:1).

117. SAWHAR ZKC (1986).

the farming, fishing and mining industries of the country.[118] But in the developing urban spaces whites had a majority.

The position of South Africa's indigenous people was precarious. The political capital generated after 1902 favoured white interests. Up to the 1930s South Africa was demographically considered to be a 'white man's country'.[119] However, the government and the imperial leadership in London remained sensitive to the 'native' population and the 'Dutch' of South Africa.[120]

After Union, for Africans the challenge was overcoming the obstacle of the *Natives Land Act* of 1913. This legislation confined them to small areas of land where they eked out an existence in what would become known as the native reserves. Many soon became strangers to the rural areas as they sought a future as labourers in the country's urban areas.[121] As the income from farming declined, African men preferred to enter the wage labour system and worked as migrant labourers in the mining sector to support their families, only returning periodically to their traditional rural homes.[122]

In the urban areas the policy of segregation, introduced by the British authorities in 1905, ensured that whites and people of colour had to be kept apart. The measure, a typical colonialist strategy for keeping people of colour outside the confines of privileged white colonial lifestyle, except as a source of poorly paid labour, prevented Africans from being integrated in white society.

In the rural areas Africans had limited water security and virtually no access to the modern technology of irrigation. Indigenous systems of irrigation – essentially leading water by means of slanted terracing and in wetlands – were not considered relevant by the authorities, largely as a result of the successful use of energy in modern irrigation systems that followed in the wake of the British and American industrial revolutions.[123]

African access to European irrigation technology was primarily confined to the missionary settlements where since the 19th century, irrigation had become a feature of communities of Christian believers.[124] In the early Union period there was limited support from the white authorities for indigenous irrigated farming practices.

118. Thorp and Thorp (1926:308–309); UG32/1912 (1912).

119. Dubow (2009:14).

120. Solomon (1911:429–432).

121. Schapera (1928:187–188).

122. Wickens (1983:61).

123. Tempelhoff (2008:121–160).

124. Bundy (1979:45–46); Casalis (1889:255); Grove (1989); Jacobs (1996:239–241, 2003:171–172); Endfield and Nash (2002:727–742).

Ultimately the free market determined the environmental affordances of the land for development in South Africa. The African presence on the land implied that labour as factor of production was readily available for the country's entrepreneurial groups to exploit. Although by far the majority of the country's population were Africans it was up to the people of European descent to make the key decisions on water governance.

Even more ironic was the fact that despite most farmers in South Africa being African,[125] they did not have a proportionally corresponding share of the land. Water was directly linked to land. As countrywide crop and livestock production expanded, Africans increasingly became marginalised. Some were able to hold their own in the 'native reserves' well into the 20th century, but this was mainly under communal subsistence circumstances.[126]

Promoting an agricultural–food hydraulic mission

At the time of Union, farming was the prime area of human industry in South Africa. The political drivers behind Union included new technologies that could promote agriculture in the country as a whole. The drive for a strong agriculture-based hydraulic mission made sound sense. There was an abundance of labour available in the country. Integrating labour with new farming technologies from the northern hemisphere, enabled the creation of an industrious society running on the energy of sufficient food supplies.

It was up to government and its engineers to take responsibility for the construction and development of water schemes and dams.[127] The prevalent mindset in the political and technical spheres of the country's water sector primarily associated water schemes with the agricultural sector. This mindset persisted well into the 1930s.

In 1910 the country's farming potential was still uncertain. It was a new dispensation in which politicians, officials and entrepreneurs had to resort to pioneering initiatives to determine the environmental affordance of a large biodiverse swathe of land in southern Africa. One firm priority was the need for human settlement, preferably in communities. Farmers had to be familiar with the water resources available locally, the nature of local soil, and the types of crops suitable for farming in their area.

125. Christie (1984); Feinberg (2015).

126. Mbongwa, Van den Brink and Van Zyl (1996:47–48).

127. Turton et al. (2004:156–157).

Experts argued that the right focus on the settlement process equalled out any distinctions between irrigation and dryland farming.[128] The prospects for comprehensive dryland farming operations in the Union were uncertain, but it did seem to be the most common form of production in which cereals and grain were the crops of choice. But even dryland farming required water, albeit in the form of rainfall.

In 1910 C.M. Stewart, secretary to the Union's meteorological commission, speculated that the average rainfall of the country was about 610 mm/a. It was evident South Africa was a country of variable rainfall, so he argued that it made sense for local farmers to emulate the dryland farming in the United States. Drought was seen as the prime threat, so farmers and engineers in the water sector had to be fully aware of drought conditions, their cycles, duration and the implications of flooding.[129]

The Union's director of irrigation was optimistic. Irrigation was one way for farmers to secure a foothold in the country's economy. The proviso was that they had to be prepared to work hard. The best and most experienced farmers, according to him, were resident in the Oudtshoorn and south-western districts of the Cape. Some of these farmers, he argued, could settle in the northern areas of the country and on a communal basis could inculcate the skills and practices of the latest irrigation technologies.[130]

In the Cape itself, the farming community had been critical of irrigation as the key to successful farming for some time.[131] However, there were influential pro-irrigation voices. W.A. Legg, supervising engineer at the Cape irrigation department, was of the view that it merely required proper legislation, better rainfall knowledge, the ability to put to use some local indigenous irrigation strategies (such as *zaaidams*)[132] and firm government support. And importantly, more comprehensive water storage facilities were essential to create better opportunities for irrigation farmers.[133]

The farming sector, in general, was optimistic and wanted to put the available water to the most advantageous use. The authorities were aware of the relative water scarcity and they advised livestock farmers to make impoundments to produce fodder for animals.[134]

128. MacDonald (1910:599–604).

129. Stewart (1910:552–554); Legg (1912:329–330).

130. Kanthack (1910:531–533).

131. Brown (2003:122, 126–129).

132. Uys (2008:xii).

133. Legg (1912:327–344).

134. Du Toit (1910:693).

Farming held considerable promise for the future. In 1910 the northern and eastern parts of the Orange Free State were the premier maize producing areas in South Africa with an annual production of 2.1 million bags, of which almost half was exported.[135] Within the next decade maize was even described to be the 'king of cereals' in farming circles when the country's production rose from 877 000 tonnes in 1911 to almost 1.4 million tonnes within a decade.[136] Some experts even propagated maize production as feed in sheep farming operations.[137]

Over more than a century, the Cape had built up the reputation of being sheep farming country. Adding the sheep farmers of the other provinces further enhanced South African sheep farming capacity. By 1911 the country's sheep population compared favourably with that of Australia and New Zealand.[138] Local wool production was at a premium, but the problem appeared to be having the right breeds to meet the demands of the market.[139]

Ultimately, the early identification of water as the prime driver of farming for food production formed part of an institutionalised way of thinking in governance circles. The Department of Irrigation's responsibility was to be of service to the farming sector. The technology of irrigation had to drive a hydraulic mission in which food – energy for humans and animals – was a prime component of the WEF nexus.

The *Irrigation and Conservation of Waters Act*

The *Irrigation and Conservation of Waters Act,* No. 12 of 1912 consolidated all the previous water laws in South Africa. There were numerous amendments over the years, but for the next four decades this legislation regulated the use of water in public streams; it provided the judicial machinery for dealing with the definition of water rights along public streams, the settlement of disputes, the granting of servitudes and permits, as well as some other matters regulated by the *Water Act*. In short, it laid the basis to promote the development of irrigation and the development of water conservation strategies in the Union of South Africa.[140]

The law stipulated that no person could 'own' the water in a public stream. However, it was possible to acquire rights to abstract water from public streams.

135. MacMillan (1910:14).

136. Bosman and Osborn (1924:83–86).

137. R. Solomon (1911:424); Burtt-Davy (1912:843–853).

138. Bean (1913:328).

139. McNab (1915:429).

140. UG2/1914 (1914:2).

Riparian owners of property had the right of access to water in public streams on the banks of their properties. The act embedded water courts. It also provided guidelines for groundwater supplies. Borehole technology made it possible to farm in the arid parts of the country. In terms of governance, the legislation made provision for irrigation districts, river boards and irrigation boards. Technically, it also made provision for normal streamflow water use, as well as for surplus water streamflows.[141]

Conservation of water

To all intents and purposes the responsibility of the irrigation department, as stipulated in the *Irrigation and Conservation Act,* No. 8 of 1912, was to deal with the conservation of water. This had a very narrow meaning. It implied water storage. In the water sector at the beginning of the century, the concept of water conservation had little to do with environmental conservation.[142]

In 1910, F.E. Kanthack, the Union's first director of irrigation, equated conservation with the need to save the resource in times of abundance, for times of scarcity. South Africa, he argued, because of its aridity, was unlike the 'parent' countries of the northern hemisphere where there was 'no need for irrigation and water conservation'. He was in favour of the state providing the most efficient water legislation which, while respecting existing rights to the fullest extent possible, had to be progressive and even, 'of a Socialistic character'.[143] Kanthack's 'environmental' inclination, which he articulated from time to time,[144] had a bearing on the conservation of the natural vegetation (not necessarily forests, but also plantations) in the mountainous regions of the country to ensure that water would accumulate and flow down streams in the valleys.[145] What he had in mind was that:

> Storage sites must be assiduously searched for and investigated, which may either benefit existing irrigation or form a source of supply for new irrigation [...] every effort must be made to discover the small local possibilities on each farm, be they in the nature of works for utilising flood water on lands or on the veld, storage works for irrigation and stock, or methods for the reclamation of the veld and prevention of sluits.[146]

The department's responsibility was to seek effective supplies of water, especially to the irrigation sector (farming interests) in the country.

141. Murray et al. (1952).

142. Brown (2002:77).

143. Kanthack (1910:537).

144. Kanthack (1908:200–201).

145. Kanthack (1910:537).

146. Kanthack (1909:18).

Importantly, drought conditions created greater awareness of the need to secure water storage facilities. In terms of planning, the department gave attention to the construction of dams in 1915–1916, as a result of emergent drought conditions. Although primarily intended for irrigation purposes, dam construction also allowed for the construction of water reservoirs; these were not exclusively for farming purposes, but also potentially for domestic urban water consumers, if and where possible.[147]

The early Union's water governance system

Grouping officials together in a single national water governance department was conducive to the dissemination of modern irrigation technology and basic governance know-how throughout South Africa, based on the experience gained in the Cape since the 19th century. Officials in the Cape irrigation department were not only experts in water management; they were familiar with the local hydrology and with the highly prized modern technology of borehole drilling.[148]

The water sector in the Cape was experienced in the management of water systems and progressive irrigation technology. Advanced technologies developed in the industrial revolutions in Britain and the United States of America formed part of the new dispensation. Industrial borehole drilling technology and modern wood-and-iron windmills used in the western Karoo from as early as 1876,[149] held great prospects for other parts of South Africa where surface water resources were scarce.[150]

In addition, the Cape had the best equipment to do the necessary work.[151] In fact, the passing of the *Irrigation Act* of 1906 in the Cape Colony was the impetus for government thinking on effective water use in a future united South Africa. The new legislation was informed by court decisions related to earlier legislation and took note of water courses both in the water-rich and in the arid parts of the Cape.[152]

The Cape's water governance was highly specialised. Since the 1870s, experts like J.G. Gamble served with distinction as the colony's first civil engineer (1875–1886). Apart from valuable meteorological investigations, he played a pivotal role in the development of water supply systems for

147. RP53/1988 (1988:2); Mäki (2008:80–90); Tempelhoff (2003:22–23).

148. Cape of Good Hope (COGH), CI/1903 (1903).

149. Walton (1974:155); Grobler (2011:80); Archer (2002:120–121); Noble (1886:233).

150. UG29/1925 (1925:6).

151. National Archives Repository Archives (NARA) (1916).

152. Hall (1947a).

several Cape municipal authorities, as well as the government water storage works at Brandvlei and Vanwyksvlei in the arid parts of the north-western Cape.[153] The Cape's advantage as a partner in the new Union was not only confined to its civil service. A number of modern and well-informed private sector farming operations were already operating successfully in the Cape Colony prior to union.[154] The other provinces had much to gain from a unified department.

Departmental operations

The director of irrigation in the Union was appointed by the governor general and he served under the authority of the responsible cabinet minister. The minister wielded substantial authority. He approved key management decisions, the department's expenses, and the appointment of all senior officials.[155] The director of irrigation, apart from being a highly skilled engineer had to have substantial local experience and the necessary managerial skills required for serving the policy objectives of the ruling party.

The former Cape colonial director of irrigation, F.E. Kanthack (1872–1961), became the Union's first director of irrigation – a position he held until the end of 1920 when he declined the opportunity to extend his government contract and instead went into private practice.[156]

Departmental staff

The organisation of the staff in the department in 1910 was compact, comprising a total of 34 people.[157] District staff was minimal. There were nine circle engineers and nine assistant engineers. In a manner of speaking, the department started as a 'one-man show'.[158] Kanthack was slow to expand his staff component. He was cautious of imminent conditions of economic depression and chose to keep the regular permanent staff in the department as small as possible to maintain stability, instead of having to deal with possible retrenchments.[159]

153. Brown (1877); Plug (2016).

154. Visser (2013:1–28); Brown (2003:122–129).

155. Mackenzie (1947:1–2).

156. Isaacson (1977:473); SAWHAR DH1 (1972:364).

157. UG26/1911 (1911:13).

158. SAWHAR WLC B574 (1986:2).

159. UG39/1912 (1912:1).

In 1911, the engineers and surveyors responsible for reconnaissance surveys were not on the regular staff. They only served on a temporary basis, and their salaries were paid from the funding allocated for the particular surveys in which they were engaged. However, soon there was growth in the department, largely because the Union government had more funds at its disposal for irrigation development than any of the former colonies.[160]

Section 5 of the *Irrigation Act* of 1912 made provision for the appointment of local staff and workers at the department's construction sites.[161] The number of clerical assistants in the department soon increased from 17 to 21 in an effort to improve the financial accounting services at head office. The department had to conform with the controls laid down by the auditor general.

Although the administrative circle offices also required the services of clerical assistants, there were not enough well-trained people available and this jeopardised the performance of the decentralised system of administration the department envisaged.[162]

From 1914 most of the senior officials appointed in the irrigation department were civil engineers[163] with a sound knowledge of hydrology[164] and extensive experience in systems of British irrigation, especially in colonial India and Egypt. However, although the department offered expert practical training, many of the best engineers chose to spend a brief time in the department before seeking opportunities in the more lucrative private sector.[165]

There was always a shortage of engineers in the circles. Each circle was supposed to have an engineer at the helm of operations and at least one assistant engineer, while two of the larger circles required a second assistant engineer. As a rule, a circle engineer such as A.D. Lewis in the Lower Orange circle had a working knowledge of local conditions and considerable experience in the field of irrigation engineering and managing his officials. Assistant engineers, in turn, were junior officials with limited practical experience but who generally had a keen appetite for securing this experience in the service of government.

160. UG26/1911 (1911:13); Kanthack (1924a:24).

161. Hobbs and Phélines (1987:33).

162. UG2/1914 (1914:1).

163. National Archives SAB (n.d.).

164. The first engineers were appointed in the Department of Irrigation on 01 July 1914. They were: George Powell Scott and Gardiner William Ranciman, both as engineers with a monthly salary of £35, William Daniel Cornwell as an assistant engineer with a monthly salary of £30 and George Walter Garnham Williams, both as surveyor with a monthly salary of £30.

165. UG39/1912 (1912:1–2).

Irrigation circles

The circles served irrigation interests and operated where there were government or private irrigation schemes and farmers who required water allocations for irrigation purposes. The Central Karoo and Natal circles each had one engineer by 1913. This was considered untenable and Kanthack personally worked on the appointment of at least one senior engineer at head office who could step in and take over to provide support.[166]

Governance remained problematic for the new department. Officials did not always have sufficient local knowledge and data at their disposal to make informed decisions and take the appropriate steps. Up to 1916, according to Kanthack, farmers usually dictated to the irrigation department where, when and how irrigation schemes had to be started up, but hydrographic and general reconnaissance surveys were expensive and preliminary investigations took a great deal of time. As a rule, they were only conducted after cooperative enterprises such as irrigation boards had been formed by groups of farmers. This meant, in Kanthack's opinion, that some schemes were developed that were not viable.[167]

River and irrigation boards

In Chapter 5 of the 1912 *Irrigation Act* the responsibilities of river boards were outlined, based on the *Cape Irrigation Act* of 1906. These institutions acquired significantly more power in terms of the *Transvaal Irrigation Act* of 1908. The river and irrigation boards did not always function well. To make the situation even more complex the transition to the new central government system in the Union was not seamless. Once the 1912 Act came into effect there were district power tussles, especially in the Transvaal. In contrast Cape irrigation farmers used the irrigation boards to establish cooperative schemes.[168] In the Transvaal these plans did not work. Large-scale irrigation was a new technology and farmers of the former Boer Republic hesitated to collaborate with their neighbours. In the northern parts of the country memories of the South African War (1899–1902) were still fresh in the minds of rural white communities.

Elsewhere in the country, river boards had the authority to do the following:

- oversee certain streams
- develop a system
- keep a register of servitudes
- protect the sources of certain streams
- take steps against water wastage

166. UG2/1914 (1914:2).

167. Kanthack (1924a:178).

168. Kanthack (1913:5).

- monitor unlawful abstraction of water
- ensure the protection of river embankments against erosion
- maintain fairness in the distribution of water supplies.[169]

In the Transvaal there was opposition and suspicion in the workings of these boards and most of them lapsed into varying states of dysfunctionality.[170]

In other parts of the country, irrigation boards and districts functioned more effectively and even appeared to curry favour with both the department and water users.[171] In 1913 the department had 37 irrigation districts on its register of which 30 had been approved and the remainder were either in a phase of development or preparing an application for registration. With the exception of the proposed irrigation districts of Klerksdorp (in the Potchefstroom district of the Transvaal) and Zoutpansdrift (in the Boshof district of the Orange Free State) all the irrigation districts were situated in the Cape Province.[172] The Klerksdorp irrigation reservoir was officially opened on 01 July 1916 as an extension of the first irrigation works established by the Transvaal colonial irrigation department after 1902.[173] This development held the greatest promise for the development of an irrigation board.

After the First World War, the department created a post for an inspector of irrigation boards,[174] because the number of irrigation districts and boards was increasing. Between 1922 and 1924 the number of irrigation boards rose from 84 to 95 for South Africa as a whole. A further 11 entities were under consideration in the course of 1924.[175] The growth of river districts and boards was somewhat slower and less consistent, with the total standing at five in 1924.[176]

Impact of the First World War on the department

When the First World War broke out in 1914 the Department of Irrigation was thrown into turmoil. A number of officials signed up to participate in the war effort. Kanthack was appointed special commissioner for transport, remounts, and mechanical transport in the defence force. In the interim, the Orange Free State circles merged and became known as the Swartberg circle, now including

169. Legg (1912:333).

170. UG12/1914 (1914:10).

171. UG12/1914 (1914:10).

172. RP53/1988 (1988:52).

173. Anonymous (1916b:5).

174. UG32/1921 (1921:1).

175. UG25/1926 (1926:2).

176. UG8/1923 (1923:2); UG25/1926 (1926:13).

the whole of the Gourits River and the important irrigation districts of Oudtshoorn and Ladysmith. However, the circles were clearly too large and were difficult to administer from distant headquarters. Natal proved problematic and was consequently incorporated into the southern Transvaal circle.[177] A notable trend was that the administration and management of the circles were increasingly influenced and shaped by local political forces.

The department was in shambles when Kanthack reported back after his spell of active duty in the war effort. He pointed out that the number of irrigation circles was '[...] maintained theoretically at nine', with certain alterations made to their boundaries.[178] By the 1920s there appear to have been only eight (Figure 1.1). With the exception of officials of the borehole drilling branch, who had been on active service outside South Africa, most officials returned to their positions at the conclusion of hostilities.

Rapid development of irrigation schemes

It soon became evident that the rapid development of irrigation schemes meant that the department would have to appoint more qualified engineers and clerical staff. In addition to the construction of new schemes it was also necessary to undertake maintenance of existing schemes. The era of the Mentz ministry (1915–1922) saw substantial growth in the department. However, in the early 1920s there was a significant decline in the number of employees, which circle engineer A.D. Lewis ascribed to the shortage of labour at the end of the First World War. By 1924 it was evident that many of the department's workers had been attracted to the private sector.[179]

By 1922, despite serious economic recessionary conditions, the department was active in a number of irrigation board areas, upgrading storage facilities and improving canals that served local farming communities (Figure 1.1). Local irrigation boards collaborated with the department's officials to improve the schemes under their authority. Ongoing improvements were made in the management of operations in the Blyde River (Pearston); at the site of the future Bon Accord Dam near Pretoria; the Breede River conservation scheme at the Brandvlei Dam; the Great Fish River conservation project at Grassridge and Kamanassie in the area to the south of Bloemfontein; at Leeuw Gamka where the canal system was upgraded; and on the Sundays River where extensive work was done on sluice gates and plans were developed to combat flooding.[180]

177. UG19/1918 (1918:5).

178. UG19/1918 (1918:5).

179. UG19/1918 (1918:2).

180. UG8/1923 (1923:35–38).

Source: Map by Suzan Laubscher, North-West University (SAWHAR, PRC 1987:21).
FIGURE 1.1: Identifiable circles of the irrigation departments in *c*. 1920.

Loans to the farming sector

An important service provided by the irrigation department was granting loans to bolster irrigation farming in South Africa. The legislation of 1912 made provision for funds to be managed by the director of irrigation, operating under the oversight of the responsible minister. Although the *Irrigation Act* came into effect in 1912, it was only between 1913 and 1914 that loans first became available throughout South Africa. In the course of the year, 200 applications were submitted, of which 103 were approved, to the combined value of £369 794. As a result of the outbreak of war in 1914 no further loans were made available. Only 47 loan applications, valued at £109 710 were approved in the interim, while in the period 1914 to 1916 only 11 loan applications were approved. Drought conditions, especially debilitating in the Cape Province from about 1914, tended to restrict the willingness of the state to extend loans for irrigation schemes. By 1916–1917 the department once again opened up to servicing loan applications and received 152 applications, whereupon £177 075 was made available for new irrigation farming operations.[181] However, whereas in 1906 the original interest rate for irrigation loans was set at 3.5% p/a, in 1912 the rate was raised to 3.75% with the introduction of the new legislation; in 1916 it went up to 5%.[182] The rise in interest rates on loans was not conducive to farmers embarking on an irrigation growth path. Post-war recessionary economic conditions into the 1920s also tended to stifle government loan spending on the irrigation sector.[183]

Groundwater and technology

Subterranean water supplies in the Union of South Africa came into the discourse regarding the country's water supplies directly as a result of the *Transvaal Irrigation Act* of 1908, which addressed the issue of the dolomite formations in the central and southern Transvaal that stored considerable amounts of water.[184] Providing the technology for borehole drilling was a key strategy used by politicians to promote the formation of a united South Africa. By making government subsidies available, the farming communities living in these parts could gain access to crucial water resources.[185]

Drilling boreholes also provided valuable geological information on the mineral deposits and groundwater resources in the northern parts of South Africa.[186] Apart from informing plans for future mining, the department kept records to gain a better long-term understanding of the country's groundwater resources.[187] At the time of Union in 1910 it was known that there were substantial groundwater in the Transvaal and the Ghaap Plateau near Vryburg and Kuruman in the Northern Cape.[188]

The 1910s borehole rush in the northern parts of South Africa was similar to what had happened in the Cape in the 1890s.[189] In May 1910, there were 31 drilling machines in operation in the Transvaal. That year the rrigation department's drilling teams sank 376 boreholes, with a collective depth

181. UG19/1918 (1918:32).

182. UG19/1918 (1918:32).

183. UG8/1923 (1923:1).

184. UG2/1914 (1914:5).

185. UG39/1912 (1912:45).

186. Mellor (1915:57–71); Draper (1912:90–93); Du Toit (1916:1–13); Horwood (1912:77–80); Hall (1921:98–110); Mellor (1922:1–22).

187. Midgley (1949:119).

188. UG2/1914 (1914:5).

189. Van Sittert (2004:915–937).

of 17 000 m. The average daily yield was more than 100 000 L. Most boreholes – 337 out of 376 – were for farmers. More requests by farmers kept rolling in. By 1911 drilling teams were busy in all districts of the province, with the exception of Piet Retief and Barberton.[190]

The Department of Irrigation had to stop the government subsidised drilling programme when the office of the auditor general queried the drilling being subsidised for only one of the country's four provinces.[191] Then followed an official notice to the effect that the government drilling service for boreholes would no longer be subsidised. Kanthack, as director of irrigation, favoured a policy that would provide such services for farming communities throughout the country, not in terms of demand in the individual provinces, but rather in terms of the geological nature of the particular terrain.

He argued there were three primary geological areas in the country, each requiring dedicated attention. They were:

1. the coastal folded belt
2. the Great Karoo, consisting of the central part of the Cape and the larger part of the Free State
3. the geologically older area situated to the north of the Karoo, embracing the north-western Cape – specifically the districts of Namaqualand, Kenhardt, Carnarvon, Prieska, Gordonia, and Griqualand West – as well as Bechuanaland and the whole of the Transvaal.[192]

The department was eager to introduce a uniform policy throughout the country.[193] In terms of Government Notice, No. 691 of 1911, drills could be hired in the Transvaal as well as in the Cape, where there was a distinct focus on securing groundwater supplies in the more arid areas. These included Mafeking, Vryburg, Kuruman, Hay, Herbert, Kimberley, Barkly West, Gordonia, Prieska, Kenhardt and Namaqualand. Kanthack favoured extending the drilling opportunities to places such as Van Rhynsdorp, Calvinia, Sutherland, Fraserburg, Carnarvon, Laingsburg and Prince Albert.[194] In the Transvaal, the districts of Rustenburg, Soutpansberg, Marico and Bloemhof proved good for drilling because of their vast quantities of groundwater.[195]

190. UG39/1912 (1912:47).

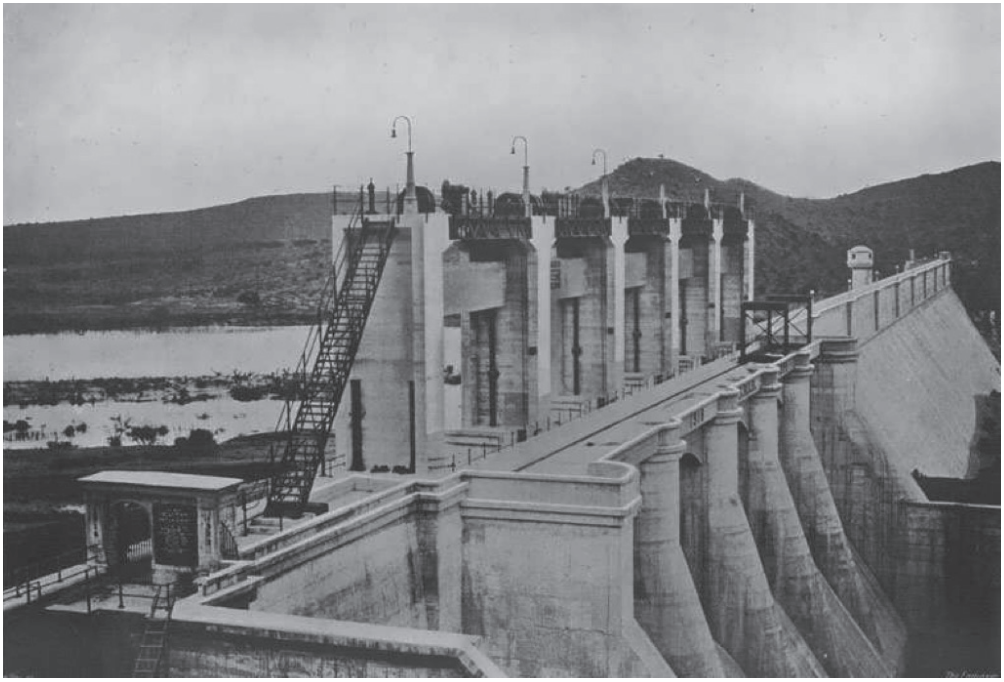
191. UG26/1911 (1911:8–9).

192. UG39/1912 (1912:46).

193. Appendix C: Government Notice No. 193 of 1911, in UG39/1912 (1912:45–46, 66–68).

194. UG39/1912 (1912:47).

195. UG39/1912 (1912:48).



Source: Illustration of the then recently completed 'Lake Mentz' (The Engineer 1924:122).
FIGURE 1.2: Lake Mentz, completed in 1924.

Drilling and pumping technologies

The development of mechanised borehole drilling was evidence of the growing importance of technology since the British Industrial Revolution in the 18th century. By the 19th century similar trends spread from the European mainland and the US to the parts of the world colonised by European states. A variety of technologies reached the shores of South Africa by the early 20th century. By the mid-1910s windmills were being used in the Transvaal to irrigate crops, so boreholes were much in demand.[196]

However, there were severe constrains to technological development. For example, after the First World War it was almost impossible to secure equipment from Britain or the United States. The irrigation department's officials had to make do with refurbished and second-hand equipment that was locally available, such as building materials and technical equipment at the dam construction site at Lake Mentz in the Eastern Cape (Figure 1.2).[197]

Meanwhile the borehole drilling trend in many parts of the country stimulated the demand for new technological innovations. In 1913, the irrigation

196. Cleghorne (1915:148–150).

197. Venter (1970b:315–316).

department's drilling section started moving away from using diamond drills. It was considered too costly and ineffective for the type of drilling necessary for locating water resources. The company of A. McNamara, a Canadian engineer resident in South Africa since 1895, produced the McNamara chilled shot drill, which proved ideal for local conditions.[198]

The McNamara drills seemed popular, as were the No. 3 and 23 Star Percussion drills. There were also a number of combined shot and percussion drills in use by the Department of Irrigation.[199] In the field of pumping groundwater there were also local innovations. By the early 1920s Gearings Limited of Cape Town proudly advertised their steel windmills of entirely 'colonial manufacture', produced at the firm's Atlas Works in Cape Town.[200]

The early drilling machines used by the department relied on steam boilers for generating energy. Finding timber for energy proved to be a problem in some parts, as was lack of water for the steam boilers.[201] In 1924 a mechanical engineer, J. Donnelly, reported on the technology of centrifugal pumps and how internal combustion engines could be used as an efficient and cost-effective source of energy.[202] There was consensus on the purchase of one of these engines for use in the dry northern districts of the Cape Province. Experiments with drilling and borehole equipment were ongoing. In the eastern Transvaal in 1923, irrigation technology experts even speculated on the potential of introducing gas engines for local irrigation and drilling operations.[203] However, because of financial constraints after the war, the adoption of these power sources remained slow. Of the 86 drilling machines being used by the department in 1924, more than 90% (78 drilling machines) were still steam-powered.[204]

The culture of the drilling teams

In the course of the 20th century government drilling teams were working in many parts of the country. They became a distinct itinerant breed with a pedigree dating back to the 1880s in the Cape Colony, when the first qualified British drill operators and mechanics arrived from overseas to operate the first

198. Agricultural Journal of South Africa (1916a:51–53).

199. UG2/1914 (1914:72).

200. Advertisement (1921:74).

201. UG39/1912 (1912:48).

202. Donnelly (1924:84–86).

203. Agriculture Journal of South Africa (1923).

204. UG25/1926 (1926:17).

borehole drill in the public works department.[205] One of the main problems in the South African setting was the shortage of skilled drilling foremen. In 1913, the department had 62 drill foremen, 10 assistant foremen and about 200 African workers, to service the whole country.[206]

As a rule, farmers requesting borehole services were not wealthy. On the contrary, most were relatively poor and there were those who were unable to pay for drilling activities.[207] Many lived in parts of the country where the land was of relatively low value; living conditions were harsh and isolated – far away from urban markets. Yet, apart from a slight decline in the early 1920s, the department continued to respond to requests from farmers for drilling activities in the sparsely populated and relatively inaccessible regions of South Africa. The desolation posed problems too, making the repair of broken equipment slow and costly.[208] Drilling remained a risky venture and securing water was by no means a foregone conclusion.[209]

Departmental work for municipalities

Before Union, the Transvaal's irrigation department helped out with two water schemes in the municipal areas of Vereeniging and Pretoria. At Vereeniging, the department helped the municipality complete its water supply system at a cost of £4700. Certain parts of the project were completed by the municipality, or contractors were hired to do the work.[210]

In Pretoria, after a particularly severe 1909 flood, the department started a project to build cement canals in the Apies River, a project completed in 1912.[211] An amount of £50 000 was set aside by the government to finance the construction. The Department of Irrigation was instructed that the work on this project was to be carried by white labourers resident in the municipal area. However, it proved difficult to locate suitable (indigent) white workers and the Department of Irrigation finally, in an effort to get the work done, handed the project over to the Pretoria municipality.[212] Whites chose to seek jobs in urban areas where they could earn more money. Those who could not find work in industry and trade, seldom chose to work for government construction projects.

205. Venter (1970a:291–296).

206. UG2/1914 (1914:72).

207. UG39/1912 (1912:49).

208. UG25/1926 (1926:16).

209. UG39/1912 (1912:48–49).

210. UG26/1911 (1911:7).

211. Haarhoff, Juuti and Mäki (2012:780).

212. UG26/1911 (1911:7).

After Union, the Department of Irrigation tended not to meddle in engineering issues in the larger municipalities. If they needed assistance in water-related management problems they had to make use of civil engineers in the private sector. However, the department was inclined to provide assistance to smaller municipalities that were unable to afford the services of consulting engineers. One such example was in 1901 when the department helped the local municipality with the Wolmaransstad Dam project. Unfortunately, by 1911, although the dam had filled up, there was no satisfactory development of the surrounding land. It transpired that the government had not yet transferred a large number of erven to the municipality.[213]

By 1911, most of the work done by the department for rural local authorities was in the Cape Province. The Department of Irrigation increasingly applied the principle that it would provide professional advice to provincial authorities, but the work had to be implemented by private engineers. It would, however, make an exception to the rule in the case of small local authorities that were unable to afford professional engineers in private practice.[214]

In 1911, in addition to the appointment of a mechanical engineer, the department also appointed an engineer, T.W. Stainthorpe, to take responsibility for sanitation and municipal affairs. This was not considered a specialised post because most engineers were familiar with the nature of municipal management. In the case of Stainthorpe, the department secured the services of a professional colleague who had a thorough knowledge of the Cape health department and who was also familiar with the provincial public works department.[215]

As for Natal, after 1910 the department had to provide special support at the provincial level. Prior to Union there had never been an irrigation department in Natal.[216] In fact, irrigation matters fell under the office of the surveyor-general.[217] What did exist seemed to focus on a few small urban settlement water supply services.[218] The *Village Water Supply Act*, 19 of 1897 was revised by Act 16 of 1908. In essence, after 1910 these acts empowered the governor general to give instructions for the development of water works in small towns. It was also possible to levy rates for the services rendered. If and when village boards became municipal authorities, the water works would be transferred to

213. UG26/1911 (1911:7).

214. UG26/1911 (1911:35).

215. UG39/1912 (1912:4).

216. UG39/1912 (1912:1); Hall (1947a:6).

217. UG26/1911 (1911:1); Hobbs and Phélines (1987:31).

218. UG2/1914 (1914:47–48).

the new local authorities on the understanding that they would pay for the costs incurred for the developments.[219]

After unification, many of the powers of the governor general were transferred to the administrator of the province, who then requested funding from central government. Until 1913, the most expensive project in Natal supported by the Union government was for the water supply to Stanger, which took its water from the Umvoti River. The irrigation department also carried out smaller public water supply works for Richmond and Stuartstown.[220]

The department provided advice, especially during Kanthack's time (1910–1920), but only if it was possible to charge a consulting fee. In the case of municipalities in the rural areas, the department provided substantial services and even loans if necessary. The construction of the municipal dam in Victoria West was one example; once the project was under way the government made a loan of £24 000 available.

After the First World War, there was close collaboration between the irrigation department and the Department of Lands in supplying water to a number of urban settlements in the rural areas. In the case of Lamberts Bay on the Cape West Coast, at the request of the Department of Lands, the irrigation department stepped in to secure water for the local fishing industry and some residential areas. At Leydsdorp in the north-eastern Transvaal Lowveld, a windmill and pumping equipment were installed, with a drinking trough for livestock. At Kopjes, in the Orange Free State, where the department was responsible for the local irrigation system, its officials laid on water supplies for domestic and industrial purposes. Furthermore, between 1919 and 1920, in a number of Transvaal settlements, the department installed hand pumps at 140 boreholes at an average cost of £30 per complete pump.[221]

In many respects the system of municipal government that emerged in the early 1900s was based on the principle that the free market could afford the upgrading of water infrastructure in urban areas. However, in respect of the African populations resident on the periphery of the urban settlements, it was the responsibility of the native affairs authorities to supply rudimentary services for the areas where no rates were levied because of the low economic status of the residents. The African residents as a rule would have access to communal hand pumps or windmills, drawing groundwater where boreholes had been sunk. In rural towns, residents dug wells on their small plots of land to secure a supply of water.[222]

219. UG39/1912 (1912:50).

220. UG39/1912 (1912:50).

221. UG32/1921 (1921:17–18).

222. Ginster et al. (2010: 6–11); Mäki (2008:5–6).

By the 1920s, after A.D. Lewis became director, the nature of the work done for municipalities changed substantially. For example, in 1924 the geological division of the department gave advice to the municipalities of Durban (for the Shongweni Dam) and the municipal authorities in Ermelo and Molteno. The department also assisted Vryburg municipality in the evaluation of tenders it put out for work, and gave advice on the town's water pipelines. At Knysna the department worked on the town's turbine pumps.[223] The standing Irrigation Commission in the 1920s also advised the government on the legal aspects of an agreement between the municipality of Pretoria and the government to extract water from the Hartbeespoort Dam.[224]

Service to industry

The department's responsibilities in the service of the country's industry at the time of Union were limited. In Section 21(1–5) of the *Irrigation and Water Conservation Act*, No. 8 of 1912 reference is made only to support for the administration of railways and harbours,[225] as well as a restriction, in Section 22, on granting permission to develop water power.[226] The department was an example of the way the economy of South Africa was structured. Industry per se was directly associated with the farming sector. However, it became increasingly evident that in the wake of the country's mining revolution, manufacturing industries would coincide with rapid urbanisation and the demand for locally manufactured products.

On the Witwatersrand, the country's mining sector had considerable development potential. In 1903 the colonial authorities, the municipality of Johannesburg, and the Chamber of Mines joined forces in the establishment of the Rand Water Board, a water utility to provide bulk water supplies to urban, domestic and industrial water users on the Witwatersrand. In due time this became South Africa's largest water utility, the outcome of a successful partnership between the industrial private sector, colonial government and a group of local authorities.[227]

The Transvaal Colony's Department of Irrigation merely played a monitoring role. Its engineers were responsible for the inspection of the mine dams on the Witwatersrand. As a rule, the department made a recommendation and saw to it that the work was done properly and did not present a safety risk. At the time of unification the department's officials inspected the Rosherville Dam,

223. UG25/1926 (1926:14–15).

224. UG7/1929 (1929:25).

225. Murray et al. (1952:309, 311).

226. Murray et al. (1952:311).

227. Tempelhoff (2003:Ch. 3).

New Primrose G.M. Company's dam, New Kleinfontein Dam, Van Ryn G.M. Company's dam, New Modderfontein Company's dam, Robinson Dam, Simmer Pan and the Geldenhuys Dam.[228]

The first formal legislation to generate power for the mining industry on the Witwatersrand, the *Rand Mines Power Supply Company Water Supply (Private) Act*, No. 14 was introduced in 1919.[229] At Vereeniging, where the Rand Water Board's bulk water purification works began operations after the completion of the Vaal River Barrage in 1923, a number of power stations (as of about 1907), as well as, from 1911, the country's first iron and steel manufacturing plant, the Union Steel Corporation, expanded exponentially.[230]

Rand Water Board, as *de jure* owner of the Barrage, was responsible for managing the water supply and overseeing water consumption activities of the mining industrial sector. Once plans were set in motion in the mid-1920s for the construction of the Vaalbank Dam (Vaal Dam), the irrigation department's responsibilities in the region were extended to oversee the allocation of water for construction and irrigation farming in the Upper Vaal region.[231] Then too, when state-assisted industrial developments, such as Escom in the 1920s, started expanding their activities, the irrigation department was consulted. The Rand Water Board, as a bulk water utility, was a major client of the Department of Irrigation, and in turn the board serviced numerous industrial concerns in the areas where the board provided services.

Advice to farmers

A notable development in the activities of the irrigation department was the provision of advice for farmers. In the Cape, this system developed well in the period prior to Union and farmers paid the department for the advice received. However, in the Transvaal this was not the case and farmers did not pay. In 1910 officials provided advice to 92 farmers on matters of small-scale irrigation works.[232] Kanthack had fixed ideas on giving advice to farmers. He stated in 1911:

> I have long [...] been convinced that professional advice [...] given gratis, is demoralising and useless so far as results are concerned. In fact, advice is often asked for almost as a joke. The results certainly never justify the large

228. UG26/1911 (1911:7).

229. Murray et al. (1952:575–588).

230. Prinsloo (1992:253–258, 260–263).

231. UG25/1926 (1926:7); Lubbe (1942:53).

232. UG26/1911 (1911:19).

> expenditure of public money entailed [...]. The moral effect of imposing an even nominal fee for engineering services is remarkable. The assistance is [...] applied for in all seriousness, and when rendered, it is taken seriously and leads to a tangible result.[233]

Kanthack was prone to using the Cape as an example and in this province farmers were charged a 'reasonable fee'. They took the advice of the engineers seriously and hardly any schemes were developed without consulting the department. Kanthack noted that farmers in the southern parts of the Orange Free State also tended to respond well to advice. However, in the Transvaal he experienced considerable problems. In his words, the progress in this area was 'very disappointing'.

In the Cape Province the Department of Irrigation adhered to a government notice that gave officials permission to provide professional advice and charge a fee, although in many cases government assistance was provided towards funding the fee. By 1913, officials who participated in reconnaissance surveys looking for potential irrigation areas were frequently asked for advice. Often this was by farmers in some of the most desolate areas of the country and engineers of the irrigation department provided the necessary advice free of charge.[234]

The need for advice from the department kept increasing despite attempts to limit the service. Between 1920 and 1921 the department advised on 135 matters in the Cape Province, 22 in Natal, 150 in Transvaal and 52 in the Orange Free State; but these 359 instances of service rendered less than £4000 in revenue for the department.[235] The requests for help were certainly on the increase, and most of the requests came from the Northern Transvaal and Natal.

Many of the enquiries from water users had a bearing on water storage and water directing. For the department it meant the workload of the circle staff increased in leaps and bounds. The circle engineers were responsible for attending all the proceedings of the water courts in their areas of jurisdiction. In addition, they had to keep an eye on all construction activities and deal with the systematic collection of hydrographic data, as well as silting and harvest data. Furthermore they had to provide help to the management of completed irrigation schemes.[236]

233. UG26/1911 (1911:33).

234. UG2/1914 (1914:14).

235. UG8/1923 (1923:21).

236. UG8/1923 (1923:21).

Science, and survey exploration

Meteorology

Meteorological information about South Africa played a significant role in the development of water-related scientific research. Among the major contributions by the irrigation department after Union in 1910 were the measures taken to secure scientifically generated knowledge on South Africa's weather conditions, hydrography and the development of suitable technology to study the environment. Many contemporary authors noted the paucity of basic scientific information. The engineer, A.M.A. Struben, who studied at the South African College in Cape Town and the Crystal Palace Engineering School and University College, later worked in London before returning to the Cape Colony to work as civil engineer. After moving north to the Transvaal Colony in 1902, he practised as a hydraulic engineer, immersing himself in the study of weather conditions.[237] In 1906 he explained that '[a]t present our knowledge of the climatic and hydrographic conditions of the country is vague, indefinite, and too unsafe to build large works upon.'[238] H.E.S. Fremantle, almost in desperation, explained to the Royal Statistical Society that 'most of us never know what the weather is likely to be until it comes.'[239]

In 1912, Kanthack, as director of the irrigation department, was responsible for starting up a meteorological section that later became the South African Weather Bureau. By the 1920s the department's meteorologists collaborated with officials of what was to become South African Airways, as well as the South African Air Force, in conducting aerial reconnaissance and observations of the country. They also provided reports on weather conditions for the first airmail postal service along the South African coastline.[240]

At the same time, it was necessary to form a more comprehensive impression of precipitation, drought and floods as well as the relevant climatic conditions in this large and highly diversified region of southern Africa. Shortly after Union the lack of knowledge about the hydrosphere created problems and hampered the construction of irrigation works. To meet this need, from 1912 comprehensive hydrographic surveys were undertaken by the Department of Irrigation.[241]

Most of the work was still done in the Cape. In 1913, for example, the annual report describes surveys conducted on the Gamka River, the Olifants River at Oudtshoorn, and the Worcester–Robertson water canal, as well as

237. Plug (n.d.b).

238. Struben (1906:301).

239. Fremantle (1912:315).

240. UG25/1926 (1926:4).

241. Turton, Meissner, Mampane and Seremo (2004:375–376).

the Great Fish River and the Lower Orange River.[242] In the Orange Free State, surveys followed of the Tierpoort River and the Riet River, with an extensive exploration being carried out simultaneously of the Modder River.[243] However, the outbreak of the First World War hampered these hydrographic surveys.

As early as 1911 the department, in view of the seminal importance of their scientific information, started publishing the hydrographic reports as a separate section of the departmental annual report. The first of these reports appeared in 1913. In the Orange Free State, hydrographic reporting continued in collaboration with the Cape Province, with a survey of the Wilge River above Frankfort and the Tarka River above Tekenfontein in the Cradock district of the Cape. Between 1914 and 1915 the department was instrumental in assisting the Rand Water Board with the installation of water gauging stations on the Vaal River and some of its tributaries.[244] By the 1920s the department was actively collecting data on the mean annual rainfall (MAR) in the country, determining the relationship between the MAR and rainfall in specific regions and their water catchments.[245] How comprehensively this data was mined is evident from the fact that by the end of 1945 there were an estimated 4500 gauges monitoring rainfall in all parts of the Union.[246]

Reconnaissance surveys

Shortly after the establishment of the national irrigation department its officials conducted a number of reconnaissance and survey expeditions in various parts of the country (Figure 1.3 provides an overview of the estimated river catchments). More comprehensive work was difficult in post-war conditions, and the weak economy in the first half of the 1920s also delayed more intensive investigation. However, the work done in the period shortly after 1910 was impressive despite the limited staff component.

Before 1924 most irrigation work was done in the Cape Province. Up to the mid-1910s conditions were favourable for flood irrigation schemes, although in the Great Fish River area irrigation was essentially a side-line for farmers to cultivate lucerne for their ostrich farming operations. The board schemes in existence were able to pay the rates. In times when water was available it was possible to pay the redemption fees of loans and also maintain the system, but then, as the drought of 1914 to 1916 set in, water supplies dropped. One of

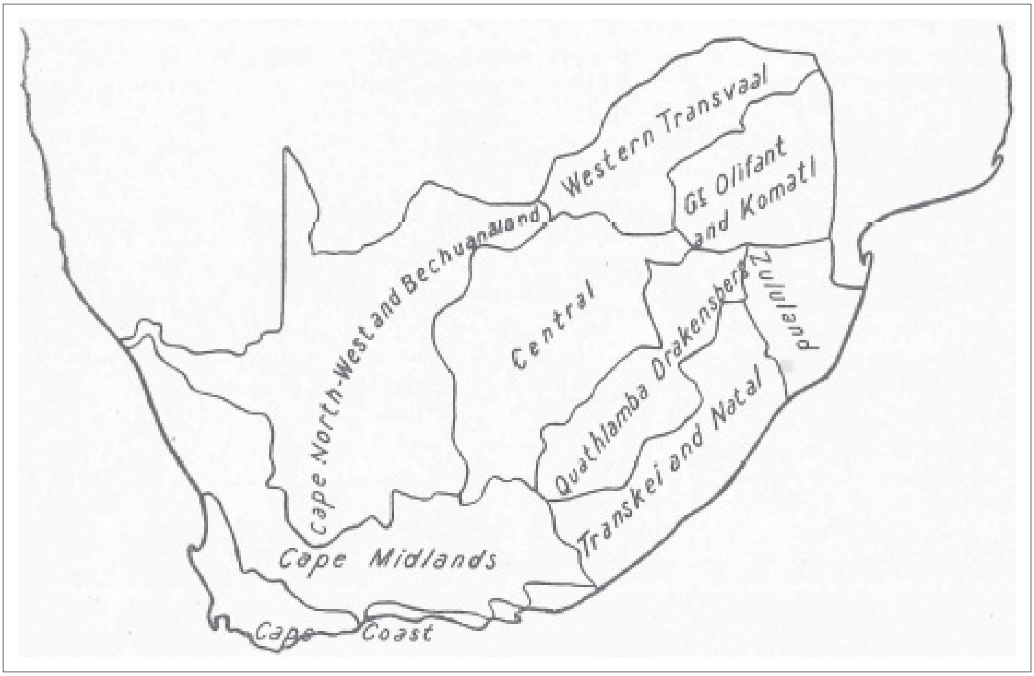
242. UG2/1914 (1914:16–17).

243. UG2/1914 (1914:18).

244. UG19/1918 (1918:12).

245. Turton et al. (2004:376).

246. Terblanche, Pegram and Mittermaier (2001:4).



Source: Copy of the original map (Department of Agriculture 1926:30).
FIGURE 1.3: An outline of the estimated river catchments in the Union of South Africa by the drought commission of 1920–1923.

the first enterprises to suffer was ostrich farming and the market collapsed.[247] This had severe consequences for farming in the region.

Earlier, a number of potential water storage facility sites in the area of Oudtshoorn were surveyed by officials of the irrigation department. These were the Toverwaterpoort, Meiringspoort, Kamannasie, Calitzdorp, Moeras and Saffraanrivier.[248] These operations were originally suspended in 1912, but surveys were resumed in 1913 to connect two large proposed irrigation schemes. These were the Warm Water canal scheme and the Moeras River storage scheme. The work was done by a private consulting engineer. The Calitzdorp and Nels River storage project meanwhile materialised and a loan of £390 000 was granted by the government for the construction of a dam. Construction work began in 1913.[249]

In the Orange Free State, by 1911 the department's surveyors had explored the Tygerpoort reservoir on the Tyger River and plotted the site on both sides

247. UG2/1914 (1914:24).

248. UG2/1914 (1914:25–26).

249. UG2/1914 (1914:15).

of the river. The possibility of the Leeuwpoort reservoir on the Riet River also came up for inspection. The problem was that both sites that were identified and surveyed had not yet been linked to the railway network, a factor that had a negative influence on potential development.[250]

In the Transvaal a comprehensive hydrographic survey was under way by 1910. The colonial irrigation department, in conjunction with the meteorological division, had about 260 observers of river and rain gauges in different parts of the province throughout the year.[251] They were also constantly expanding their activities. In 1909 the catchment of the Blyde River and Vaalkop, near Pilgrim's Rest, was added to the list of observation areas. In 1911 the Transvaal officials of the department surveyed the Apies River in the vicinity of Pretoria, the Murchison Range and the north-eastern Transvaal Lowveld, where they found substantial water supplies of up to 4800 kL in the vicinity of the Thabina River.[252]

Lewis's Lower Orange reconnaissance

One of the major accomplishments of the department in the early years was a memorable reconnaissance expedition undertaken by one of its senior officials. This was evidence that despite limited funding the department supported exploration. In 1912, two years before the outbreak of the First World War, the circle engineer for the Lower Orange River, A.D. Lewis, undertook a reconnaissance expedition in an aircraft, flying over the Orange River from Kenhardt to where it flows into the Atlantic Ocean near Alexander Bay. Apart from taking note of human settlements and farming operations, Lewis was able to identify potential irrigation lands in a relatively unknown area of South Africa (Figure 1.4 and Figure 1.5).[253]

Today Lewis is primarily remembered for this courageous expedition. A year later he published an impressive report for the department on the development of irrigation in the United States of America, which shed light on issues that could be taken into consideration when planning irrigation settlement schemes in South Africa.[254]

In the years to come, much of South Africa's development in terms of water schemes and irrigation projects, was influenced by exemplary developments in the US. The attraction of the United States as a benchmark for South Africa can be ascribed to the fact that it was then a relatively youthful state, and by the

250. UG39/1912 (1912:26).

251. UG26/1911 (1911:7).

252. UG39/1912 (1912:27).

253. UG2/1914 (1914:App. C).

254. Lewis (1915).

Source: UG2/1914 (1914).
FIGURE 1.4: The Lower Orange River at Sendelingsdrift, photographed by A.D. Lewis in 1913.

Source: UG2/1914 (1914).
FIGURE 1.5: Johnnie Damara's huts on the farm Garganab, where, according to Lewis, irrigation on the Lower Orange River had the greatest potential.

end of the 19th century irrigation played an exceptionally important role there. In the mid-1910s there was great respect for the work done by Lewis and for how the irrigation department had explored the 'Great River'. Furthermore, water engineers in the department were aware of US developments and learnt from them. The realisation dawned that the failure of irrigation schemes was not necessarily the result of bad engineering. Instead, a lack of understanding of agricultural conditions and the process of human settlement on the land were matters that required substantially more attention.[255]

Conclusion

The unification of South Africa was a seminal event in the development of an integrated process of water governance at the southern end of Africa. The new state embarked on a hydraulic mission that served the objective of food production in a semi-arid region that would later be classified among the 30 driest regions in the world. Yet, in 1910 the prospects for the realisation of a food–agricultural hydraulic mission were good. The government provided for the establishment of a department dedicated to realisation of the ideal of using irrigation technology for promoting development.

Politically, the country was in the process of finding its feet. A white minority government charted its course – in many respects to the detriment of indigenous communities – in an era when the idea of the British Empire and a colonial mindset remained paramount. The Department of Irrigation operated along the lines of colonial systems developed in various parts of the world. Governance implied that water technology and knowledge transmission would be extended to all parts of the country. The greater part of South Africa was still an uncharted field – waiting to be developed. Water resources had a significant role to play.

In terms of resilience, the social ecological system functioning in South Africa was complex. The exploitation of the country's resources was only beginning to gain momentum. Economically, the country's mining sector was still mainly confined to certain regions. Electricity – an energy resource derived primarily from fossil fuels at the time, but also from a few hydropower plants – was a prime driver of growth and development in the new country. However, its use was still confined to a few urban areas. As will be discussed in the next chapter, ecologically the new South African society still had to locate its adaptive capacity of resilience to water-related disaster conditions.

255. Agriculture Journal of South Africa (1916c:16).

Chapter 2

Natural disasters and poverty in the early years of the irrigation hydraulic mission

Water-related disasters: Droughts and floods

Largely as a result of a notable reliance on rain and surface water resources,[256] drought has always been a catalyst for change in Africa.[257] South Africa, since 1910, is no exception. In the first decade of the Union drought conditions had a marked impact on the livelihood of all South Africans. Inadequate government support meant that drought conditions were in part responsible for the decline of African peasantries – a process that had already started in the 19th century. Nor did the drought have a negative impact only on indigenous peoples. Drought conditions caused population shifts and migrations; they shaped spontaneous proletarianisation, 'poor whitism', and altered forms of production and distribution in many parts of the country.[258]

How to cite: Tempelhoff, J.W.N., 2018, 'Natural disasters and poverty in the early years of the irrigation hydraulic mission', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 63-84, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.02

256. McCann (1999:162–263).

257. Ballard (1986:359).

258. Beinart and McGregor (2003:13); Bottomley (1992:29–39); Tempelhoff (2006).

One of the first serious droughts after Union lasted from 1914 to 1916. It came at a difficult time, notably the collapse of the ostrich feather market towards the end of 1913, which affected farmers in the southern and Eastern Cape.[259] It also coincided with the outbreak of the First World War.[260] In 1914 the Afrikaans poet and naturalist, Eugene Marais, even contemplated climate change, explaining that in the Northern Transvaal's Waterberg region:

> It does not seem possible that enough water can ever again fall to damp or even to cool this parched and cracked earth and to fill these moats of burning sand.[261]

It soon became apparent that natural slow-onset drought disaster conditions (to use current terminology) were destined to have a detrimental impact on development. Despite not occurring simultaneously in all parts of the country, drought had a paralysing effect on people in both the rural and urban areas of South Africa. A multitude of panarchy cycles (Figure I.1.), typically starting with a slow phase of creative destruction (Ω) and then moving into a phase of uncertain reorganisation (α), affected local and regional communities. It required of interdependent individuals and groups (especially in the farming sector) to spontaneously focus on adaptation and resilience to prevailing circumstances. The adaptive processes were shaped and transformed by the way in which people economically and psychologically experienced the disaster conditions. The politics of the day and recessionary economic conditions compounded a consciousness of hardship and feelings of intense human suffering. This mentality of social suffering persisted even after the First World War ground to a halt in 1918. It is possible to speak of a societal mentality of desperation and hopelessness. This way of thinking became a pronounced feature of South African society in times of drought throughout the 20th century.

The urban response to drought in the early years of the Union was primarily from consumers. By 1915, in some urban areas on the Witwatersrand goldfields, there were food shortages and local demands for land to produce crops. The Union's chief meteorologist, R.T.A. Innes, told the Workers' Educational Association of Johannesburg that drought conditions were usually the worst in areas where the population was sparse. He was well aware of the need for food production and the scattered population of South Africa's rural areas. He was also aware that the majority of boys at schools on the Rand left school each year without formal qualifications. They had limited prospects of gaining employment. He recommended that on the goldfields of the Witwatersrand the government should pay greater attention to the development of

259. Journal of the Department of Agriculture (1924:238–243).

260. UG19/1918 (1918:1); Journal of the Department of Agriculture (1920:676).

261. Marais (1914:170).

smallholdings outside the perimeter of the cities so that people in the urban areas could grow their own fresh produce.[262]

Farmers, the producers of food supplies, were the hardest hit by drought conditions. As conditions worsened many were unable to repay the government loans they had received.[263] Yet, if it were at all possible, the government remained unstinting in its support of the irrigation sector. In 1916, when the drought in parts of the Eastern Cape ended with abnormal floods, government even extended additional loans to local farmers.[264] When the post-war economic depression set in and coincided with drought and more floods, government remained lenient. It remained sensitive to the plight of farmers who were unable to dispose of their crops and were staring in the face of financial ruin.[265]

At the time of a drought cycle in 1919–1920, the loss of capital in terms of livestock deaths in the Union amounted to more than double the entire capital that the country had invested in irrigation up to that point.[266] It was statistics of this nature that prompted the Irrigation Commission in the mid-1920s to promote irrigation systems for livestock farmers to produce lucerne, especially in the more arid parts of the country.[267]

The Department of Irrigation's management focused increasingly on coping with drought conditions. At the same time, it worked on strategies aimed at mitigating the negative impact of floods, notably a large number of dam construction projects. Kanthack's philosophy was conservation – an approach, he suggested, that the Cape farmers had learnt the hard way, in the process of rehabilitating themselves. They realised the effects of calamities and the need to remedy matters by the 'conservation of flood water'.[268]

The department's officials in turn developed a flood warning system in the Eastern Cape that by 1922 started paying dividends. In some cases these measures came too late. Farmers were demoralised by destructive floods. At the Great Fish River irrigation scheme, some farmers even started selling off their farms, and the value of irrigation land dropped significantly.[269] In the case of Lake Mentz, the department conceded that its officials had to develop a

262. Innes (1915:117–128).

263. UG19/1918 (1918:32–33).

264. UG19/1918 (1918:32).

265. UG8/1923 (1923:1).

266. Van Reenen (1925:38).

267. UG29/1925 (1925:15); UG7/1929 (1929:27–28).

268. UG19/1918 (1918:2).

269. UG8/1923 (1923:1).

sound knowledge of local conditions to manage streamflow effectively and prevent serious flooding.[270]

Some of the lessons learnt from dam projects and irrigation schemes in the Eastern Cape included:

- the need to be familiar with local conditions
- being sensitive to local climate and soil conditions
- combating erosion
- dealing effectively with silt accumulation in the valleys of river schemes.[271]

In brief, there was a need for farming communities to develop resilience and persistence with the help of local knowledge systems based on the experience of local farmers, and of the officials responsible for governance and providing state support.

■ Solutions to aridity?

Desperate times of drought called for desperate measures. The discourse on the 'drying out' of southern Africa that gained significant support in the mid-19th century was revived after the formation of the Union in 1910.[272] More people in the various provinces became aware of the intrinsic value of water in a country spanning a surface area of more than one million km^2.[273] While the natural resources of the arid regions were subject to investigation by agriculture experts and geologists,[274] the Department of Irrigation's focus was on securing water for the arid parts under drought conditions.

There were also some ideas that arose in academic circles on how to deal with drought conditions and these captured the public imagination. For example, in 1918, an Eastern Cape geographer and geologist, Prof. E.H.L. Schwarz of Rhodes University, attended the Johannesburg meeting of the South African Society for the Advancement of Science, where he spoke on 'The desiccation of Africa'. He maintained that something had to be done to halt the 'drying process' in central South Africa. An article by Schwarz in a Johannesburg daily newspaper attracted considerable public interest. He argued in favour of the construction of weirs across the Kunene River below the Kinga and the Chobe, between the Okavango swamps and the Zambezi River.[275]

270. UG8/1923 (1923:10).

271. Mackenzie (1947:15).

272. Tempelhoff (2016a:121–122).

273. Solomon (1911:420).

274. Du Toit (1916:1–13).

275. Juritz (1919:88).

It was his opinion that the weirs would ensure that the Kgalakgadi indenture would then begin to fill up. This, in turn, would fill the Etosha Pan (in South-West Africa) and Lake Ngami (the protectorate of Bechuanaland). The anticipated outcome, he explained, was a supply of rain clouds that would refresh the Kalahari and bring about the greening of the region with plant life. Schwarz was convinced that this would also benefit South Africa with a return to conditions that had prevailed 300 years earlier when the Karoo was water-rich. He envisaged that it would be possible to start up settlements with white farmers in areas where no indigenous people were resident.[276]

Experts had their reservations about Schwarz's plan. The director of the Irrigation Department, F.E. Kanthack, was sceptical. C. Stewart, chief meteorologist of the Union, was of the opinion that the climatic effect that Schwarz hoped to achieve was too optimistic and was bound to fall short of expectations.[277] Juritz referred to Du Toit's recent ground-breaking work in geology that was critical of a former flowering landscape. Du Toit, an early proponent of continental drift, was of the opinion that the re-condensation of the moisture evaporating from the impounded water, as Schwartz suggested, would instead become problematic in that it could (if developed artificially) lead to fever swamps and even produce marginal barren salt flats.[278]

Schwarz refused to concede that his critics could be right. He was influenced by the ideas of Ferdinand Gessert (1870–1953), a German scientist and farmer in the former German South-West Africa (now Namibia), who claimed it was potentially possible to reinvigorate the arid Kalahari with water resources if a few appropriate steps were taken.[279] Gessert studied physics and climatology in Berlin, before emigrating to the German colony in 1894. He settled on the farm Inachab between the Fish and Konkiep rivers, where he made a thorough study of local climatic conditions before theorising on plans for procuring water in the desert.

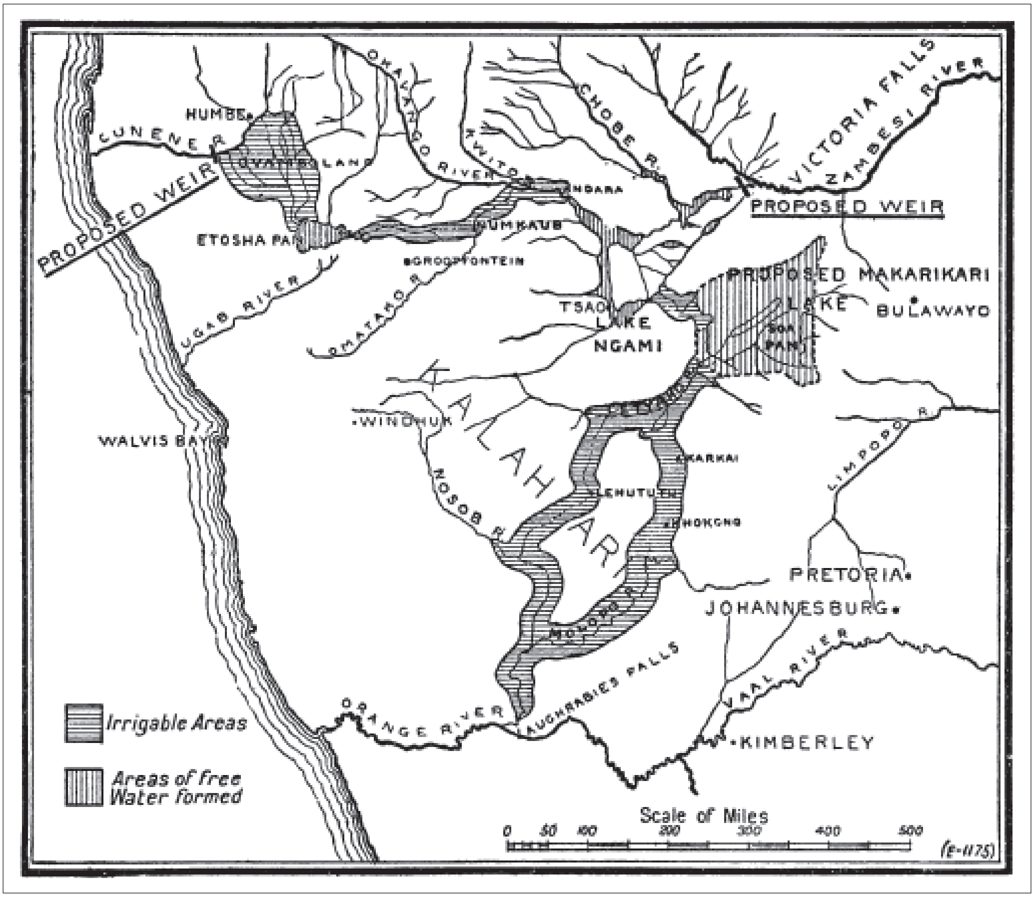
Gessert was influenced by the geographer and climatologist, Eduard Bruckner (1862–1927) and the geographer Alexander Supan (1847–1920). Gessert was of the view that most precipitation over land was the result of water that had evaporated from the land itself. Therefore, it would be possible to attract water to accumulate in the atmosphere if there was moisture rising from an existing water resource on the land surface. In his opinion, if the water of the Kunene River in Angola could be diverted southwards to Lake Ngami, it would be possible to start irrigation farming along the newly formed waterways

276. Schwarz (1920:1–12).

277. Juritz (1919:89); Mountain (1976:733–734).

278. Juritz (1919:89–90).

279. Plug (n.d.a).



Source: Schwarz (1920:1–12).

FIGURE 2.1: Schwarz's map of the way a comprehensive irrigation strategy could be introduced in the Kalahari.

of the Kalahari. He published a number of articles on the topic, but his views were not shared by the colonial rulers of German South West Africa.[280]

Schwarz concurred with Gessert's theory. By the end of 1918 he visited the western parts of Ovamboland where he undertook an extensive trek. On his return in 1920, he published a book on the Kalahari and how the 'thirstland' environment had come about.[281] In the same year he published a paper in the *Journal of the Royal African Society* and provided a map of the comprehensive irrigation scheme that could be created in the Kalahari which can be seen in Figure 2.1.[282]

Interest in Schwarz's work coincided with a growing awareness in government circles that little was known of drought conditions and what could

280. Plug (2017).

281. Schwarz (*c*. 1920).

282. Schwarz (*c*. 1920:1–12).

be done to address the problems these posed for farming. Faced with severe drought in 1919 the government appointed the South African Drought Investigation Commission to conduct an enquiry into the occurrence and effects of drought in the Union of South Africa.

In a number of sections of its report, the commission pointed to the fact that there was a difference in perspective between government officials and the country's farmers. The farmers the commissioners interviewed were of the opinion that the rain started falling at a later date each year. They also made the point that the annual average rainfall was decreasing. For the farmers, rainfall was determined by its 'wetness' rather than its actual incidence. The authors of the report, on the other hand, suggested that the farmers' perception of 'dryness' was not so much the result of the lack of rainfall. Instead it was the inability of the soil to absorb the rain once it had fallen.[283]

According to Beinart, what the commission was really driving at was that the land was being overgrazed and overstocked, and surface soils hardened in times of veld fires.[284] There was also an emergent discourse on the need for farmers to use land with greater care. In the irrigation sector, it was evident that the available water supply for irrigation farming was too limited for planting all fields with crops. From the vantage point of the Department of Irrigation and its young meteorological division, it was evident that there was a paucity of relevant data for scientists to make proper assessments of drought and flood conditions. The investigations carried out in departmental surveys on the potential siting of water schemes and reconnaissance expeditions from the mid-1920s made an important contribution to a better understanding of natural phenomena. At the beginning of the 20th century, floods and droughts were not yet contextualised as conditions of natural disaster. That would only change in the 1990s.

Irrigation department, Africans and indigent whites

South Africa's first national water legislation was structured on the development of a state in which the farming industry played an important role. Little provision was made for African access to the country's irrigation sector. Early attempts in Natal appear to have yielded few results. Furthermore, the issue of African rights to own land was problematic. Most irrigation projects launched in the 19th century tended to be in the arid regions of the Cape where Bantu-speaking peoples did not historically have a significant presence.

283. Department of Agriculture (1926).

284. Beinart (1984:58).

There also appears to have been limited interest and willingness to recognise indigenous systems of irrigation technology. Civil servants outside the confines of the Native Affairs Department, often chose to ignore African traditions. For example, Kanthack, in evidence before the Eastern Transvaal Land Commission, which had been tasked with securing more land for Africans, tended to dismiss claims by African farmers that they customarily irrigated lands.[285]

African water rights were systematically ignored until the early years of the 20th century, with the possible exception of irrigation settlements for Africans operated under the tutelage of missionaries. After unification, as issues of 'native administration' increasingly shifted, the Department of Native Affairs simply assumed that Africans would have marginal access to water in urban areas and hardly any access in rural areas.

By 1910, although a considerable part of the irrigation department's work was in private irrigation ventures, it realised that it had a primary responsibility to help the government address the troublesome issue of indigent white communities. The proactive role the department played in the development of irrigation schemes proved to be of substantial value in this regard.[286]

Furthermore, fulfilling a dual role, the department made use of government funding that was available for the deployment of local unemployed white males in the rural regions of the country. These indigents (poor whites) were paid to work on the construction of water storage facilities, such as the Hartbeespoort Dam and its irrigation scheme (1916–1925). Up to the late 1930s it was the largest irrigation dam project in the South African interior.[287]

Government irrigation schemes

At the time of unification in 1910 there was considerable optimism about irrigation. At the same time there was an awareness that in terms of its climate and hydrography South Africa was diverse. The exponential increase of the state's surface area and the diversity of local and regional ecologies posed a major problem for a holistic understanding of the country.

Firstly, it was difficult to design legislation and introduce measures that would suit all areas of the Union equally well.[288] Even in the Cape, the region that had been exposed to the most comprehensive hydrographic investigations by 1910, there was uncertainty about ideal locations for water storage and

285. Tempelhoff (2008:121–160).

286. Hobbs and Phélines (1987:33); Mackenzie (1947–1948:8–16); Tempelhoff (2006).

287. See Hugo (1933:24); Andrews (1931); Van Vuuren (2008:19–21).

288. UG2/1914 (1914:2).

irrigation farming development. Developing government-supported irrigation schemes in the more arid parts of the province proved to be challenging.

Government water schemes for the purposes of irrigation from 1912 to the 1930s included the schemes of the Great Fish River (Lake Arthur and Grassridge Dam), the Clanwilliam Dam, the Van Rhyneveldspas Dam at Graaff-Reinet, Lake Mentz on the Lower Sundays River in the Cape Province and the Hartbeespoort Dam on the Crocodile River in the Transvaal.

All these developments were fraught with problems and unexpected obstacles. In many cases the anticipated water run-off calculations of the dams were overestimated. In others, dam construction coincided with the development of irrigation board schemes. Then, from the user side, farmers who took advantage of the schemes to irrigate their crops were seldom in a position to pay for the capital development. To keep the schemes operating, the government had to be lenient and it was the Department of Irrigation that bore the brunt of management. Not only was it responsible for the construction of all the large water schemes, but its officials had to be supportive of the farming communities operating in the irrigation systems.[289]

■ Cape Province

In the Cape, one of the most advanced provinces in the field of irrigation, there were reasonable prospects at the time of Union. F.E. Kanthack was confident that within a relatively short time, the old Cape irrigation developments at Stellenbosch, Oudtshoorn and Worcester would be replaced by new, more efficient methods of irrigation.[290] However, his confidence was put to the test, and in smaller water-rich and drier parts of the province, such as Williston, the development of a local irrigation scheme proved difficult.[291]

In the Eastern Cape, private sector initiatives were at the forefront of promoting the development of irrigation schemes after 1910. Since the 19th century, local and overseas entrepreneurs had been active in the Port Elizabeth area via its harbour. On the Sundays River, where a number of companies produced oranges for export, the completion of the Korhaans Drift government irrigation scheme in 1913 created a significant community of irrigation farmers. The scheme was the largest of its kind in the country and capable of putting an estimated 4176 ha of lands under irrigation from a river weir extending over a distance of 87 m with a crest of 30 m. In 1917, with the establishment of the Sundays River irrigation board, construction work began on Lake Mentz. There were high expectations, and Kanthack's positive view of

289. Bruwer and Van Heerden (1995:4).

290. UG2/1914 (1914:3).

291. Kruger (2013:57–58).

the project was based on the local run-off data of the river dating back to 1886 and the availability of extensive additional water storage facilities.[292] Although the state paid for the construction of the dam, it was anticipated that irrigators using the canal water would pay a levy and that this would eventually cover the construction costs.[293]

In the more arid parts of the Cape, many irrigation schemes supported by the department dated back to the mid-19th century. There was considerable local knowledge of prevailing conditions, as well as a tradition of working on irrigation systems in arid regions.

Douglas

The town of Douglas, on the banks of the Northern Cape's stretch of the Vaal River, developed as a result of the Backhouse settlement, founded by the London Missionary Society in 1838. In 1884 the Cape colonial government made available the first funding for a local irrigation scheme at the confluence of the Vaal and the Orange rivers.[294] By 1910, the most important element in the local irrigation system was the weir across the Vaal River, which, according to Kanthack, was in a good condition and capable of putting 141 ha of land under irrigation.[295] The next year the amount of land under irrigation had increased to 193 ha.[296]

By 1911 there were 107 agricultural lots and 78 town lots in Douglas. Government provided funding for an experimental farm to help local farmers cultivate the most suitable crops. But Douglas remained a small community and development was slow to take off.[297]

In 1913, when local production increased, expansion was hampered by upstream users who had not been limited by servitudes on water for storage purposes. It worked to the detriment of the development of the Douglas scheme. In the 1910s local farming operations were severely affected by drought conditions.[298] Following the First World War, the department stepped in and made significant improvements to the main water canal and its subsidiaries to deal with floodwater in the settlement.[299]

292. UG49/1918 (1918:99–101).

293. Van Vuuren (2009:25).

294. Raper (2004:75); Christopher (1984:106).

295. UG26/1911 (1911:13).

296. UG39/1912 (1912:5).

297. UG26/1911 (1911:14).

298. UG2/1914 (1914:17).

299. UG32/1921 (1921:12).

Brandvlei

The village of Brandvlei in the arid north-western region of the Cape Province, was originally laid out in 1876. The Cape colonial authorities hoped to establish Brandvlei as an urban meeting place for the farmers of the Achterveld, making the town an administrative centre. But the project was unsuccessful because by 1880 only an estimated 40 of 182 building lots had been sold.[300] In 1906 and 1907 more improvements were made to the local dam, and the Brandvlei Village Board waived its rights of control over the land required for irrigation. It was also prepared to pay water rates to the government.[301]

At the time of Union there were attempts to make a fresh start in Brandvlei, but there were delays in settling issues of local water rights and servitudes. The problem arose because all the money required for the development of the scheme had not been made available.[302] By 1911 conditions at Brandvlei had improved considerably.[303] A special meeting of the village management board agreed to dispose of all irrigable land below the dam to the government on the understanding that if a suitable irrigation scheme was developed it would be beneficial to Brandvlei and the rates for water supply would not exceed £1 p/a/morgen.[304] Because of the aridity of the land there was a firm understanding that government was under no compulsion to distribute water in years of low water supply.[305]

In addition to the dam facility there were soon good opportunities for the development of *zaaidams* below the Klippekraal to the east of the Brandvlei storage reservoir.[306] This technology was home-grown and unique to the area. It required of farmers to physically 'scrape' the dam fields to remove the silt of the previous season and open up fertile soil for future flooding.[307] The technique was even promoted as a potential strategy for prospective irrigation farmers in other parts of the country.[308] At the time the most popular forms of irrigation

300. Christopher (1984:99).

301. UG39/1912 (1912:13).

302. UG26/1911 (1911:14.

303. UG39/1912 (1912:7).

304. Morgen was an imperial measure of surface areas. In the case of South Africa, one of the standards measures was the Cape morgen. 1 Cape morgen = 0.85 ha.

305. UG39/1912 (1912:13–14).

306. UG39/1912 (1912:14).

307. Bonnin Hobson (1897:90–92).

308. Van Zyl (1914:493–495).

recommended by engineers were flood and furrow strategies.[309] There is reason to believe that the development of private sector farming operations had a marked effect on the community-based organisational system of cooperative irrigation farming. By 1920 Brandvlei's local small farmers found it difficult at times to compete with the nearby Zak River Estates commercial farming operation for consistent water supplies from the scheme throughout the crop growing season.[310]

In 1921, the Brandvlei irrigation scheme experienced severe floods, but it was still possible for local farmers to produce 4500 bags of wheat. In the aftermath of the floods the department stepped in to help rebuild the local dam, and following a water court judgement, the local storage dam and all the damaged works were upgraded. The storage dam's wall and the winged walls of supporting structures were lifted in an effort to enlarge the output potential of the eastern outlet of the dam.[311]

Van Wyksvlei

The Van Wyksvlei Irrigation Settlement, initiated in 1880, was by far the most ambitious scheme of its kind undertaken by the British authorities in the Cape Colony in the 19th century. However, it was fraught with problems because of over-optimistic planning. By the 1890s the government started selling off the land. Most local farmers opted for livestock farming. It was less risk prone than irrigation farming.[312] A Scottish agricultural specialist in the 1890s identified siltification as the major problem with the soils in the area.[313] Subsequent remediation was only partially successful before the project was once again revived in 1906.[314] In 1910, for the first time since the establishment of the scheme, local farmers started planting summer crops. The outcome was favourable, except that wheat-louse and rust caused considerable damage to the crops.[315]

In 1910, the Department of Irrigation granted these irrigation farmers free water to address local *brakking* (siltification) problems. De-*brakking* experiments, conducted on parts of the government plots, proved successful.

309. Braine (1911:242–254).

310. UG32/1921 (1921:12–13).

311. UG8/1923 (1922:19).

312. Christopher (1984:101).

313. Wallace (1896:426–427).

314. Christopher (1984:102–104).

315. UG26/1911 (1911:14).

The yield on this land was twice that of lands that had not been de-*brakked*. On the whole, by 1910 Van Wyksvlei was a successful irrigation scheme. Local crops were outstanding and the farmers' gardens produced beet, parsnips, carrots, radishes, mangel wurzel, melons, vegetable marrow, onions, tomatoes, beans, cowpeas, peas, lucerne, tobacco and vines.[316]

Between 1912 and 1913 the Van Wyksvlei settlement was subjected to severe drought conditions. Officials of the irrigation department tested the dam's water quality and found it to have a high alkaline content. By October the water was so brackish that it became impossible to use it for domestic or irrigation purposes. As an emergency measure, wells were dug from which livestock were provided with essential water. From November to December 1912 a large number of frogs passed through the discharge pipe of the storage dam and started dying in the furrows. Kanthack reported:

> The stench was so bad near the dam that the Bayliff was forced to leave his quarters and stay at the village. Large trenches were dug and the frogs buried.[317]

From the annual report for 1913 it appears that a number of employment opportunities made it possible to improve the future prospects for developing irrigation in the Van Wyksvlei settlement and that there was a renewed sense of community. The new building of the local Dutch Reformed congregation came into use; a public school was completed at a cost of £850; and agricultural plots earmarked for irrigation purposes were fenced off.

In total 116 ha of land was allocated to farmers as permanent sowing fields and as many as 1650 trees were planted to secure a local supply of timber. In addition, 500 fruit trees and 3000 vines were planted. At that stage the community had 141 ha of permanent winter crop fields and 11 ha of permanent gardens.[318]

Despite post-war drought conditions in the Van Wyksvlei area, the settlement made headway. When the rains fell at last, some farmers worked selectively with their water allocations and in some cases confined their water allocations to smaller portions of land so that these could be cultivated more intensively.[319] There were ongoing experiments in grain farming, with farmers reducing the irrigation cycle schedule for grain crops from four to two opportunities, with proper cultivation of the soil well in advance.[320]

316. UG26/1911 (1911:14).

317. UG2/1914 (1914:18).

318. UG2/1914 (1914:21).

319. UG32/1921 (1921:12).

320. UG8/1923 (1923:18).

Government irrigation schemes in the Orange Free State

The Orange Free State was not traditionally an irrigation farming area. The authorities also had no proper knowledge of riverine water resources other than the Vaal and the Orange before 1910. By the early 20th century the British authorities initiated plans for starting up irrigation settlements, of which those at Kopjes and near Rouxville were the most prominent.[321]

Kopjes

The Kopjes Irrigation Settlement near the town of Kopjes in the Heilbron district, about 60 km from Kroonstad, was sanctioned by the Orange River Colony's parliament as a settlement for poor whites, at an estimated cost of £80 000. Work began in July 1909,[322] consisting of a concrete dam about 200 m wide and 20 m high across the Rhenoster River. The length of the earthen dam was 1000 m.

The department made exclusive use of white labour for the construction works at the irrigation settlement, offering employment to between 80 and 140 people by the end of 1910. A further 30 to 100 men were employed on the project to do daily piece work. The work teams varied in size, especially in the winter months.[323] Following good rains it was possible to prepare 1254 ha of land in the planting season for potential irrigation purposes, in collaboration with the government land surveyor. By the time the work was completed, J.P. Klein, who had managed the construction work, was appointed engineer for the irrigation settlement, which was able to accommodate 250 settlers on about 200ha.[324]

In 1911, Kanthack made a personal visit to Kopjes. He expressed serious reservations.[325] In his view the construction work had neither been properly planned nor well executed. Not only was the local dam construction unsafe but the furrow that had been built was unsuitable.[326] This gave rise to a number of problems. In 1918 a severe flood caused considerable damage to the irrigation scheme and the department stepped in to lift the dam wall. By 1920 extensive work had to be done to strengthen the wall. At the time the local water supply

321. UG26/1911 (1911:16).

322. UG26/1911 (1911:16).

323. UG26/1911 (1911:16).

324. UG2/1914 (1914:26–27).

325. UG39/1912 (1912:17–18).

326. UG39/1912 (1912:15–20).

was 60% of capacity.[327] In 1922, the department reported back on a two-year survey its officials had conducted on the Kopjes reservoir in the period 1920 to 1922. The survey put the average annual rainfall for the period at 608 mm; the storage facility accumulated 6.8 MCM.[328]

Odendaalstroom/Goedemoed, district of Rouxville

In 1906, the Dutch Reformed Church in the Orange River Colony initiated a poverty relief programme at Odendaalstroom in the Rouxville District of the Orange Free State.[329] The church paid for part of the development on a piece of land of about 3200 ha and the Orange Free State government, prior to Union, contributed about £20 000.

The project was based on the style of the Kakamas labour colony – a successful initiative in the Lower Orange River that had been in operation since 1897.[330] By 1910 the Odendaal scheme – soon to be renamed the Goedemoed scheme – relied on a turbine that pumped water from the Orange River to a number of plots of land, each about 2.5 ha in size. In total the project covered a surface area of about 428 ha. Despite rising costs, the Union government continued to finance the project. Some 30 families settled on the land under the supervision of a superintendent, P.C. van Zyl, and there was further oversight by the Dutch Reformed Church's poor white commission.[331] The project failed to reach the same heights as the labour colony at Kakamas and subsequently closed down.

Government irrigation schemes in Transvaal

Potchefstroom

At Potchefstroom in the Transvaal,[332] irrigation land settlement schemes that had started shortly after the South African War – with mixed results – were resumed after 1910. There were more officials in the service of the department, and they aimed to take the development further. However, local residents were not keen to settle on the land until the department undertook considerable maintenance on the canal system and created order by enforcing the new

327. UG32/1921 (1921:13).

328. UG8/1923 (1923:19).

329. Van der Bank (1989:332).

330. UG26/1911 (1911:16).

331. Van der Bank (1989:333).

332. UG26/1911 (1911:4).

Irrigation Act's governance guidelines.[333] Considerable time and money was invested in the Potchefstroom region on the government canal, the burgher land settlement canal, the Loopspruit Dam, Potchefstroom's reservoir, the Wolmaranstad Dam and the Witpoort settlement dam.[334]

Other local development included a reservoir site on the farm Klipdrift 287, about 23 km northeast of Potchefstroom, identified in 1907 for local irrigation farmers. However, it was felt that the estimated cost of the project at £60 000 to irrigate about 1200 ha of land was too high. After Union the department purchased the land for £15 700 and by 1911 the reservoir embankment was extended over a distance of more than 1.5 km.[335] The Potchefstroom reservoir filled up in the course of 1911 but appeared to be unable to maintain sufficient resources during times of drought.[336] The Potchefstroom canal, also under the supervision of the Department of Irrigation, actually fell under the responsibility of the town council of Potchefstroom.

White River and Politsi

In the case of the White River canal in the Barberton district of Eastern Transvaal Lowveld, Kanthack reported in 1912 that the scheme had been a complete failure and that the department's officials had been removed from the area. Kanthack was critical of the scheme. In the Politsi area of the Northern Transvaal, the Politsi River irrigation works provided for the irrigation of the Tzaneen Estate, further south. The works, which cost £2500, were handed over to the management of Tzaneen Estates on 24 March 1911.[337] The system appeared to be functioning properly.

Hartbeespoort Dam

At the time of its completion in 1925, the Hartbeespoort Dam on the Crocodile River in the Western Transvaal was the largest departmental storage construction project in South Africa. The potential of the site had been identified in the 19th century, but it was only after the Anglo-Boer War that A. Karlson, the Transvaal Colony's hydrographic engineer, surveyed the site and made positive recommendations. In 1914, in an effort to garner the support of the electorate and stem the tide of the Afrikaner rebellion and the recent mineworkers' strike on the Witwatersrand, the *Hartbeespoort Dam Act* was

333. UG2/1914 (1914:19–20).

334. UG2/1914 (1914:23–26).

335. UG39/1912 (1912:21).

336. UG39/1912 (1912:10).

337. UG39/1912 (1912:11).

passed by parliament. Construction work began in 1916 in the era of the Mentz ministry. The primary focus was to secure job opportunities for poor whites.[338] Later Hartbeespoort Dam also provided opportunities for soldiers who had returned from the First World War. That was before African workers were brought in to help complete the large project. In the period 1916 to 1925 the dam project provided job opportunities for an estimated 3500 people.

Government schemes in Natal

Relatively little information is available on Natal government irrigation schemes before 1917 and there were no annual reports during the First World War period. Many of the early irrigation developments were in the proximity of the Tugela River and started out as settler initiatives, aimed at promoting farming and industry in the British colony. There were initiatives for South Africans of colour at the Tugela River,[339] but like the scheme for whites at Winterton,[340] these tended to be stifled by the difficulty of integrating Natal's water sector into the national irrigation department's system. For example, Winterton fell under the Land Board of Natal Province.[341] The land board and local irrigation settlements, after Union, gave their support to irrigation department officials working in the province. Settler communities, like Winterton, received considerable support from the department in the form of advice and recommended funding.[342] The report of the Director of Irrigation also mentioned the Weenen irrigation scheme. The developmental nature of irrigation technology in Natal at the time of Union is most apparent in the governance presence of the Department of Irrigation in the province. Part of the departmental circle's administration also worked in either the province of the Free State of Transvaal. In 1911 Kanthack reported on the improvement of irrigation projects in the Native Trust areas of the Tugela River and Mooi River.[343]

Kanthack reported that the department was aware of a new irrigation settlement at Winterton. The local water works started providing a supply of water to the residents of the village early in 1912.[344] They asked the Department of Irrigation for advice and subsequently its officials conducted an inspection

338. Beinart (2003:188).

339. UG39/1912 (1912:9).

340. UG2/1914 (1914:29).

341. UG2/1914 (1914:31–32).

342. Whelan (2015:1–12).

343. UG39/1912 (1912:7–9).

344. UG2/1914 (1914:29).

in January 1913 to determine what strategies had to be followed in the execution of the project.[345]

Similarly, settlements in Transvaal and the Orange Free State that were under the supervision of the Department of Lands in the Transvaal did not actually fall under the Department of Irrigation. Nor did the department directly involve itself with labour colonies, such as Kakamas along the Orange River, the Lagersdrift colony at Middelburg, and the Goedemoed labour colony in the Orange Free State.

Tugela

The original Tugela works were constructed in 1898 as an irrigation furrow in the Tugela about 3 km above the Umhlangana Spruit. Private engineers worked in collaboration with engineers from the Native Trust in colonial Natal. The irrigation furrow crossed the Umhlangana Spruit for several kilometres by means of an aqueduct along the right bank of the river. At one place a cast iron pipe with a diameter of 53 cm was responsible for transferring water to the left bank of the Tugela River over a distance of 10.8 km. There was a weir on a dolerite dyke in the Tugela, which formed a small waterfall. The offtake of the canal was some distance above the weir and this caused the furrow to be filled with silts.[346]

In 1909 the colonial department requested the Trappist monk, Father Nivard, a highly respected architect and engineer of the religious order, to advise them on making the works more efficient.[347] Then officials from the Natal Department of Public Works reported on urgent steps required to make the appropriate repairs.[348] Officials from the irrigation department were responsible for the repairs and improvements to the canal for irrigation along the Tugela River.[349] Soon there were three blocks of land of about 809 ha, of which about 405 ha were of a high quality for irrigation purposes. However, in 1912, Kanthack expressed the view that the department did not need to spend any more money on improving the irrigation scheme because it was only of limited value to the community. As far as he was concerned, the project had limited development potential.[350]

345. UG2/1914 (1914:32).

346. UG2/1914 (1914:7–8).

347. Brain (1982:64–65).

348. UG2/1914 (1914:32).

349. UG39/1912 (1912:7).

350. UG39/1912 (1912:8–9).

Mooi River

In many respects the Mooi River scheme resembled the Tugela irrigation scheme. Its water supply was taken from the Mooi about 24 km upstream of its junction with the Tugela. The canal extended over a distance of about 20 km and it could irrigate about 687 ha of which only about 405 ha proved to be fertile. About 200 ha were suitable for lucerne. The scheme cost about £27 000 to develop and local farmers paid £2 per acre per annum (ha/p/a) in rent. Furthermore, the scheme earned the department about £800 p/a and it could afford the salaries of local officials to the tune of £450.

Kanthack did seem to be more positive towards the Mooi River irrigation scheme, which was also under the supervision of the Natal Native Trust. The scheme provided irrigation water for about 688 ha of land of which 404 ha was good agricultural land. At the time plots of land were rented to Africans at a rate of £2 ha/p/a. The annual income generated from this project amounted to about £800. The cost of maintaining the scheme and paying the salaries of the local officials was estimated to be in the vicinity of £400.[351]

Commercial irrigation farming

The irrigation department gave substantial assistance to commercial irrigation farmers. From the mid-19th century there was vigorous growth in the farming sector of the Cape Colony as far as irrigation technology was concerned. Many initiatives came from private enterprise, before government stepped in to assist farmers in the 1870s.[352] By 1910 the irrigation sector in the Cape Province was bustling. Of the 45 applications received in 1910 for irrigation loans to the tune of £84 000, most came from private property owners. Only eight applications for loans came from cooperative irrigation boards.[353]

In the reports issued by the Director of Irrigation and by the Irrigation Commission in the 1920s, there were frequent references to loan applications, and departmental recommendations to government on projects undertaken by private interests.[354] One of the problems with private irrigation schemes was that they were not subject to governmental control. It was more a matter of irrigation farmers exerting influence on their elected politicians. Until 1916 farmers often dictated to the irrigation department where, when and how irrigation schemes had to be started up.

351. UG39/1912 (1912:9).

352. Lavin (2005:133–134); Langham-Carter (1971:3–5); Cape of Good Hope (1899:vii).

353. UG26/1911 (1911:3).

354. UG7/1929 (1929:3–5).

Hydrographical and general reconnaissance surveys were expensive and also took a great deal of time. As a rule, they were conducted after cooperative enterprises such as irrigation boards had been established by groups of farmers. According to Kanthack the consequence was that some schemes were not viable. This caused a crisis in the irrigation sector, most markedly as a result of the collapse of the ostrich feather market and the economic downturn in the aftermath of the outbreak of the First World War in 1914.[355] Private sector investments in irrigation technology on small farming units tended to be the driving force behind irresponsible speculation in land.[356] In 1924 Kanthack came to the conclusion that:

> The ostrich feather boom gave a great impetus to the promotion of irrigation schemes, but a large number of the promoters were much more concerned with the sale of their land at greatly enhanced prices than with the working of it.[357]

The government frequently had to intervene and take over irrigation schemes in an effort to secure the livelihoods of communities that had settled in particular areas and invested in private irrigation schemes. The Sundays River scheme of the Smartt Syndicate and the subsequent development of a cooperative citrus industry in the Eastern Cape, is an example of this trend.[358]

In the mid-1910s Bathurst farmers reported good orange, pineapple and apple crops that were exported overseas.[359] There were also success stories of private irrigation schemes started by farmers on their own initiative. In 1924 the civil engineer, C.D.H. Braine, published an article in *The Star* that was later re-published in the *Agricultural Journal of South Africa,* in which examples were given of how individual farmers in the Transvaal had been able to use the available water on their land and had established their own irrigation systems.[360]

Views on government and irrigation

In the 1920s there was a strong voice for larger numbers of settlers on the land to make irrigation more viable. Both engineers and leading entrepreneurs were confident of the country's farming potential. What was needed was more people.[361] In 1924 both Kanthack (writing as a former head of the irrigation department) and the engineer C.D.H. Braine (specialising in irrigation development) emphasised that it was often a case of the population being too

355. Kanthack (1924a:174–181; 1924b).

356. Forde (1925:347).

357. Kanthack (1924:176).

358. Lavin (2005:133–149).

359. Webber (1916:48–50).

360. Braine (1924b:66–71).

361. Agricultural Journal of South Africa (1921:73–75).

sparse to warrant the development of an irrigation scheme.[362] Another engineer, C.D. Forde, pointed out that for South Africa's irrigation sector this was a problem of major proportions.[363] Braine was convinced that if enough people could be found to apply themselves to farming, it would justify large irrigation schemes.[364] Ironically, the potential of black settlers on the land outside the native reserves, never became an active part of the government's planning in promoting irrigation.

In 1925, irrigation in South Africa was still considered a little known, relatively new technology, but underutilised. Of the 1.3 million km^2 of farming land in South Africa, a mere fraction was under irrigation. Given the fact that modern irrigation was a fairly new technology that held considerable promise, Forde felt this was a pity. There was also a growing awareness that it would hardly be possible in the Karoo and the western parts of the Orange Free State to practise modern farming unless irrigation technology was put to use.[365]

On a personal level, Kanthack tended to favour private sector initiatives aimed at promoting farming and irrigation developments, while A.D. Lewis, Kanthack's successor in 1921 as director of the irrigation department, was a firm supporter of irrigation development per se. He provided government with substantial advice on the establishment of a permanent irrigation commission, which would in time to come play a major role in the water governance of the Union.[366] Lewis felt that the only way forward was to attract more farmers to irrigation settlements.[367]

By mid-century, L.A. Mackenzie, director of the irrigation department, saw the evolution of irrigation settlement populations in a different light to his predecessors. In a 1947 report he explained that early irrigation farmers had more land than they could work themselves, or could economically irrigate. This meant that the land was subdivided and sold at inflated prices. The effect was that before long, buyers of land found themselves unable to meet their debt to the state, and the government was obliged to write off the capital and interest. Meanwhile, most of the farmers who had originally started the irrigation had cleared out, and 'a few benefited at the expense of the many'.[368] In the case of a few boards this was not the case. However, they were said to be in the minority.

362. Braine (1924a:202–206); Kanthack (1910:174–181).

363. Forde (1925:342).

364. Braine (1924a:204).

365. Forde (1925:342).

366. RP91/1989 (1989:17).

367. UG25/1926 (1926:1).

368. Addendum: The irrigation department: Its functions, operation and policy, in Mackenzie (1947:11).

Conclusion

The first quarter of the 20th century is notable for the way a young state, controlled by people of European descent, rose from the ashes of a destructive war and was able to form a unitary state and create a system of water governance that served the hydraulic mission of food production. The exchange of ideas and systems of governance between the former Afrikaner republics and British colonies contributed to a greater pool of knowledge in the Department of Irrigation.

This proved of vital importance in the future development of the country's water resources. Politically, it was not a period of tranquillity. The clear cultural differences between the main groups of European descent (English and Dutch/Afrikaans speakers) simply ignored the relevance of the country's indigenous people for the more comprehensive development of South Africa. Political infighting in parliamentary politics saw numerous changes in the ministers responsible for the oversight of the irrigation department.

Fortunately, the senior management of the department was not subject to significant change, with only two directors, F.E. Kanthack (1910–1920) and A.D. Lewis (1920–1941) at the helm of operations. There were indications of continuity and significant institutional knowledge in the young department, and both management and officials were innovative. They worked hard in the water administration circles, at the frontline of irrigation operations, and on the development of schemes with significant water storage capacity.

Moreover, they used new technologies and focused on scientific work that was destined to serve the department well in later years. Despite the First World War (1914–1918) and industrial violence in the form of the white mineworkers' unrest on the Witwatersrand in 1922, the state flourished. The irrigation department's officials supported the development of the farming sector and – via the Rand Water Board – in the development of the country's gold mining sector and the emergent metropolitan areas of country. The department's management realised the importance of nurturing the engineering profession in the private sector. Their skills in the development of large urban potable water, wastewater and storm water infrastructure were vital to South Africa's development.

Chapter 3

Irrigation, pact and fusion: Traces of adaptive governance

Introduction

From an environmental perspective, the death in 1919 of Louis Botha marked the onset of a state of social ecological collapse in South Africa. Botha's successor as prime minister, J.C. Smuts, was unable to muster sufficient political capital to respond appropriately to a process of creative destruction that had its roots in the troubled political and economic atmosphere of a world war, and with drought and flood disaster conditions that required government and the country's farming sector to engage constructively with aquatic systems that had been altered by technological interventions. The situation required what is described in resilience studies as an 'adaptive management' approach, which flourishes under specific social, economic and governance circumstances to facilitate appropriate change.[369] Despite a number of remedial measures by the Smuts government and concerted efforts by the Department of Irrigation to resolve problems, the resilience of many pioneering irrigation farmers was at risk of being compromised.

How to cite: Tempelhoff, J.W.N., 2018, 'Irrigation, pact and fusion: Traces of adaptive governance', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 85–134, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.03

369. Gunderson and Light (2006:323–334).

In the aftermath of the First World War, the country's economy never quite recovered. Recessionary conditions and the poor performance of the economy boosted the social mobility of the country's population. Many rural South Africans drifted into the country's urban areas in search of jobs and better socio-economic opportunities. The country's agricultural sector was in the doldrums. In the southern Cape and Little Karoo, ostrich farmers had not yet recovered from the wartime ostrich feather market collapse.[370] Furthermore, the wool farming sector was also struggling.[371]

By contrast, in the irrigation farming sector there was evidence of entrepreneurial irrigators with sufficient skills who appeared to be capable of producing smart profits. However, this was confined to specific parts of the country – mostly areas with a long history of irrigation farming in the Cape Province. Despite positive reports on the performance of Transvaal's progressive entrepreneurial irrigation farmers,[372] a number of local issues prevented farmers from making a breakthrough in other parts of the country.

Problems in the irrigation sector included; a lack of the mastery of irrigation technology, too little engineering expertise, and the need for improved marketing opportunities for the irrigation farmers' produce. Much the same could be said of the Orange Free State's irrigation schemes. There was uncertainty about the most profitable crops farmers should focus on. In the Cape, lucerne, citrus, deciduous fruit, subtropical vegetables, fruits and vines proved to be ideal.[373] But it did not mean that Transvaal irrigators could do the same.

Ultimately it meant that government departments had to become a driving force for change. Given the work done by the Department of Agriculture in all parts of the country, there was a good reason for the Department of Irrigation to become more proactive in supporting irrigation schemes in the northern provinces. However, it required political will and effective leadership to focus the initiatives of dedicated civil servants on a hydraulic mission that favoured agriculture and specifically food production. Interdepartmental collaboration was key to realisation of this hydraulic mission. The opportunity for collaboration presented itself in the era of the depression of the 1930s.

What started out as a comprehensive poverty reduction strategy in social ecological terms became a cumulative panarchy phase of conservation of

370. Tatlow (1924:284).

371. Freund (2011:220–221); Feinstein (2005:118).

372. Braine (1924b:66–71).

373. Kanthack (1924b:27); Lewis (1925:4–16); Journal of the Department of Agriculture (1925:377–378).

water resources that was destined to have a profound impact on water governance and the hydraulic mission of the department. As will be explained below, the panarchy conservation phase (K-phase) of accumulative water resource development, at the time of the Second World War (1939–1945), paved the way for a new phase of creative destruction, requiring water governance authorities to make alterations to a hydraulic mission in which industrial development and energy resources were prioritised.

■ The political dynamics of adaptive governance

In 1924, the primary preoccupation of the new 'Pact' government led by Prime Minister J.B.M. Herzog was to deal with an agenda that appealed to a well-defined constituency. The NP's support lay with white Afrikaners who, although still primarily resident in rural areas, were drifting to the cities seeking employment in the public and private sector. The other Pact government partner, the LP, focused on the white urban working class. By 1929 the LP was a spent force, but Hertzog continued to support its leadership and kept white labour's leaders in his government.

The African working class, living under restrictive circumstances in mine-owned hostels, tended to be more representative of the 'real' working class in South Africa, but they were largely marginalised. Most had no vote. The only places where a small number of Africans had voting rights were in the provinces of the Cape and Natal where the franchise was subject to domicile and a reasonable level of wealth. Many unskilled workers on the mines and in industry were migrants from neighbouring colonial states, as well as from South Africa's rural native reserves and white-owned farms. African workers were severely hampered by colour bar legislation that was introduced as early as 1911, with the *Native Labour Regulation Act* that prescribed the types of labour, mostly inferior and unskilled work, for which they were eligible.[374]

More repressive legislation followed in 1924, culminating in the *Mines and Works Act* of 1926, which delineated the colour bar between white and black labour.[375] In the new industrial urban areas Africans were largely migrants who, like their white counterparts, sought opportunities to make a living in a modernising society. Whereas an influential grouping of urban whites set the pace for the development of a free enterprise economy, this was not the case in the African urban environment. Instead, the new black working class, received attention from the South African Communist Party, which chose to shun government because it had become insensitive to the values of working

374. Bonner (2011:254).

375. Bundy (2016:59).

class people of all races.[376] In the rural areas, as will be discussed below, there were strategies to promote agriculture, but these were not effective in reducing the process of urbanisation. The expanding urban areas became desirable destinations of residence for many South Africans, as job opportunities improved after the depression in 1933.

Although Hertzog's NP did not control the country's urban areas, it was well-organised in the rural areas, where the prime focus was on white indigence. The active propagation of community support by the cultural mainstream of Afrikaans churches and educational institutions saw government making commitments of support, especially to the country's poor whites. Much like Smuts, Hertzog was aware of the voting power, arrogance and presumptive demands of the impoverished whites.[377] His government, therefore, made concerted efforts to secure job opportunities for the poor in the irrigation sector, government construction works, the state iron and steel industry (Iscor), on the railways and in the state's forestry sector.[378]

A prime, but futile, objective was to encourage people to remain in the country's rural areas instead of swelling the steady stream of migration to the urban areas.[379] The growth of urbanisation was rapid. In 1890 fewer than 10 000 (2% – 3%) Afrikaans-speaking whites lived in South Africa's urban areas. In 1926, they numbered 391 000 (41%); and by 1936 more than 535 000 (50%) of the country's Afrikaners lived in the densely populated urban areas.[380]

Welfare reform

Welfare reform and the upliftment of indigent whites became an increasingly important item on the government's agenda.[381] The development of irrigation settlement schemes offered one answer to the dilemma of dealing with white poverty and stemming the tide of urbanisation. Since the 1870s, progressive land acquisition by entrepreneurial farming interests had led to the removal of poor whites from rural areas in the Cape.[382] In the interior of the country, many whites had been economically marginalised by the destruction of farms during the Anglo-Boer War (1899–1902) – now more popularly known as the South African War – and found themselves unable to make economic headway.

376. Bonner (2011:301–302).

377. Giliomee (2003:344–345).

378. Bennett and Kruger (2015:109–114); Bundy (2016:50–51).

379. Jansen (1930:38).

380. Giliomee (2002:612).

381. Seekings (2007:384).

382. Bundy (2016:41–49).

Not only had they become financially disadvantaged, they had lost out on access to opportunities of cultural capital, such as knowledge of new farming and industrial technologies. Their absorption into the irrigation sector was a potential avenue of development. Initially, indigent rural white men were taken in as labourers on the construction sites of dams and irrigation schemes; they were identified as potential settlers who, with the necessary guidance, might become farmers on government developed irrigation schemes.[383]

The political and economic drive to create irrigation communities for uplifting poor whites also had an exogenous benchmark. As indicated in previous chapters, the US set the best example in this regard. In the 1920s, E.G. Malherbe, a South African postgraduate student in education studies at Columbia University in New York, brought the issue of South Africa's poor whites to the attention of the staff of the philanthropic Carnegie Corporation in the US. At the time, the Americans were grappling with the predicament of their own indigent whites in the southern states.[384] When the corporation made funding available for research on South Africa's poor whites, it was more than a mere gesture of American altruism towards South Africa. Similarities between the South African poor and their American counterparts made for a better understanding of the socio-economic predicaments of an emergent class of people of European descent who were no longer resident on the European continent.

There were lessons to be learnt, and a comparative focus on white poverty made for well-informed strategies by the governments of the US and South Africa. At the request of the South African government, the Carnegie report was compiled into five volumes by academics at the University of Stellenbosch and it shed significant light on the phenomenon of white poverty in the country. The commission made valuable recommendations on strategies to address the problem that became most pronounced at the time of the worldwide economic depression (1930–1933).[385] In the case of South Africa, the use of water to promote sound farming opportunities for food production became a primary driver of development. The irrigation department's original hydraulic mission to develop irrigation infrastructure and conserve water resources for its effective distribution to consumers, reached a peak in the latter half of the 1930s.

The study of South Africa's poor whites benefited immensely from the US engagement. The time was ripe for a cultural engagement with American modernity. As early as the 1910s there had been several *volkskongresse* (peoples' congresses) where Afrikaans church leaders, the educated elite and

383. Tempelhoff (2006).

384. Bell (2000:481–504); Giliomee (2003:346).

385. Grosskopf (1932); Wilcocks (1932); Malherbe (1932); Murray (1932); Albertyn and Rothmann (1932).

politicians deliberated on strategies to address white poverty.[386] But the youthful country was in an emergent phase of statehood, and government focused on economic development. The First World War was an exogenous catalyst that caused a phase of social and economic creative destruction.

Politically, the cycle of panarchy favoured the revival of Afrikaner nationalism, white working class interests and keeping a check on unbridled capitalist enterprise. In the period of the Hertzog government, beginning in 1924, the corrective strategy of accumulative social and economic growth was to secure taxation of the industrial sector to pay for government's development agenda.[387] Government was aware of the need to prepare and educate the poor in both the rural and the urban areas. In the irrigation sector, the Carnegie report's findings shaped the thinking of government advisers.[388]

Political adaptation and fusion government

The mining sector was not necessarily the goose that laid the golden egg for the South African economy during the depression era (1930–1933). Instead, conditions of intense economic collapse and ecological debilitation due to drought paved the way for the constructive development of the country. The need for a spontaneous adaptive governance approach was part of the social ecological system under which government operated. The worldwide economic depression (1929–1933) in the case of South Africa, coincided with drought conditions (1930–1933). Poverty became widespread and there was mounting political uncertainty. In 1932, Hertzog's NP lost a key by-election in Germiston. The government was keen to keep South Africa on the gold standard in the best economic interests of the country, although the rest of the world tended to have abandoned it.[389]

However, an intervention by the mercurial politician, Tielman Roos, shifted government's thinking,[390] making it possible for the NP and Smuts' opposition SAP to find common ground on a strategy to address white poverty in South Africa. The outcome was the formation of the fusion government (NP and SAP) as the new United Party (UP). Hertzog became premier and Smuts was his deputy, in a dispensation that lasted until the outbreak of the Second World War in 1939.[391]

386. Tempelhoff (2006:9–10).

387. Turton et al. (2004:17).

388. Tempelhoff (2006:24–26).

389. Pogue (2006:88, 117, 140, 146, 165).

390. Minnaar (1990:106–107); De Villiers (2004:169).

391. Freund (2011:215).

The spontaneous process of adaptive management to create an integrated South African society was the product of a complex social ecology that flew in the face of many Afrikaner nationalist principles. However, the environmental, political and governance conditions were conducive to the establishment of an adaptive governance system.

The new government, in a manner similar to Roosevelt's New Deal plan in the US, began to intervene in the lives of South Africans on an unprecedented scale. For example, there were informal measures taken by local authorities in Johannesburg and Cape Town to introduce residential segregation between whites and people of colour. Whites were accommodated in more favourable residential areas with better facilities,[392] preparing the way for other disparities, for example in water infrastructure services.

Creating an exclusively privileged white population made it possible for government to marginalise people of colour and, in the process, create a precise focus on better economic livelihoods for whites. The dismal circumstances of the poor whites made it possible for government to take a more authoritarian stand and pave the way for a form of local coercion in some irrigation schemes, especially in the 'labour colonies'.[393] These colonies, dating back to the 19th century, were created under the auspices of the Dutch Reformed Church in the Cape, and were tantamount to authoritarian labour communities. By the 1920s they made it possible for the government to introduce an even more coercive form of local governance and social coordination in rural communities. The thinking was that a docile civil society made it possible to govern the people better.

In the Cape Province, where the Dutch Reformed Church had a long tradition of engagement with the Afrikaner *volk*, the church provided a strong working base for a tradition of local governance in which the church supported a disciplined authoritarian inclination. The consequences were not always negative. Kakamas labour colony on the banks of the Lower Orange River in the 1890s, was a prime example of the role the church could play in developing irrigation communities.[394]

Despite the growing authority of central government in the country's rural areas after 1910, religious governance continued to play a significant role in many successful irrigation communities by the 1930s.[395] Furthermore, authoritarianism was not confined to religious communities. What appears to be evident is that thought systems with an authoritarian inclination are

392. Giliomee (2002:612).

393. Roos (2011:54–67).

394. Rossouw (1951).

395. Visser (2015:58, 241–242, 302); Van Jaarsveld (1982:17, 21, 43, 49, 120–121, 134, 242).

conducive to the development of sustainable irrigation systems. This sweeping generalisation sounds somewhat far-fetched, but in the first half of the 20th century Wittfogel reported on a long tradition of Asian authoritarianism observed in the management of China's irrigation systems. He subsequently formulated the principle that because they rely on extensive planning and orderly system operations, irrigation schemes tend to thrive on a culture of authoritarian governance.[396] It is posited that an anthropogenic social ecology of technology-driven water governance and consumption in South Africa also paved the way for a rural farming society obedient to the state.

What is associated with a form of authoritarianism could be the result of a free will – an individual, or a community, resorting to life in a 'technium' mode. Kevin Kelly, an American philosopher of technology, developed the term to explain how culture and technology form a technium, in which people subject themselves to rules and a system of conformity to integrate optimally with a comprehensive technological infrastructure.[397] In the case of irrigation, the cultural component of interacting with the environment forms part of an ecological system and the environmental affordance of a resource under specified cultural conditions. When irrigation labour colonies exhibit an authoritarian character, it is because participants, as a group, want to be part of the evolving technium.

■ Developments in the water sector

In the 1920s the Department of Irrigation was in good hands under the directorship of A.D. Lewis, the longest serving departmental head in its history (Figure 3.1). Lewis was at the forefront of strategies aimed at securing more government funds for the development of water storage facilities and irrigation schemes. By 1922 it had become increasingly difficult for the department to grant loans to farmers; the stark reality was that the department's first golden era of dam construction had come to an end. In the transition to the Pact government under Hertzog in 1924, funds were also limited, because the government decided to wait until its Irrigation Finance Commission had finished its deliberations and made its recommendations on irrigation and water developments.

In the Smuts era, government had extended loans to the Eastern Cape's irrigation sector, where there was a strong political support base. In contrast, under the Hertzog government, funds were released in fairly small amounts to support indigent white irrigation farmers.[398] This strategy, applied until 1930,

396. Wittfogel (1957).

397. Kelly (2009, 2017).

398. Bennett and Kruger (2015:97–98).

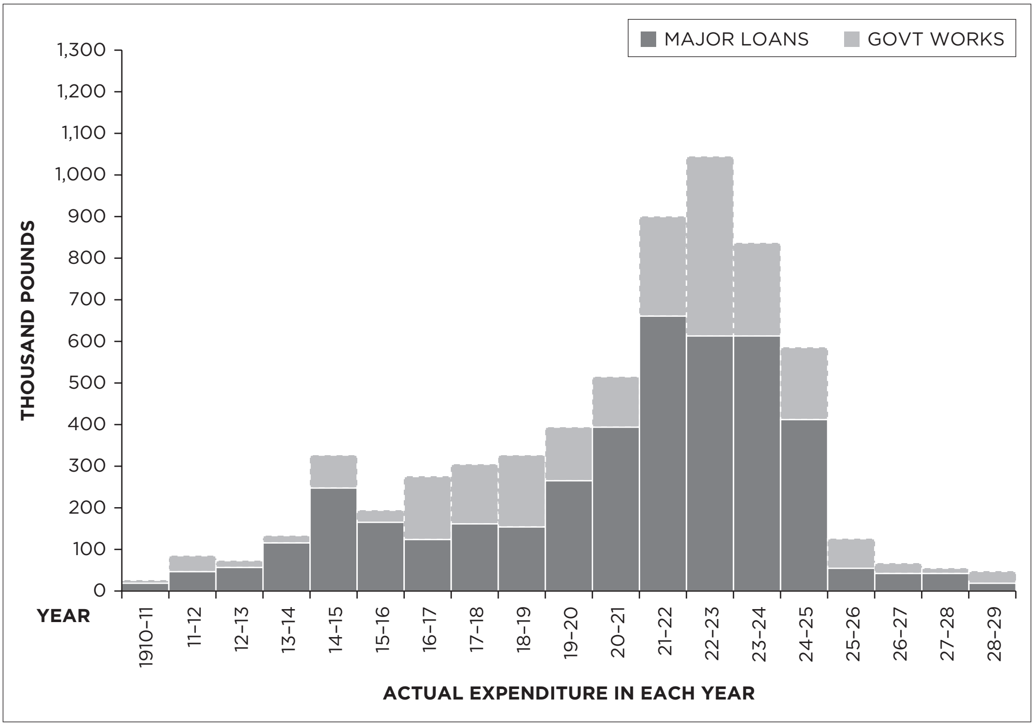
Source: Department of Water Affairs (1987:21).
FIGURE 3.1: Alfred Dale Lewis, the longest serving departmental head (1921–1941).

had a marked effect on how government financed its schemes and extended loans to the irrigation sector.

Lewis was able to identify a bell curve in government expenditure on water-related development for the period 1910 to 1929 (please refer to Figure 3.2), making it clear how marked the decline was.

Although the trend for the period 1926 to 1929 was one of the growth of small irrigation projects with the support of government loans, many of these schemes were projects that had been in operation for a considerable period. Government funding for construction work and loans to the irrigation sector were frequently the result of earlier investment and development. Lewis maintained that the trend held few prospects for future development in the irrigation sector of South Africa.[399] However, after 1930 the picture changed rapidly.

399. UG9/1930 (1930:6).



Source: UG9/1930 (1930:6).

FIGURE 3.2: Lewis's view of the actual expenditure by the state on major loans and government works in the period 1910 to 1929.

Departmental surveys

Although the construction of dams declined in the mid-1920s, officials of the irrigation department continued with surveys on sites that were potentially ideal for the development of dams and irrigation infrastructure. The funds for costly construction were seldom at hand, but surveys at least contributed to a greater knowledge of South African river catchments and their hydrological usefulness. In the 1930s, when the demand increased for dams and irrigation schemes at relatively short notice, there were many to choose from. In the Middle Orange River, work had been ongoing since 1922 to identify irrigable lands in the Brak River Vlei, scheduled to fall under the proposed Vanderkloof scheme. At the time, it was estimated the site could yield irrigable land of up to 51 400 ha.[400]

The Vaal–Rhenoster irrigation scheme was given to a select committee to investigate – a project that began in 1921 and reached completion in 1925.[401] In the same year the first comprehensive surveys of the future Vaalharts

400. UG16/1927 (1927:13).

401. Whysal (1944:17).

scheme started.[402] Other irrigation department officials participated in the 1925 Kalahari reconnaissance expedition. Their surveys were submitted to the Department of Irrigation in 1926.[403] In 1927 two survey teams started working on the Riet River Valley from a point about 24 km from Koffiefontein, up to the confluence of the Riet and Modder River.[404]

In 1927, a survey team worked on the Breede River from a point near Lake Marais, to Ashton station.[405] In the same year a survey team started working on the Koppies irrigation scheme to determine what height the storage dam's crest should be if the water was used for flood drainage.[406] The Department of Irrigation was also responsible for a survey on the municipal lands of Pretoria for the local Chamber of Commerce and Industry. Work was done on the selection of a suitable site for a factory for the new parastatal Iron and Steel Corporation (Iscor). No other state department was in a position to conduct an investigation of this nature. About a month after the project was started in August 1927, the survey was halted and then held in abeyance awaiting acceptance of the South African Iron and Steel Industry bill by parliament.[407]

In the financial year 1927 to 1928 the Department of Irrigation conducted a comprehensive survey of the Black Umfolozi River in Natal. It collaborated with the office of the Department of Native Affairs and the chief section engineer of the irrigation department for the province. The Department of Native Affairs contributed £200 to the survey.[408] When the depression began to bite and unemployment became a serious issue there were numerous surveys of potential water schemes available to choose from.

■ The Irrigation Finance Commission

In the 20th century the appointment of commissions to investigate and make recommendations on water matters proved to be a highly successful device for the country's political leadership.[409] It was an effective tool to deal with latent socio-economic problems.[410] It was also an opportunity to bring politicians up to speed with critical and complex problems that required their attention.

402. UG16/1927 (1926:13).

403. UG16/1927 (1926:13).

404. UG16/1928 (1928:7).

405. UG16/1928 (1928:7).

406. UG16/1928 (1928:7).

407. UG8/1929 (1929:6).

408. UG16/1928 (1928:7).

409. See Louw (2014:26–29) and Hurley (1906:733–742).

410. Roos (2011:55–57).

Shortly after assuming control in 1924, the Hertzog government appointed an 'irrigation finances commission' – a management body the likes of which A.D. Lewis, director of the irrigation department, had earlier studied at close quarters in Australia.[411]

As early as 1923, politicians had been talking about just such a commission to investigate the financial position of irrigation works constructed with government funds. The objective was to establish a permanent commission that would administer and coordinate engineering, settlement, financial and other matters related to irrigation schemes.[412]

Since 1910 there had been substantial government expenditure on irrigation infrastructure. By 1924 it totalled £4 784 000.[413] However, much more needed to be done. In 1925, the engineer C.D. Forde pointed to the fact that despite this expenditure, a mere 231 ha of agricultural land in South Africa was under irrigation. Irrigation technology was of vital importance if South Africa wanted to make headway in the arid regions of the Karoo and the western parts of the Orange Free State.[414] The former irrigation director, F.E. Kanthack, agreed; he was convinced that successful farming in the Cape and the southern Orange Free State depended on the availability of irrigation.[415] Excluding the provinces of Transvaal and Natal, he explained, it was all a matter of the size of the country's population and the availability of suitable land for irrigation farming. In 1924 he was optimistic, predicting that 2.6 million ha of land could be used for irrigation.[416] The estimate of A.D. Lewis, Kanthack's successor at the helm of the department, was slightly lower, at 2.4 million ha.[417]

It was with good reason that in 1925 Sir Horace Plunkett, a famous Anglo-Irish agricultural reformer, expressed the view that South Africa was still only in the pioneering phase of irrigation farming.[418] The area of land under consideration amounted to a mere 1% of the country's total land surface. Experts were confident that sufficient water would be available. The agricultural sector's gross value to the country's economy, in terms of food production, was 46.1%. However, the 31% nett value of imported goods (which included foodstuff), suggested that the country was still heavily reliant on imported goods and services.[419]

411. UG25/1926 (1926:1).

412. UG8/1923 (1923:1).

413. UG29/1925 (1925:6).

414. Forde (1925:342).

415. Kanthack (1924a:174).

416. Kanthack (1924a:174).

417. Kanthack (1924a:174–175).

418. Plunkett (1925:307).

419. Feinstein (2005:116).

The new Pact government of 1924 was aware that it had to reinvent the management of irrigation technology and the governance system if it was to achieve its goals. Therefore, government's appointment of a temporary irrigation commission was key to developing a roadmap. The idea was for the commission to provide expert advice on irrigation developments in South Africa.[420] As a preliminary measure the new Minister of Lands and Irrigation, P.W.G. Grobler, first appointed a short-term commission to report on the financial condition of the irrigation schemes developed with government funding. It also had to advise government on measures to bring relief. The four members of the commission were:

1. A.P.J. Fourie, a Cape-based Hertzog supporter and soon-to-be cabinet minister[421]
2. Montague Gadd, a well-known farmer of Middelburg (Cape) also favourably disposed towards the NP[422]
3. James Collie (OBE), a civil servant with extensive experience in the field of old age pensions and poverty alleviation in South Africa[423]
4. Reenen Jacob van Reenen (1884–1935), an engineer who had formerly worked in the Department of Irrigation.[424]

Van Reenen was a qualified civil engineer, born in Calvinia, who studied at the University of Cape Town and later at Lehigh University, Pennsylvania in the US. He was a member of an old and respected Cape family. Apart from writing Afrikaans literature, he specialised in the rock art of the San, ultimately becoming one of the first authors in the Afrikaans language on indigenous South African rock art. Van Reenen was highly rated as an engineer, scientist and government adviser.[425] He was responsible for important work in the water sector, but also advised on matters related to the country's historical monuments, low-grade mines, and proposed industrial legislation, as well as on the demarcation of the boundary between South West Africa (Namibia) and Angola.[426]

The commission received its instructions on 21 October 1924 and reported back five months later. It consulted extensively with a broad spectrum of stakeholders and there was a concerted effort to secure public participation.[427]

420. UG16/1927 (1927:4).

421. Liebenberg (1984:415, 440).

422. Kruger and Bennett (2013:165).

423. Seekings (2007:384).

424. Plug (2014:n.p.).

425. Nienaber (1977:837); Schoonees (1939:120); Plug (2016).

426. Duffy (2012:1–13); Plug (2014:n.p.).

427. UG29/1925 (1925:1–5).

The commissioners visited various irrigation schemes, interviewing as many as 136 people in all parts of the Cape. Participants included farmers, officials and communities of farmers at government and private irrigation schemes.[428] Senior civil servants interviewed included the director of irrigation, A.D. Lewis; J. Sommerville, the secretary for lands; P.J. du Toit, the secretary for agriculture; as well as the circle engineers, W. Farrant, T. Hopwood, E.M. Fincham, C.H. Warren and J. Espinase. The only problem was that the investigation was confined to the Cape Province.

The commission singled out several problem areas. The first was the need for closer settlement. A mere 10 966 ha of the country's land set aside for irrigation purposes belonged to farmers owning less than 42.84 ha per capita. Most farmers were unable to irrigate the large tracts of land they owned, yet they had to pay taxes on the land. The commissioners favoured plans to establish settlement schemes, so that irrigation farmers could make a profit on land that was worked intensively. In many cases, there was a lack of essential knowledge on the complex matters of irrigation farming practices. In contrast to dryland farming, the irrigation farmer had to work in a labour-intensive manner and required substantial capital. Then there was also the need for a sophisticated knowledge of how to use the land properly to prevent crop failures.[429]

The commission discovered that private irrigation schemes were not as successful as was generally believed. Only 101 780 ha (60%) of the land set aside by the state for private irrigation schemes had been developed. In many cases the quality of the properties sold by land companies to prospective irrigation farmers did not live up to expectations. Potential investors were not interested in taking up irrigation farming. Added to this, many new property owners were unable to pay back their loans. Government was between a rock and a hard place in terms of the funding and development of irrigation schemes. The commission's advice was that government should try and regain ownership of the unused land and make it available to irrigation farmers with expertise, who would make a success of their operations.[430]

Traditionally, irrigation schemes focused primarily on crops that would yield assured profits. Local farmers were familiar with the soil and knew how to use the available water supply. The commission singled out *zaaidam* irrigation in Calvinia's Brandvlei area. The land did not need extensive preparation before being planted and the overheads of working the land were relatively low, while profits were high.

In the case of ostrich farming, until the collapse of the feather market in 1914, many farmers had invested in irrigation. The crop produced most widely

428. UG29/1925 (1925:4).

429. UG29/1925 (1925:5–8).

430. UG29/1925 (1925:10–11).

was lucerne.[431] There was a widespread misconception that if the land and the water were available it would always be possible to produce crops and make a profit. Many farmers only realised when they experienced crop failure that it was essential to have sufficient capital to provide for the maintenance and upkeep of irrigation.

Public response on the first report was neutral. Parliamentarians and the prospective beneficiary communities they represented had consensus that more land could be used for irrigation. However, there were concerns that large amounts of government funds had to be invested in interest-free loans to farmers. This meant, in effect, that tax payers had to subsidise irrigation schemes.[432] Furthermore, the government was not in favour of a commission having such extensive powers.

Lewis himself, when at a later stage the matter was mooted again, spoke on behalf of the department's officials. He did not want to see officials subjected to more external authority. They performed a thankless task in the service of the state and the public. He went on to explain that although the expertise of the department's officials was highly useful to the public, officials seldom received recognition for the work they were doing.[433] The government was sensitive to the points that Lewis made and after 1925 took steps to address the discontent of the Department of Irrigation's officials. It was clear that the officials had an important role to play. Departmental engineering advice to the irrigation farming sector more than doubled by 1927. It was clear that the engineers rendered a valued service and would continue to do so in future.

The second report of the Irrigation Commission was completed on 25 October 1925. This time the commission's brief was more generic. Commissioners were asked to:

1. investigate the finances of government irrigation works
2. make recommendations on financial write-offs or any other form of financial relief that could secure a reasonable livelihood for irrigation farmers
3. make recommendations on conditions that should be laid down before financial relief was granted.

The commission had to look specifically at the acquisition of surplus land and determining how settlers could be placed on the land purchased by government in terms of the *Land Settlement Act*. At the same time, attention was to be given to a system of reasonable water rates and the elimination of administrative problems. Government wanted to know if it would make sense to create a

431. Van Reenen (1925:15).

432. Braine (1925:396).

433. UG8/1929 (1929:2).

permanent commission. Meanwhile the commission had to be ready, at the behest of the minister of lands, to investigate any matters related to irrigation.[434]

By 1925 the Hertzog government had taken effective control of the civil service. There was more self-confidence to interrogate the way irrigation loans had previously been approved by the director of irrigation and his administration. At the same time the Pact government was intent on keeping a check on funds for irrigation loans, reducing interest on loans, or scrapping the interest on loans.

The commission gave clarity to political decision makers on the role of private irrigation schemes and those initiated by government. It was evident there were inherent problems in the system. These should be dealt with in a systematic manner. The commission's report provided insight into the operations of large irrigation schemes such as the Sundays and the Great Fish River. There was a better understanding of the weaknesses and strengths of smaller irrigation schemes.

Government was satisfied with the report and Tielman Roos, the minister of justice and irrigation, even promoted the idea of turning the commission into a standing commission that would report to the legislative assembly. It made sense for him to have the annual report of the director of irrigation and the Irrigation Commission subjected simultaneously to parliamentary scrutiny. In effect, government could secure important information and a variety of perspectives on the engineering works, settlements, financial and agricultural activities that had to be made administratively uniform at all irrigation settlements in the country.[435]

But there was one major problem. By 1925 the idea of a permanent irrigation commission no longer appealed to Lewis. He had spent part of 1924 working in East Africa while the Hertzog government settled in. In his presidential address to the South African Institution of Civil Engineers (SAICE), Lewis bluntly questioned government's plan to introduce legislation for the creation of a permanent irrigation commission. In what was clearly a typical class issue, he stressed a trend in the working class to 'claim its territory'. It meant, he argued, that professional organisations such as SAICE should organise themselves better.[436] It was no more than a storm in a tea cup. Lewis was a highly respected engineer,[437] but like many South Africans he was inclined to take a more critical view of the new government's plans to provide support for the benefit of the poor whites.

In the same year, Reenen van Reenen, in his first address as newly-elected president of the South African Academy of Science's A Section, remarked that

434. UG44/1925 (1925).

435. UG25/1926 (1926:1).

436. Lewis (1925:5).

437. Bozzoli (1997:99).

private individuals had previously availed themselves of government loans for irrigation projects, but that in many such cases, borrowed money was not paid back.[438] Van Reenen was well informed. As member of the Irrigation Commission, he knew of a number of discrepancies in state loans. He was later to become the first chairperson of the permanent Irrigation Commission.

Van Reenen and Lewis did not see eye to eye. Government was in no hurry to grant the Irrigation Commission executive powers. Instead, the commission was to remain an advisory body, working under the minister's instruction and reporting to parliament. If there was to be an adversarial relationship between the head of the commission and the Department of Irrigation, it did not reflect on government. In his annual report for 1925, as director of the irrigation department, Lewis let it be known that he preferred the idea of an irrigation commissioner who was more focused on a strong administrative system, to take firm control of the financial administration of irrigation in South Africa.[439] Government ignored his objections.

The permanent commission began its formal operations on 01 June 1926. The *Irrigation Commission Act,* 33 of 1926,[440] determined that its membership would be confined to between three and five members; each would serve a five-year term.

In a relatively short time the commission had the responsibility of building up a comprehensive understanding of the way irrigation activities were conducted in all regions. Members personally visited irrigation works countrywide and reported to government on the adequacy of water supplies to any irrigation scheme and potential sites for developing new schemes. The commission was also required to report on trends in the irrigation sector and make recommendations to mitigate negative circumstances.

Once the permanent Irrigation Commission began its operations, the government had access to a more reliable system of controlling its expenditure on irrigation, especially the non-paying irrigation schemes that prevented the department from functioning properly. In its first decade the commission conducted painstaking investigations, often in person and on site at irrigation settlements or prospective scheme sites, in various parts of the country. It also put an end to easy government loans for irrigation farmers.[441] Better supervision and a more disciplined private sector paid dividends. For example, the White River settlement in the Lowveld was revived in 1927.[442]

438. Van Reenen (1925:25).

439. UG16/1927 (1927:4).

440. Murray et al. (1952:425–432).

441. UG14/1937 (1937:1).

442. UG7/1929 (1929:5).

In the first years of the new government, the Irrigation Commission did not readily advise government to make funding available. Lewis's concern was that before more schemes were launched for large storage facilities in the arid parts of the country, a decision had to be taken on promoting settlement schemes – either by means of state subsidies, or more dense settlements.[443]

In his annual report of the irrigation department for 1928 to 1929 Lewis submitted details of government spending on irrigation. He was concerned that expenditure on actual construction had come to a standstill. Strategically, to prove his point, Lewis acknowledged that he had omitted the amount spent in government funding on smaller schemes. Neither did he include projects scheduled for construction which had not yet started.[444]

Lewis maintained that government works on irrigation projects had seemed to peak between 1914 and 1915; only to resume effectively again in 1917 to 1918. Then followed a collapse after the war. It was followed by another peak in government spending in 1920 to 1921. Government investment in irrigation infrastructure coincided with loans being extended to irrigation farmers, except for the post-1918 depression period, when government tended to favour paying indigent labourers working on government schemes, such as the Hartbeespoort Dam.

By the late 1920s the Irrigation Commission had built up a formidable body of knowledge of the conditions facing irrigation farmers and it was able to advise government on issues such as loans and collective schemes. Commissioners had worked in consultation with farming communities and officials on a number of strategies to secure government financial support.[445] However, nothing came of many plans on offer. Instead, the commission's vast amount of knowledge on irrigation, the technology's locations and storage sites in various parts of the country, was destined to be used at a much later stage.

■ The economic depression and departmental water schemes

In 1930 the Irrigation Commission became part of an interdepartmental committee, called together by the minister of labour and the various employment-related departments, to address the issue of unemployment. The ramifications of the worldwide economic depression were beginning to settle into the fibre of South African society. The Department of Irrigation reported that in terms of the state's relief fund legislation, relief funds had been made available via water boards to farmers who were unable to pay their water rates. One of the key reasons for the impasse was that farmers were unable to secure

443. UG16/1928 (1928:4).

444. UG9/1930 (1930:5).

445. UG3/1931 (1931:68–69).

appropriate prices for their produce.[446] In one situation, in 1931 government even took over the McGregor irrigation scheme from the local municipality, when it was unable to finance ongoing operations. In addition, there was relief on rates instalments that had fallen in arears.[447]

Water-boring regulations were adjusted in September 1930, providing for rebates to farmers who made use of the department's boring services if the boreholes did not yield sufficient water during the drought.[448] Furthermore, the Irrigation Commission made recommendations to government on strategies to defray the costs of borehole drilling in cases where farmers were unable to pay for the work done.

By 1932 there were 124 irrigation boards and four river districts in South Africa. An exceptional number of irrigation institutions were placed under government administration because of the economic depression and the crippling drought. Examples were the irrigation boards at Prins River, Bellair, Olifants River, Smalfontein, McGregor, the Lower Seacow, Spekboom, Zandspruit and Klerksdorp.[449]

Government support to these boards varied from administrative assistance to accounting services, for which the boards were unable to pay. In some cases, the existing arrangement of government relief implied total relief. In others the department had to undertake repairs where works had not been maintained for a long time. In 1932 a total of 73 irrigation boards received irrigation loans from the government to the value of £4.5m. In only 23 irrigation districts were there schemes without government loan funding. In terms of alternative government funding the Department of Labour was an important role player. It provided funding for the irrigation schemes of Buchuberg and Oukloof. This government support increased from £227 039 in 1931, to £462 018 in 1932.[450] Like its predecessor, the Hertzog government became well aware of the capital-intensive nature of irrigation farming development.

Although the depression era is generally associated with social and economic deprivation in South Africa, it was an ideal time for the Department of Irrigation to embark on the second 'golden period' of dam construction, by setting up water schemes and irrigation operations that served the country well in the future. In a panarchy context it was a typical K-phase of social ecological development. The department embraced the opportunity of using relatively cheap human resources at a time of social and economic uncertainty to realise the conservation objective of its hydraulic mission.

446. UG10/1932 (1932:15).

447. UG9/1932 (1932:16).

448. UG10/1932 (1931:17).

449. UG12/1933 (1933:16).

450. UG10/1932 (1932:5).

There is reason to believe that the creation of the United Party government by 1934 was beneficial for irrigation infrastructure development. Deneys Reitz, who served as Minister of Irrigation and lands in the era of Louis Botha and Smuts (1918–1924) had a wealth of knowledge that that was useful to the Hertzog cabinet. For example, Reitz had been informed in the 1920s of the potential of developing the Vaalharts Irrigation Scheme – a plan mooted by Cecil Rhodes in the 19th century. Vaalharts and the Vaal Dam would become the edifice of 1930s irrigation development in South Africa. Reitz had been part of the 'first golden era' of water development. Moreover, he and the irrigation department director, A.D. Lewis, had an amicable relationship. It paved the way for the 'second golden era' of dam construction. It was possible for Reitz, also serving in the agriculture portfolio in cabinet, to create a synergy between the irrigation department and that of agriculture. Government benefited too.[451] The outcome was the realisation of government's policy of white poverty alleviation in the rural areas of the country.

In the first half of the 20th century the contribution of the Department of Irrigation to the farming industry of South Africa, and specifically the irrigation sector, was enormous. The department was committed to farming at the grassroots level. In the mid-1930s, for example, A.D. Lewis published a useful paper on the construction of small farm dams across streams for irrigation farmers in times of drought.[452] Financially, the department's contribution to irrigation schemes was even bigger. By 1935, 25 years after Union, the department had spent about £11m on irrigation.[453]

Lewis estimated that loan write-offs to the irrigation sector, especially in the depression era was about £4.5m. Dam construction projects required a large purse. By 1938 the department's annual spending exceeded £2m – for the first time in the history of the department. Most of the money was used for the construction work at the dams of Vaalbank (Vaal), Loskop and Kalkfontein. When these projects were almost completed the annual expenditure of the department was 10 times more than a decade earlier.[454] It was at about this time that the second wave of dam construction since the formation of the Union in 1910, drew to a close.[455]

Many projects were not merely intended to relieve poverty. Instead, they enabled the irrigation department to set up irrigation and water storage

451. Reitz (1943:196–205, 214–218, 228).

452. Lewis (1935).

453. UG15/1936 (1936:8).

454. UG12/1939 (1939:7).

455. SAWHAR WLC B572 (1986:2).

schemes for which there had not previously been funds. In the long-term it was a sound investment in water infrastructure.

In the next sections we trace the investments made in the development of irrigation and water-related infrastructure in each of the four provinces of the Union.

Cape Province

Local history has it that in precolonial times, the Griqua people were responsible for the first weir in the region of Buchuberg, on the banks of the Orange River in the north-western part of the Cape. They had apparently placed rocks in the river to create a water storage facility. In the colonial period there were plans since the 1870s for the construction of a dam and irrigation scheme at Buchuberg. Only by the 1920s, after the Irrigation Commission investigated the scheme,[456] did the government approve of the Buchuberg scheme.[457]

Ostensibly the aim was to provide an income for unemployed whites. The depression had begun to bite and there was incipient poverty in the north-western parts of the Cape. Although construction work was primarily intended for uneducated people, or those insufficiently qualified, once the depression began in 1929, even educated people found themselves unemployed. Agricultural products fell to rock bottom prices and many farmers could not meet all their creditors. To make matters even worse, there was a long period of drought. Many farmers were forced to leave their farms to look for work.[458]

A future secretary of the Department of Water Affairs, J.M. Jordaan (1960–1969), cut his teeth as a youthful assistant engineer on the Buchuberg project in the years 1930 to 1931 where he met his wife (then a teacher at the local construction site school).[459] The local community gradually picked itself up and residents could once again make a living. The development of the irrigation project drew to a close in the mid-1930s when the country's economy improved.

By 1933, work was also under way at the Olifants River in the Cape where, close to Clanwilliam, an additional storage dam was under construction. Surveyors were also on the lookout for more storage facilities in the tributaries of the Doorn River. In total, £6400 was paid out for the maintenance of the Olifants River irrigation scheme with an additional £5400 from loan accounts. Most of the labour was carried out by white people who had been recruited by

456. UG7/1929 (1929:19); Van Zyl (2007:13–14, 18).

457. Turton et al. (2004:170–171).

458. Venter (1970b:318–319).

459. SAWHAR DH8/article J.M. Jordaan Collection (1995:18); SAWHAR DH8/J003 (1996:98).

the Department of Labour. People of colour were employed for construction work on the roads.[460]

At the Olifants River extension works on the Clanwilliam Dam an average of 262 whites and 366 coloureds worked on the project in the period 1934 to 1935. By the end of the financial year there were only four whites working on the site. White workers received a daily wage of four shillings and eightpence, while coloured workers were paid two shillings and sixpence. At Vioolsdrift and Beenbreek, also in the Northern Cape, where construction work on irrigation schemes was anticipated to be completed by September 1935, both whites and coloureds were employed. The whites slept in bell tents, two to a tent, while the coloureds slept on the opposite bank of the river. Workers were divided into separate workers' gangs according to race.[461]

Transvaal

In the Transvaal, employment opportunities for indigents were in place even before the depression. In 1927 government made funding available for an irrigation loan extending over a period of 40 years for the construction of the Olifantsnek irrigation scheme on the Hex River at Rustenburg.[462] As the economic depression deepened, the department, collaborating with the Department of Labour, made increasing use of white labour on construction projects. Irrigation department illustrations of the Marico-Bosveld Dam project shed light on how labour was used in the depression years (Figure 3.3 and Figure 3.4). They also provide valuable insight on the construction machinery in use by the department in the 1930s (Figure 3.5 – Figure 3.8).[463]

In the eastern Transvaal, at the Loskop Dam construction site, the government made available a sum of £60 000 and work started in July 1934, when the departmental work teams pitched a campsite. The dam structure, situated on the Olifants River, about 50 km from Middelburg, began in March 1935. The project was scheduled to accommodate about 15 400 ha of irrigable land. The 460 married white men employed as construction workers each earned five shillings per day and were provided with food and free accommodation. Ultimately the scheme made provision for 5000 farming units of about 21 ha, and about 300 of an average size of about 3 ha. The smaller plots were intended for the elderly and frail. All participated in farming activities under the supervision of the Department of Welfare.[464]

460. UG5/1934 (1934:21).

461. UG15/1936 (1936:36, 38).

462. UG16/1928 (1928:15).

463. SAWHAR AHCA25/132 (1976).

464. Mackenzie (*c*.1947–1948:1–2).

Source: SAWHAR AHCA25/132(e) (n.d.).

FIGURE 3.3: Local farmers provided scotch carts and oxen, as part of relief works for whites, to transfer soil at the Marico-Bosveld construction site.

Source: SAWHAR AHCA25/132(e) (n.d.).

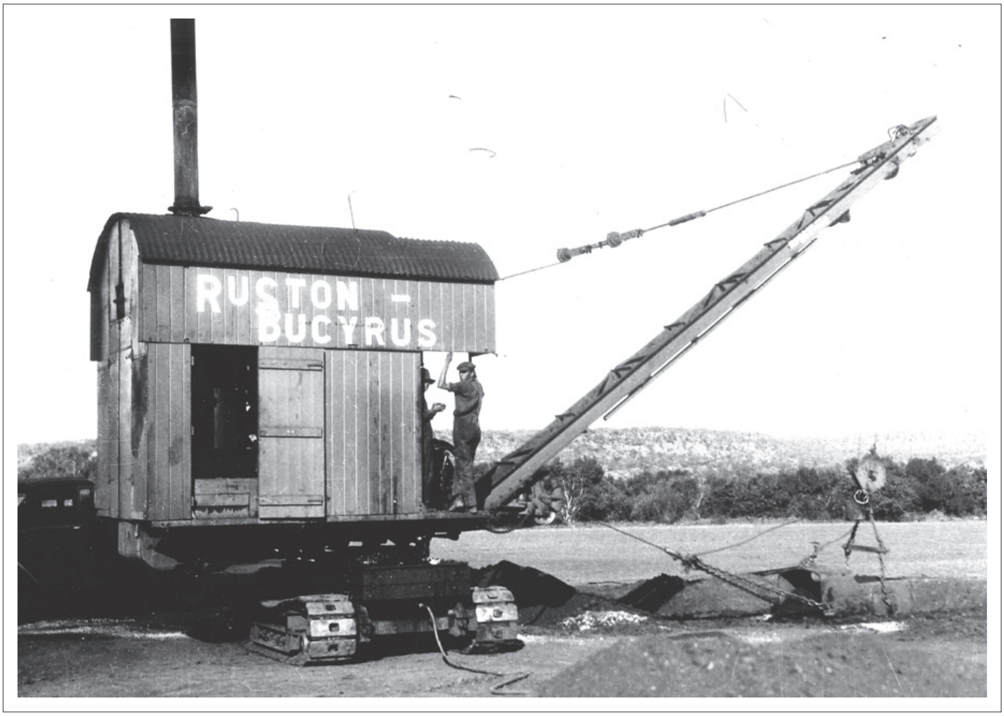
FIGURE 3.4: A large number of white labourers were used on the construction site of the Marico-Bosveld Dam.

Source: SAWHAR AHCA25/132(e) (n.d.).

FIGURE 3.5: A portable steam-powered pumping system was used to pump water from the river.

Source: SAWHAR AHCA25/132(e) (n.d.).

FIGURE 3.6: Steam power was used for crushing rock on the site of the Marico-Bosveld Dam.



Source: SAWHAR AHCA25/132(e) (n.d.).

FIGURE 3.7: A steam shovel with dragline attachment, preparing a canal at the Marico-Bosveld project.

Source: SAWHAR AHCA25/132(e) (n.d.).

FIGURE 3.8: A Caterpillar 'Thirty' tractor bulldozer was used to level soil. In the background one of several tipping trucks used on the Marico-Bosveld Dam construction site.

The labour arrangements at Loskop were similar to those at Rust de Winter where the department made use of married white men who were paid five shillings per day and were provided with free accommodation, food and medical attention. Labour was recruited from local families in the area. The £180 000 project began as a government irrigation project in 1932. The scheme's water supply came from the Elands River in the district of Pretoria.[465] The dam site in the Elands River, about 98 km north of Pretoria, made it possible to irrigate about 1860 ha.[466] By 31 March 1935 a total of 460 men had been employed on the project.[467]

Natal

Indigent white men who were resident in the eastern part of the Transvaal, were employed on a Natal water scheme project in the 1930s. In the Pongola area, an irrigation project that extended into the districts of Piet Retief (Transvaal) and Ngotshe (Natal) started in June 1932. A diversion weir and canals were to be built, with the objective of serving an irrigation surface area of more than 5000 ha. When work began in June 1932 on this £180 000 project the understanding was that black labour would be employed, with white overseers. However, by 1933 there was an instruction that at least 250 whites were to be employed to provide support for indigent whites living in the Vryheid and Piet Retief districts, where poverty was endemic. Projections in 1933 suggested that by 1934 there would be 1500 black labourers and 200 whites working on the scheme. In response to the threat of malaria, the Department of Health secured funds and launched a campaign to provide workers on the site with appropriate medical services.[468]

By the end of July 1934, the whites were paid off and only African workers were kept on site. The average strength of the construction group had been 64 whites (for 4 months only) and 1072 Africans. The maximum number of Africans used on the site was 1586. The Pongola irrigation scheme made a significant contribution to the war effort in the years 1939 to 1945, with local farmers producing crops of potatoes and other vegetables for convoy ships. After the war, the area was planted with sugar cane.[469]

465. UG5/1934 (1934:21).

466. Venter (1970b:322).

467. UG15/1936 (1936:35).

468. UG5/1934 (1934:22–23).

469. UG15/1936 (1936:37); Venter (1970b:322–323).

Flagship projects of the Vaal and Vaalharts

The flagship irrigation labour schemes of the depression were the developments at the Vaalbank/Vaal Dam and the related Vaalharts Irrigation Scheme, downstream in the Vaal River. The Vaal Dam (originally known as Vaalbank) was the premier dam construction project by the department in the 1930s. The dam is situated at the confluence of the Vaal and the Wilge rivers. Its catchment area extends over a surface area of 38 505 km^2 in a region where the river has an approximate annual run-off of 4300 MCM. Construction work started in January 1934.[470]

The construction of the Vaal Dam must be seen against the backdrop of the irrigation–food hydraulic mission that the Department of Irrigation pursued in the first half of the 20th century. It was the largest water storage facility in South Africa until the 1960s and from the outset was scheduled to be a multi-purpose reservoir facility. It was conceived as an integral component of the Vaalharts project – a scheme already identified in 1873 in view of the rapid growth of the Kimberley diamond fields, in what was then Griqualand West.[471]

In 1923, planning began with a search for an appropriate site for the dam in the Vaal River, close to its confluence with the Wilge River in the Highveld region. Three potential sites were identified, and geological surveys followed, with drilling equipment to determine the ideal site for the wall.[472] A youthful L.A. Mackenzie, was appointed as the first-grade resident engineer (permanent construction staff) on the dam construction project in September 1934. Previously, Mackenzie had worked on construction and dam site surveys in the Cape Midlands, the Clanwilliam Dam and the southern Transvaal.[473]

When construction began on the Vaal Dam, the prime irrigation beneficiary of the Vaal River's water supplies was the Parys irrigation scheme, situated about 20 km below the Rand Water Board's Vaal River Barrage, completed in 1923.[474] However, the Vaal Dam, as part of the Vaalharts project, was destined to become more comprehensive. In 1933 a White Paper to parliament formalised the new scheme with the passing of the *Vaal River Development Scheme Act*, No. 38 of 1934.[475]

The Vaal Dam scheme made provision for supplying water from the Vaal Dam reservoir, about 40 km upstream from Vereeniging, to the Vaalharts

470. SAWHAR DH5/MKC2a (1988:1); SAWHAR DH5/MKC2b (1956:n.p.).

471. Whysal (1944:17).

472. UG14/1925 (1925:9).

473. SAWHAR DH5/MKC3b (1934); SAWHAR DH5/MKC3a (1932).

474. UG14/1925 (1925:9).

475. UG15/1936 (1936:9).

Irrigation Scheme, some 200 km downstream. In effect the evolving Vaal River system – from its origins on the Eastern Transvaal Highveld grasslands near Breyten and Lake Chrissie –would provide water over a distance of more than 1300 km, to irrigation projects on the Orange River near Upington.[476]

A second factor that shaped the construction of the Vaal Dam was the need for water on the Witwatersrand. The Rand Water Board, the bulk potable water utility responsible for supplying water to municipalities and key industries on the Rand, acquired a significant share of the available supply of the Upper Vaal River system. In 1934 the department acknowledged the Rand Water Board's right to a comprehensive water supply from the dam. The utility contributed £240 000 to the construction project. Construction work on the dam began in 1934 and the project was completed by 1938, at an estimated cost of £900 000.[477]

Two years later parliament approved the *Vaal River Development Scheme Amendment Act* of 1937. The reason for introducing the legislation was that the Rand Water Board required much more water than was originally estimated. It had become necessary, in view of the phenomenal development of gold mining, industries and towns on the Rand to plan for more water.[478] Significantly, at the end of 1937 there had been floods in many parts of the South African interior. The result was that at the time of its completion, the Vaal impoundment was full to the extent that the water level was a mere 2.6 m below the spillway. The engineers immediately started controlling the flow of the river by releasing water at the rate of as much as 57 cubic metres per second at one stage, between 20 December and 22 December

The project was immense and ultimately the Vaal Dam became the largest dam in South Africa. A total of 60 963 tonnes of cement were used in its construction, making the project the largest consumer of cement on any single site in the Union of South Africa at the time. When completed, the total expenditure on the Vaal Dam was more than £1.4m. It was anticipated that in future the department would have to acquire more properties to accommodate the larger than anticipated storage capacity of the dam. With the capacity of storing 994 MCM the dam was indeed larger than anticipated.[479] It also meant that the average cost of the land on which the dam would be situated was far higher than the price paid originally.[480] White labour had been used from the outset of the project in 1933.

476. Mackenzie (*c*. 1947–1948:5–8).

477. Mackenzie (*c*. 1947–1948:5, 9, 33).

478. UG3/1938 (1937:8).

479. Kriel and Van Der Walt (*c*. 2000:1).

480. UG12/1939 (1938:31).

Most machinery used in the construction of the dam was driven by modern electrical power, a service secured from the Victoria Falls Power Company at Vereeniging. The introduction of new technology did not reduce the demand for manual labour. On 31 March 1935, there were about 500 single white men between the age of 18 and 45 employed on the site. They were recruited by the Department of Labour, and salaries were set at two shillings per working day, plus a one shilling and sixpence bonus for every day worked. The bonus money was deposited into a post office savings account for each worker. After six months' work the daily bonus increased to one shilling and ninepence, and after 12 months it rose to two shillings. Each labourer was provided with accommodation, bedding and food, as well as overalls and boots. They were accommodated in wood-and-iron bunkhouses with electric lighting and reasonable facilities. The Vereeniging district surgeon visited the site twice a week to attend to the health of the workers. Sufficient clinical health services were also available.[481]

Special measures were taken to see to the men's welfare and recreation opportunities; facilities included a recreation hall, a football field and tennis courts. In addition, provision was made for night classes for the more studious working men. By 1936, as a result of the general improvement of the South African economy, there was a decline in the number of white labourers and the department's construction division then opted for African workers. However, the average of 517 whites employed on the project was still more than the average number (328) of African workers in the period 1935 to 1936. By 1937, on average, there were more Africans (417) than whites (391) employed on the project.[482]

The project was not as comprehensive as originally planned. In the rainy seasons of 1930 to 1933 the department's hydrologists made a more accurate assessment of the Vaalbank Dam's potential run-off. In the 1940s, as a result of the growing demand for more water downstream, the department's planners advised that more water should be made available for irrigation farmers. At the same time, the planners kept an eye on the growing industrial demand for bulk water resources. The subsequent raising of the weir enlarged the dam's storage capacity substantially. From 1952 to 1956 the wall was raised by 6.1 m by increasing the height of the concrete gravity section by 3.05 m and the installation of 60 crest gates, each with a height of 3.05 m, on top of the wall. In 1985, as part of a general betterment project, the dam's flood absorption capacity was improved, along with the installation of new mechanical and electronic equipment at the dam site.[483]

481. UG15/1936 (1936:33).

482. UG15/1936 (1936:34).

483. Kokot (1942:2015); SAWHAR DH5/MKC2a (1988:2).

Vaalharts

Since the early 20th century a number of engineers had recommended the construction of the Vaalharts scheme. Kanthack and his predecessor in the Cape Colony's irrigation department recommended such plans even before Union in 1910. Then, in 1920, there was departmental activity in the area when a select committee was appointed to investigate the development of the Vaal–Rhenoster irrigation scheme – a project that began in 1921 and reached completion in 1925.[484]

In 1922 three departmental teams started working on the proposed Vaalharts scheme. One team worked on a design plan, another focused on a survey of the dam site, while a third investigated the potential land that could be irrigated.[485] The appeal of the Vaalharts scheme was the vast level area to the east of the Harts River that could easily be put to use by means of a basic flood irrigation strategy. In addition, there was a saddle in the river through which a channel could be cut to provide some fertile soils with irrigation water. Above all, the planned system made it possible to irrigate under gravitation from the Vaal River.[486]

In 1933 a cabinet sub-committee recommended that the project should go ahead. An amount of £20 000 became available initially at the Vaal Dam, with the ultimate Vaalharts project being approved in 1934, at an estimated cost of £3.5m. In the first phase of the project a total of 21 043 ha came under irrigation, of which white settlers and private farms had access to 17 806 ha, while the native reserves had access to 2428 ha. A second phase followed by mid-century, making available a further 40 000 ha of irrigable land.[487]

The Vaalharts project provided ample opportunities for labour in the depression era. Once work began on the construction site it became a hive of activity. By 1935 a total of 1423 people had been employed. As was the case at Vaalbank Dam site, the irrigation department reported that:

> [*T*]he men who remain on the works are excellent workers; and as on other works, men from the rural areas seem to be the most suitable for this class of work.[488]

The facilities at Vaalharts were well planned. Similar to conditions on the Vaalbank Dam construction site, men were housed in wood-and-iron bunkhouses and provided with beds, blankets and adequate facilities for ablutions. In 1935 plans were afoot to establish a steam-powered laundry that would wash the bedding and the overalls the workers wore on site.

484. SAWHAR WAC7/10/1 (1944:17).

485. Reitz (1943:182).

486. UG16/1927 (1927:13); Gunthorp (1973:44); SAWHAR WAC2/2/1 (1950:5).

487. Whysal (1944:17); SAWHAR WAC2/2/1 Scientific Aspects (1950:7).

488. UG15/1936 (1936:34).

The recreational activities were similar to those enjoyed by workers at the Vaal Dam site. Because the project was in operation for longer than the Vaalbank Dam construction site, the Vaalharts workers developed sports ties with other sports clubs in the region. Sporting competitions were held against clubs based in Kimberley and neighbouring towns. In 1935 a total of 55 labourers participated in night school activities. There was a dry canteen where the workers could purchase clothing, boots, tobacco and soft drinks. Profits from the canteen were invested into the development of recreational facilities for the workers on the site. By 1936 about 200 coloured people were included in the workforce on the Vaalharts scheme. The average total number of workers was in excess of 1600, including skilled employees and labourers. Whereas there was a decline in the number of labourers on the project by 1937, the white labour sector on the Vaalharts scheme did not diminish and its numbers remained consistent.[489]

At the time of the completion of the Vaal Dam in January 1938, an estimated 66% of the work on the Vaalharts scheme was complete. One major boon for the Vaalharts project was that by March 1938 the first 30 settlers were placed on farms, on the firm understanding that they would put the land allocated to them under irrigation. At this time the number of people still working in the project totalled 1240, of whom more than 60% were white labourers.[490]

Farmers who wanted land at Hartswater, at the centre of the Vaalharts scheme, were subjected to a strict selection process. A committee of control under the chairmanship of the resident engineer, the superintendent of lands and three local farmers, interviewed candidates. Selected farmers were then allowed to settle on the land, based on a probationary lease contract. In the probationary period the farmer was provided with a house on an irrigated plot of land, along with implements, seed and livestock so that farming could begin without delay. Over a period of 18 months, probationary farmers received an allowance of a varying amount, with a maximum of £7.10 per month for the first six months, diminishing to a quarter of that amount in the final six months. The probation period could be as long as five years if necessary. The probationer received 75% of the income of the crops and the remainder was for the state. Once approved the new farmer could purchase his land and its equipment within 10 years. The terms of purchase were determined by the amount contributed by the state over a period from a minimum of 10 to a maximum of 65 years.[491]

The farmers on the scheme operated independently and in conjunction with advice from officials of various government departments. They were able to

489. UG15/1936 (1936:35); UG3/1938 (1938:32).

490. UG12/1939 (1939:31–32).

491. SAWHAR WAC2/2/1 Scientific Aspects (1950:7).

market their crops through a cooperative union. Apart from irrigation farming operations, farmers were allowed to keep livestock on communal grazing lands situated above the canal and did so under the control of the Department of Lands. The farmers at Vaalharts paid for the water they used. By March 1940, the number of settlers had increased markedly, and the Department of Irrigation was able to report that 304 settlers, representing an increase of 178 over the previous year, had settled on the irrigated lands. The main crops produced included lucerne, cereals, peanuts, potatoes and vegetables. There was also a fair amount of dairy farming and some farmers were even experimenting with tobacco, for which the area was indeed suitable.[492]

Departmental support for African irrigation in the depression era

Contrary to popular opinion on the history of irrigation in South Africa, there are indications in the 1930s of a government committed to developing irrigation systems for the country's rural African communities. Indications of this commitment was evident before the coming to power of the UP government of 1933. In fact, the attempts to assist rural African communities are seen well before the passing of Hertzog's *Natives Trust and Land Act* of 1936.

In 1930 and 1931, with the country reeling under economic depression and a crippling drought, the Department of Irrigation fell under the ministerial oversight of E.G. Jansen, who also served as minister of native affairs. In an effort to serve both his briefs, Jansen organised that the Department of Irrigation's officials were sent to render service in the Manthe native reserve in the Taung region[493] to help local residents secure an adequate water supply. Furthermore, there were surveys on behalf of local diversion project works in the division of Albany, Peddie and Victoria West.[494]

In October 1930, the Irrigation Commission visited the Transkei as part of its general brief to investigate irrigation in the Union of South Africa. They do not appear to have been particularly welcome. The commission was of the view that the Transkei did not hold much promise for irrigation. Although irrigation technology was thought to be beneficial as a form of 'insurance' in general, there did not seem to be any particular locality that favoured the construction of an irrigation scheme. However, the commission did think that some valleys in the Transkei might lend themselves to irrigation, but felt that the topography favoured a more extensive form of farming. There were limited opportunities

492. SAWHAR WAC2/2/1 Scientific Aspects (1950:8); UG11/1941 (1941:29).

493. Clynick (1987:14).

494. UG10/1932 (1932:20).

for small irrigation farming operations of between four and 13 ha. The commission suggested:

> [*U*]ntil the natives have reached a higher stage of development, irrigation of even these small areas might bring about more evil than good. Later, as the Native becomes more enlightened and educated, conditions would alter. In short, the Commission considers that it is not necessary for propaganda work to be undertaken among the natives, but that among the more enlightened classes, that is to say, among those Natives who make application for it, irrigation might be encouraged.[495]

In Natal the commission visited the irrigation settlements of the Mooi River and the Tugela to gain insight into possible schemes. However, in the annual report they did not make any significant recommendations. In 1932 the department conducted an extensive investigation into irrigation works in the Moiloa native reserve. Its officers inspected the Zebediela location and reported on gravity schemes in the Sekhukhune and Mphefu locations in Northern Transvaal.[496]

With the UP government in power, there was a marked increase in government support for African irrigation farmers. In 1933, the department constructed canals and an inlet with four siphons from the Nyelele River for Mphephu's people, the Venda-speaking communities in the Soutpansberg. The project enabled the community to irrigate about 430 ha of land. At Thaba Nchu, area officials of the department worked on the Seliba scheme. In the district of Zeerust, work started on the Gopane and Linokana projects, under the supervision of the circle engineer for the southern Transvaal circle. The objective was to promote agriculture in the Moiloa reserve and contribute towards relieving poverty, and even hunger. In Kuruman, the department started with surveys in the native reserve and towards the end of the year began construction work.[497]

By 1935 the Department of Irrigation had provided services to African communities in many parts of the country. It completed the Seliba irrigation scheme in Thaba Nchu in the Orange Free State; the Kamastone scheme in the Cape Province, which was a river diversion with a weir and a flood furrow of about 2.4 km; and the Moiloa native reserve schemes, which included the Gopani irrigation scheme with a storage dam, a flood furrow to the dam, and a distribution system with pick-up weirs and furrows. At Kuruman, the works included the Maropin scheme with an earthen *leidam* and more than 3600 m of lined furrows; the Groot Koning scheme which had a cut-off diversion wall and about 400 m of lined furrow with the necessary structures; the Bethetheletsa scheme with 4000 m of lined furrow with the necessary structures; and the Vlakfontein scheme with 2100 m of lined furrows and necessary structures.

495. UG9/1932 (1932:33).

496. UG9/1932 (1932:34); UG12/1933 (1933:21).

497. UG5/1934 (1934:25).

In the case of the community in Zebediela, near Potgietersrust, officials of the irrigation department investigated the Mogoto and Gompies River for the purposes of irrigation schemes. Officials also assessed the potential of a diversion scheme at Witzieshoek in the Orange Free State, while advice was given to people on domestic water supplies at Veeplaas and Missionvale in the Bethelsdorp district in the Eastern Cape. In 1937, the Department of Irrigation reported that in view of the *Natives Trust and Land Act* of 1936 there was bound to be expropriation of lands for specific purposes. In cases where there was no agreement, the suggestion was that the water court's services be used to determine the value of the land.[498]

Departmental science and technology

In the 1920s, the department's management developed a clear focus on science and technology research that could be of practical use in the realisation of the hydraulic mission of food production and irrigation development. However, there was a shortfall of officials to conduct scientific work – such as when the geologist and mechanical engineer participated in the Kalahari reconnaissance in 1925. Scientists were used for various projects, not necessarily related to their specific research foci.[499] A major concern was the uncompetitive salaries the government paid. The meteorological division in particular had difficulty finding suitably qualified staff because of the low salaries. Apart from the need for scientific expertise, there was also a growing awareness of the importance of technology.[500] It was of vital importance in scientific research and also in the irrigation farming sector. As the department's responsibilities increased in the field of dam and irrigation scheme construction, more support systems of an innovative technological nature were introduced.

Natural disasters: Droughts, floods and disease

In the 1920s, drought conditions remained a critical area of risk. Yet there still seemed to be a lack of scientific understanding of drought and flood disaster conditions. The tendency was to accept that droughts were 'part of the ongoing challenge' farmers faced. It was assumed they would have sufficient local knowledge to cope when there were droughts, and would know what to do in times of floods. The ideal was to nurture local indigenous knowledge among the people most directly affected. In some farming communities, this knowledge was indeed evident. Research conducted in the 1960s suggested that riparian residents on the Vaal River in the Northern Cape developed a

498. UG15/1936 (1936:40); UG3/1938 (1938:8).

499. UG16/1927 (1927:19).

500. Beinart (1984:54).

collective memory. Several decades had gone by, but they could recall a time in 1933 when the Vaal River ran completely dry for two months.[501]

As a rule, people tended to forget the harsh circumstances caused by drought conditions quite quickly, but they developed resilience strategies of adaptation, and managed to live through drought. One way to cope was the basic principle of having water conservation measures in place. But this was not the only avenue of defence. As part of the initiative to find solutions to circumstances of drought, in the mid-1920s the department's researchers began experiments in rainmaking. They looked at various strategies, such as using aircraft to seed clouds with sand; distributing chemical solvents in the atmosphere from towers; erecting powerful wireless transmitters in various places in the country; and building evaporation dams in the Kalahari. By 1926, the department reported that recommendations had been received from the public to conduct a wide variety of tests. In response the department explained that such experiments and tests were costly; they were also time-consuming and called for the accumulation of significant amounts of data. However, the department was not negative towards rainmaking tests and worked on a number of useful projects. It assured the public that its officials were keeping abreast of the latest available innovations.[502]

Watering the desert?

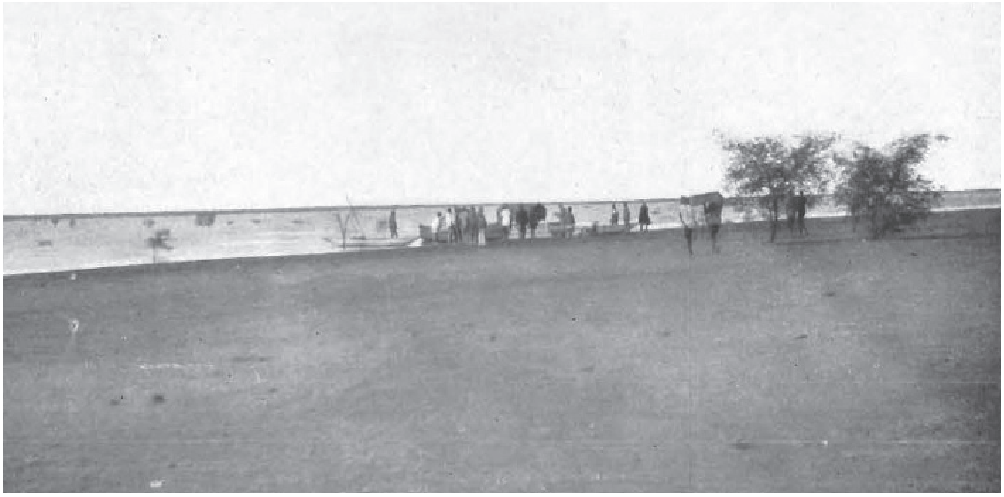
The theory of watering the desert, proposed by Prof. E.H.L. Schwarz, was still very much alive in popular memory in the mid-1920s. In 1925, government provided funds for an expedition, under the guidance of Dr A.L. du Toit, a former departmental geologist, to investigate claims made by Schwarz on watering the Kalahari. There was significant public interest in this idea and an anonymous donor even contributed £1000 towards an investigation. Schwarz accompanied the expedition, but later ventured on his own to the northern parts of the Kalahari. In 1926, the expedition issued a report in which they carefully considered all the theories propounded by Schwarz, along with the surveys that had been made.[503]

The reconnaissance team was of the view that the Schwarz theory was not viable. The expedition could find no proof that a former massive 'Lake Ngami' had covered a large surface area and had linked Lake Ngami and the Zambezi River (Figure 3.9). Moreover, plans to create channels to create facilities for irrigation purposes also appeared to be a pipe dream; it was not a feasible

501. Elliott (1962:68).

502. UG16/1927 (1927:10).

503. Department of Irrigation (1926:9); Jubb (1979:23); Mountain (1976:734).



Source: Department of Irrigation (1926).
FIGURE 3.9: Members of the Kalahari reconnaissance expedition on the northern shore of Lake Ngami near Mogotlwanen on 19 September 1925.

project in view of the high costs and the potentially weak supply of water.[504] However, Schwarz still had a significant amount of support. In March 1927, Dr A.L. de Jager urged the government in the national assembly to support a survey of the northern Kalahari, in the hope that flood water could be used for irrigation farming, instead of merely flowing into the sea.[505]

At the time when the findings of the expedition's report were made public, Schwarz contested the outcome. Presumably in an attempt to prove his point he published *The Kalahari and its native races, being the account of a journey through Ngamiland and the Kalahari, with a special study of the natives of that area* (1928). He died of a heart attack in 1928 while on an expedition to Senegal to find the tributaries of the Niger River in West Africa. In 1933, Owen Collett founded the Schwarz Kalahari Society at the Cecil Hotel in Bloemfontein, with the objective of lobbying for support to carry out further investigations on the viability of the Schwarz scheme.[506] The matter simply could not be put to rest. In times of drought, the controversy over the Schwarz scheme tended to spill over into the political realm. After the Second World War steps were taken to 'finally' address the issue.

A high-profile expedition under the Minister of Irrigation, A.M. Conroy, and seven members of parliament, set out in July 1945 to investigate the potential damming up of the Kalahari, as recommended by Schwarz. The expedition was the result of widespread public discussion. There were arguments to the effect

504. Department of Irrigation (1926:54–56).

505. Jubb (1979:23).

506. Mountain (1976:734); UG55/1947 (1947:9).

that if the government had money for South Africa to participate in the war, why was there no funding available to seek water in the Kalahari for a water-stressed country like South Africa? In an attempt to address the matter once and for all, preliminary plans included a heuristic process of developing a comprehensive up to date bibliography of all the available scientific and general information in circulation in academic and popular literature on the theme. The team of experts accompanying the expedition included the director of the Department of Irrigation, L.A. Mackenzie, the engineers D.F. Kokot, J.F. Oldfield and D.C. Midgley, along with a draughtsman C.A. Murray and the mechanic J.A.J. van Dyk. In the final report, compiled by Mackenzie, the experts reiterated that the Schwarz scheme was not possible to construct or execute. The expedition members were well informed and submitted empirically detailed and scientific arguments as to why the elaborate scheme proposed by Schwarz would not be feasible.[507]

With the benefit of better communications and members of the expedition being exposed to operations in various parts of the world during the war, there were a number of progressive ideas in Mackenzie's report. These included recommendations on:

- desert irrigation
- the development of waterways
- hydroelectrical power generation at the Popa Falls in Okavango and the Cunene rivers, at Ruakana and the Montenegro Falls
- the 'conquest' of the desert, in which groundwater had an important role to play
- an update on the debate on afforestation in the arid regions of southern Africa that dated back to the 19th century.[508]

Meteorological information

By the mid-1920s, the Department of Irrigation's meteorological office combined monitoring activities with research. In 1926, the department prepared for the printing of comprehensive meteorological data on South Africa's rainfall. The printing project included maps, tables of rainfall, bell curve designs of the average rainfall throughout South Africa and an alphabetical list of all the weather stations in the country. Daily weather reports issued by the meteorological office became more comprehensive when information was collated from several locations in southern Africa. Neighbouring countries, foreign research groups, as well as shipping lines and airlines participated in sharing information. Following a meteorological conference held at Simon's Town in 1932 on fleet meteorology, the department was motivated to take a keen interest in this field of meteorology. Consequently, for the benefit of

507. UG28/1946 (1946:1–3, 7–14).

508. UG28/1946 (1946:15–20).

shipping, the department's staff paid greater attention to available synoptic weather reports and weather forecasts. In essence, the South African weather service was expanding and modifying its services.[509]

Since the 1930s, South African meteorologists extending their contacts with the United Kingdom had proved to be particularly valuable. R.B. Schulz spent several months studying the methods and general organisation of the British meteorological office in London. His colleague, H.P. Smit, visited London shortly afterwards to study meteorological service divisions in London. One Cape Town colleague, Mr I. Lows spent some time with the Canadian weather service.[510] Construction work on the new meteorological office began in February 1937 in the grounds of the University of Pretoria. On 01 July 1938, the Meteorological Service of the Union of South Africa moved to its new offices. Previously, the division had been working under adverse conditions, whereas in its new headquarters the staff had access to proper offices and laboratories.[511]

In 1939, after deliberations with the South African Broadcasting Corporation (SABC), the general weather forecasting service of the bureau changed to the extent that there were separate forecasts available for the four provinces. For more detailed and precise forecasting the Union was divided up into 15 districts. Furthermore, the statistical statements on daily rainfall were replaced by a short report of a more general nature on daily rainfall, and on Saturdays there was a report on the previous week's rainfall. As a result of the outbreak of the Second World War in 1939, weather forecasts were significantly curtailed. Radio and printed media weather information was also reduced. By December 1939 a military meteorological unit was established, which took over the responsibility of providing weather reports for shipping, aviation and military purposes in an exclusive format.[512]

Hydrographic work

In 1925–1926, as a result of the decrease in construction projects, the department started giving more dedicated attention to hydrographic investigation. Mapping and investigating the country's water bodies meant that officials in the various water administration circles countrywide gained better insight into local conditions. This knowledge and insight, in turn, contributed to departmental work in various parts of the country. For example, attention was given to *brakking* and silting conditions. As an outcome of the earlier efforts by the department's engineers in the Transvaal there was a comprehensive report for a period of 21 years on silting in parts of the province. Setting up the necessary monitoring equipment was a cumbersome and costly process, but it was important to secure reliable data for

509. UG16/1927 (1946:8–9); UG12/1933 (1933:7).

510. UG10/1940 (1940:9).

511. UG3/1938 (1938:10); UG10/1940 (1940:9).

512. UG10/1940 (1940:9).

better scientific work. By March 1939 the department had 159 river gauging stations in operation that measured total flow. Two years later, calibration curves had been developed for 405 gauging stations.[513] There was marked progress in securing data that could guide future planning and development.

Mapping South Africa's topography

As a result of renewed departmental vigour in construction work there was a growing need for more comprehensive science-based information. From 1932 to 1933 the South African Air Force completed an aerial photographic survey of the country so the department was in possession of a mosaic of loose prints. It immediately started using the material, and Lewis reported that the department's survey teams found it to be of great value.[514] In 1935, Lewis reported that work had begun on a new 1:500 000 topographical map of the Union of South Africa. The original initiative was taken after requests for advisory work from the Cape and Natal administrative circles.

The departmental team worked in collaboration with a small advisory committee, comprising a number of well-informed and knowledgeable people who had a direct interest in producing a better map of South Africa. Before the end of 1934, there were 12 survey parties in the field and the plan was to have at least one third of the Union mapped before the start of the next financial year. It was anticipated the map would be completed by 1937.[515] In 1935 the reconnaissance branch of the department, which normally used four teams, increased its capacity with 11 additional teams of three men each to help speed up the preliminary topographical survey of South Africa. The change in the department meant that the post of inspector of surveys was abolished and a new position was created for the controller of reconnaissance.[516]

When the team presented its case for the topographical map to the South African Survey Board, there was a favourable response. The funding authorities were amenable to making about £60 000 available for the necessary reconnaissance work to be done over a period of 3 years. As early as 1934, Colonel Deneys Reitz,[517] the then minister of lands, set aside £20 000 for the first phase of the work. The project's advisory board included Lewis (as chairman) in his capacity as director of irrigation; the director of the trigonometrical and topographical survey division; the general manager of the South African Railways; the surveyor-general of Transvaal; the secretary for mines; the superintendent of roads and

513. UG16/1927 (1927:10); UG11/1941 (1941:10).

514. UG5/1934 (1934:11).

515. UG15/1936 (1936:9).

516. UG15/1936 (1936:20).

517. Reitz (1943:204–205).

local works in the Transvaal provincial administration; as well as the chief of general staff of the South African Defence Force. The planning team divided South Africa up into nine areas. By 1937, once most of the work on the project had been completed, the Department of Irrigation confidently announced that the surface area of South Africa was 1 219 488 km^2. Soon 2500 copies were printed of the new South African map, which consisted of 10 sheets. It appears there was a significant demand for the latest topographical information, and before long some sheets were completely sold out.[518]

The topographical map project focused attention on the departmental survey and reconnaissance branch much more than before. In her cartographic history of the map, Professor Elri Liebenberg suggests that part of its ultimate success could be ascribed to the work of this branch. Although the aerial photography of the country was most useful, it was too detailed. Consequently, the officials of the survey and reconnaissance branch had to carry out dedicated fieldwork to secure more reliable trigonometrical survey information.[519] The specialist officials had the support of assistants in the field, providing additional support if and where it might be required. The information would then be processed at the branch's offices. The Department of Irrigation's empirical research on soil surveys, mapping and reconnaissance, as well as important data on hydrographic monitoring, represented a major contribution to scientific knowledge about South Africa. However, in 1939 the staff of the reconnaissance and survey branch was reduced. A total of 13 field assistants resigned to find better employment in the provincial roads departments, municipalities, mines and engineering firms, where they were offered higher salaries. The number of reconnaissance and survey parties had to be reduced from six to four.[520]

The topographical map project entered a new phase and the lands department made £2500 available for revisions that needed to be done. Three topographers worked on the project. The department's mapping division then scaled the map to 1:150 000. Part of the project also included a published map of the average rainfall for South Africa to the year 1935.[521]

Ultimately, the project initiated by the visionary, A.D. Lewis, was a landmark accomplishment. The map proved its worth by:

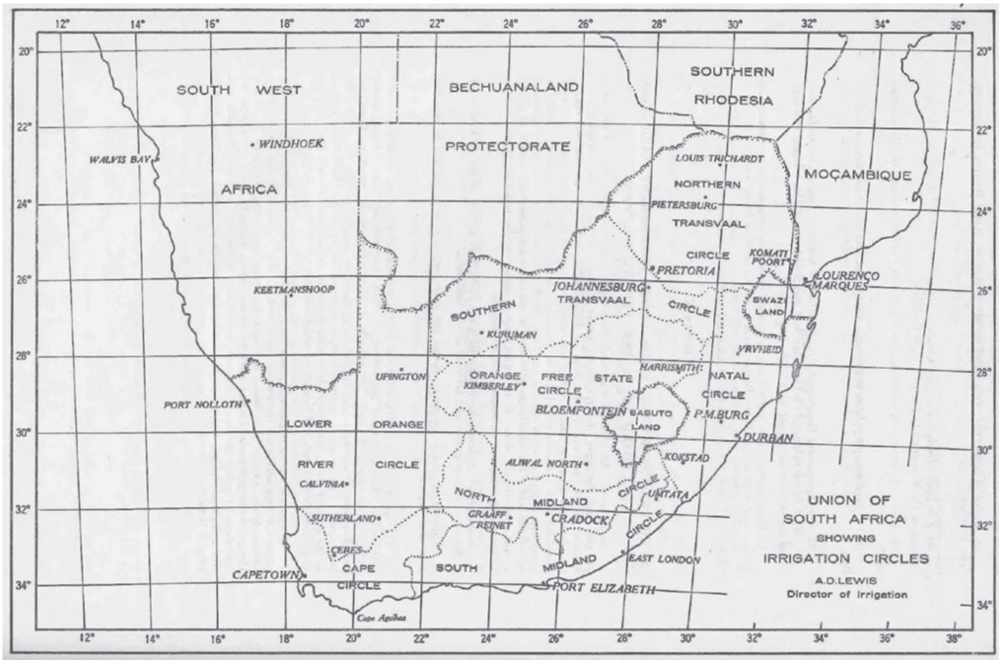
- providing the latest mapped information on South Africa for the SA Defence Force during the Second World War
- helping other government departments perform their work with more accurate locational information

518. Reitz (1943:204–205); UG3/1938 (1938:18); UG12/1939 (1939:8).

519. Liebenberg (2014:244).

520. UG10/1940 (1940:19–20); UG3/1938 (1938:17).

521. UG10/1940 (1940:n.p.).



Source: UG15/1936 (1936:42).

FIGURE 3.10: The eight irrigation circles of South Africa by March 1935.

- helping the Union's trigonometrical survey office (TSO) to secure more government funds for mapping the country
- contributing to the compilation of a magnetic isogonic map of southern Africa
- by laying the groundwork for future maps of the country by the TSO.[522]

In the 1980s the map was even described as one of the major research accomplishments of the Department of Water Affairs.[523]

Depth of knowledge on irrigation and farming in South Africa

As work began on the new topographic map and the first results came in from the survey teams, it was possible to form a better impression of irrigation and related farming activities in South Africa. By 1935, the country had eight irrigation circles (please see Figure 3.10). The total irrigable area under cultivation at the time was 142 922 ha, of which about 39 500 ha lay fallow. Of this, about 21 400 ha was fallow because of water shortages.[524] As the role of the Irrigation Commission diminished, A.D. Lewis once again took charge of

522. Liebenberg (2014:245, 247).

523. Bozzoli (1997: 99); Conley (1988:223).

524. UG15/1936 (1936:43).

TABLE 3.1: Crops and their yield in SA irrigation in 1936.

Crop	Yield per morgen of land under irrigation[a]
Citrus	£118
Vines	£66.4
Tobacco	£30.7
Vegetables	£18.9
Wheat	£12.5
Lucerne	£9.5
Maize	£5.3

Source: Table based on UG15/1936 (1936:36).
[a], One Cape morgen = 0.8567 ha.

overseeing irrigation farming activity in the country. The latest results of the ongoing mapping survey generated more data, and the information featured prominently in the department's annual reports.

Interdepartmental collaboration on the map survey provided important information on irrigation in the country. The primary crops produced on irrigated lands were wheat and citrus. In the case of cereals produced in the southern Transvaal, all harvests were consumed inside the country. As for citrus exports, the northern Transvaal and the Eastern Cape were the prime production areas. The most comprehensive citrus crop production was in the Sundays River region where the main crop was produced for the export market by 1935.[525] In 1936 the Department of Irrigation gave an overview of the crops under irrigation that provided the best yields, please see Table 3.1.

Although citrus was clearly a profitable crop, a significant investment was involved to achieve good results. By 1936, the Irrigation Commission advised government that its commitment to make loans available to citrus farmers had to be honoured. If support was withdrawn, there could even be a collapse of production levels in parts of the country.[526] The commission also pointed out that there was a need in the Union to create public awareness that fruit and dairy produce were healthy foods and should form part of a balanced diet. The commission suggested it was a matter of priority that every person should eat at least one apple or orange and drink a pint of milk per day. If a proper campaign was launched, much of the local produce would be consumed inside South Africa. The commission saw it as a practical yet immensely valuable initiative to create an awareness of the nutritional value of fruit and dairy produce.[527]

In 1937, the department disclosed information based on an informal census it had conducted in the irrigation areas of South Africa between 1934 and 1935.[528] Table 3.2 gives an overview of the crops produced on irrigated land in 1937.

525. UG15/1936 (1936:43).

526. UG14/1937 (1937:6).

527. UG9/1939 (1939:6).

528. UG3/1938 (1938:36).

TABLE 3.2: Crops produced *c.* 1937 in South Africa on irrigated land.

Crops	Hectares[a]	Percentage of irrigated land used
Cereals	45 509	31.7
Lucerne (Hay)	19 516	13.59[b]
Lucerne (Pasture)	13 435	9.36
Maize	11 249	7.84
Citrus	8655	6.03
Vines	7538	5.25
Vegetables	7366	5.13
Veld or annual pasture	7043	4.91
Tobacco	3396	2.37
Deciduous fruits	3251	2.26

Source: UG3/1938 (1938:36).
[a], Decimals rounded off.
[b], Collective percentage = 22.95%

TABLE 3.3: Crops, monetary yield and irrigated land used in *c.* 1937.

Crops	Yield per 0.9 hectare	Hectares used
Flowers	£207	50
Citrus	£178.7	7769
Tropical fruits	£64.4	222
Vines	£53.4	5911
Tobacco	£40.9	3295
Vegetables	£32.1	3679
Cotton	£22.1	311
Deciduous fruit	£15	1545
Lucerne	£10.9	17 352
Sugar cane	£10.5	582
Cereals	£9.4	42 540
Maize	£4.4	10 227

Source: UG3/1938 (1938:36).

Cereal crops were not exported; they were consumed within the country (please see Table 3.3). On the country's irrigated lands cereals were the most widely produced crops. The second highest production crop, lucerne, was used for feeding livestock. It is notable that more maize crops were under irrigation than the lucrative sugar cane in Natal. Well into the 1940s, Natal's sugar-belt farmers hardly made use of irrigation; where there was irrigation it was only under pressure pumping. The undulating nature of the landscape, with deep river valleys, did not favour irrigation farming per se.[529]

By 1938, most wheat in South Africa was produced in the Oudtshoorn region of the Cape Province and by irrigation farmers along the Orange, although wheat was also grown in schemes in the Transvaal, such as Hartbeespoort, Rust de Winter, and Hereford. The prime producers of irrigated lucerne crops were situated along the Orange River, the Olifants River at Oudtshoorn, the Olifants River at Van Rhynsdorp and the Fish River, Sundays River and Breede River in the Cape Province. Citrus production under irrigation was mainly along

529. Kokot (1942:205–206).

the Sundays River and Orange River in the Cape, and at Zebediela, the Letaba River, the Crocodile River, White River and Rustenburg in the Transvaal.[530] Vines under irrigation for the purposes of producing sultanas and raisins were situated mainly along the rivers Orange, Breede and Olifants (Van Rhynsdorp district) in the Cape. Vines for the purpose of producing wine and spirits were primarily under irrigation along the Breede River.[531]

From the mid-1930s the growing database on rainfall in South Africa enabled scientists and engineers to come to a better understanding of how, for example, rainfall shaped the country's farming potential. In 1943 irrigation department engineer, D.F. Kokot, in a presentation to the engineering fraternity, explained that a little more than one third of South Africa's surface area enjoyed an annual rainfall of more than 500 mm, while only about 10% had an annual rainfall of more than 750 mm. He went on to say that farming without irrigation technology implied that drought conditions would be a frequent occurrence, because rain was essentially confined to four months of the year. Rainfall came predominantly in the form of thunderstorms when there was a great deal of run-off, instead of gentle showers or drizzle, and for this reason there was an exceedingly high rate of evaporation.[532]

This type of knowledge made a substantial contribution to the department's institutional understanding of governance needs for water resources in South Africa. On irrigation farming, Kokot had sombre views. In 1942, echoing the views of Kanthack and Lewis two decades earlier, he explained that the irrigation potential of South Africa was confined to about 1.7 million ha. What was new, was information on the value of irrigated land. Kokot courageously ventured to put the value at about £3 per morgen (0.86 ha). He criticised the existing policy and legal arrangements related to irrigation. He urged the state to rethink its generosity in terms of writing off irrigation loans. He also felt that more people had to benefit from these schemes. Finally, Kokot argued, the department's existing policy of allocating water for irrigation schemes and even paying for it, had to be revised. What he meant by this last statement was that a uniform rate per morgen had to be calculated, and then levied within a more comprehensive system.[533]

The Second World War

As had been the case during the First World War, several senior members of the department served on active duty. Between 1940 and 1945 more than 50% of the department's technical experts, along with a substantial number of

530. UG12/1939 (1939:36).

531. UG12/1939 (1939:36).

532. Kokot (1942:168).

533. Kokot (1942:169–219).

administrative and clerical workers, reported for military service. The officials of the department served with distinction in numerous theatres of war. Many sections of the department came to a standstill and only the most important activities continued. During the war there were three changes in the directorship of the department. A.D. Lewis returned to the department in December 1940 and retired on superannuation on 23 September 1941, after heading the department for almost 20 years. Lewis was succeeded by his deputy, K.R. Shand, who retired a few months later on 19 December 1941. T. Hopwood then became the director and served until 20 July 1944, when he too was superannuated on retirement. Hopwood was succeeded by L.A. Mackenzie.[534]

During the war, the department was responsible for an extensive series of projects for the Department of Defence. It included 14 military camps; the erection of 394 Bellman aerodrome hangars, designed and supervised by a future director-general of the department, J.M. Jordaan;[535] a large naval storage depot for the British Admiralty at Simon's Town; and a number of smaller projects, all of which accounted for the expenditure of more than £4m by the state. In the workshops of the Department of Irrigation, departmental officials manufactured three 200 m radio masts for the Simon's Town naval base and 800 barrels of various sized guns. These were used for safeguarding the island of Tristan da Cunha.[536]

The establishment of the irrigation department's central construction workshop for the reconditioning of heavy plant, completed in 1941, made a substantial contribution to the war effort. Operations started on a small-scale in 1942, before becoming a self-accounting unit the following year. At first the working group was housed in buildings previously used by the operations officials of the Vaalharts scheme. They were later transferred to more comfortable and larger facilities. In the course of the war some 20 000 hours were spent on work at the workshop. After the war, the largest part of the plant was transferred to Vaalharts and nearby Kalkfontein, in the vicinity of Jan Kempdorp, where the Andalusia workshop began its operations.

According to veterans of the department, the strategic site of the workshop was because of the plant's central location in South Africa. It was beyond the reach of enemy bomber aircraft departing from airfields outside South Africa. Later there were plans to use the area for more strategic military purposes.[537] It remained in operation after the war. By 1962 there were 20 clerical officials,

534. UG55/1947 (1947:5–6).

535. SAWHAR DH8/J003 (1996:22).

536. UG55/1947 (1947:6).

537. Roberts pers. comm., Pretoria, 2017.03.04. Dr Robert was told of the strategic planning of the workshop by the departmental engineer, Mr Russel Mackenzie, son of a former director of irrigation L.A. Mackenzie.

48 artisans and skilled workers, 17 apprentices, three coloured and 61 African workers.[538] The plant was used well into the 1980s.[539]

At the time of the Second World War the borehole drilling machines of the Department of Irrigation were taken to the desert region of Western Abyssinia, where they were used to drill water holes to support the Allied forces' Italian campaigns. South African knowledge and research investment in East Africa, dating back to A.D. Lewis's 1922–1923 annual report on the water services of Kenya, paid dividends in wartime. Many officials of the Department of Irrigation, along with their colleagues in the departments of mines, forestry, and geology, as well as the South African Railways and Harbours Administration, were recruited into the Union Defence Force where they served with distinction in the Engineering Corps. Many served in the 36th Water Supply Company and the 5th Field Company. The engineers devised strategies for troops to use water sparingly at innovative veld-shower ablution facilities. In South Africa itself, wartime borehole drilling activities continued at a snail's pace. As was the case with the other divisions of the department there were severe labour shortages and the water drilling section was unable to respond to the demand by the farming and other sectors for boreholes. By December 1944, when a total of 3000 applications had been registered, the department halted all further applications for drilling.[540]

The Department of Irrigation's borehole drilling benefited from the service it rendered during the war. The increasing local demand for boreholes made it possible for the department to invest in some of the latest technology. The machines were more advanced and sophisticated than before, with steel constructed drilling units according to the very latest specifications. Apart from the 10 machines that had been built by the department, a further 20 were scheduled for manufacture. Moreover, in view of the growing need for drilling, several machines were also scheduled to be imported from overseas.

Growing need for water storage

In 1942, at the time of the Second World War, D.F. Kokot expressed the opinion that South Africa did not have sufficient water storage facilities to meet the demand for water in times of drought. The Hoover Dam in the United States, he explained, was large enough to accommodate the entire water run-off of South Africa for a year. The combined total storage capacity of the 32 most important irrigation dams in South Africa had a capacity of a mere 2266 MCM. In the world, there were at least 23 dams with capacities greater than the Vaal

538. RP25/1964 (1964:37).

539. Hobbs and Phélines (1987:37).

540. Visser and Nyanchaga (2012:36–51); UG55/1947 (1947:6).

Dam – the largest dam in the country. Its total capacity in 1942 was about 40% of the combined capacity of all the country's most important storage dams. Prior to the early 1940s, there were only three storage dams in the Orange Free State. These were the Kopjes Dam on the Rhenoster River, the Tierpoort River Dam, about 32 km south of Bloemfontein, and the Bethulie Dam. By 1942 the Riet River Dam and the Egmont Dam were added to the provincial water reservoirs.[541]

As late as 1942 there were no irrigation or storage dams in Natal, partly as a result of the good perennial flows in the river regions where there were irrigation activities. There were, however, diversion schemes that had been paid for by government. They included diversions on the Pongola River, north of Magut; the M'Kuzi River, south of Magut; the N'Kwaleni River near Eshowe; and the diversion on the Umfuli River, a tributary of the Umhlatizi River. In his review of potential dam sites in South Africa, Kokot identified these diversion schemes as possible areas for the development of large storage facilities (dams) for future irrigation purposes.[542]

In reviewing dam construction in South Africa since the 1910s, it becomes evident that at the time of Union the storage facilities at Potchefstroom, Klerksdorp and Wolmaransstad were essentially the only storage dams in the Transvaal. However, in the north-eastern Transvaal, later there were private dams at Zebediela, Louws Creek and White River. Most dams were situated in the south-western Transvaal, in the catchment of the Vaal River and almost on an east-west line from Bethal, through Johannesburg to Mafeking. These dams were the Klein Marico, Marico-Bosveld, Twyfelspoort, Lindleyspoort, Bospoort, Commissiedrift, Buffelspoort, Hartbeespoort and Bon Accord. A considerable amount of irrigation was conducted from springs in dolomite formations on the Mooi River at Potchefstroom, at Loopspruit – also near Potchefstroom – on the Schoonspruit near Klerksdorp, and a small spring at Wolmaransstad.[543]

■ A greater role for energy: Electricity

Before the end of the Second World War, the development of energy in the form of electricity and petroleum had a profound effect on consumer patterns in urban areas and at all levels of industrial activity in South Africa. The advent of appropriate legislation and a public electricity utility – Escom – in 1922,[544] had a marked effect on industrial development. Increasingly, the availability of electricity in the commercial and domestic environment started shaping the

541. Kokot (1942:169, 201).

542. Kokot (1942:205–206.

543. Kokot (1942:207–208.

544. Conradie, Messerschmidt and Morgan (2000:72-73).

socio-economic development of society in South Africa's urban areas. Escom and some of the private power producers focused on thermal power from coal-fired power stations. Since the late 19th century, Cape Town and Pretoria, as well as a number of towns in the rural areas of the country, had been supplied with the first electricity, which came from small-scale hydropower stations.[545]

In 1916, a hydroelectric mill began operations in the small labour colony of the Dutch Reformed Church at Kakamas. By 1928 the local mill had been upgraded with a new roller system and more up to date machinery to enable local residents in the settlement to mill wheat. At the time it was capable of milling as much as 55 bags of wheat in a 10 hour shift. About 5 km from the mill was the Kakamas hydroelectric power station, situated on the north bank of the Orange River. In 1928 the power station had two turbines generating 46 KW each. The problem was that the north furrow from which the water was extracted was only capable of generating 45 KW. The milling machinery of the settlement required at least 15 KW, and there were indications that considerably more power would be needed in future. Consequently, F.H. Nel, the irrigation commissioner responsible for Kakamas, recommended to parliament that attention be given to strategies for generating more hydropower in the settlement.[546] Kakamas set an example for other farming areas in the country.

One of the country's premier coal mining operation areas was the town of Witbank, in the eastern Transvaal (now Emalahleni, in Mpumalanga) which, in 1926, emerged as home to a regional head office of Escom. The utility built the town's main power generating plant, operated by the Victoria Falls and Transvaal Power Company. At the time the power station was the largest of its kind in the southern hemisphere. Having a town lit up by electricity made Witbank a 'model town'. Apart from the fact that there were some complaints about water pollution and people's health being affected by the air pollution, the urban community was in favour of developing local industries and promoting the town.[547]

In 1937, the Irrigation Commission was asked to investigate the possibility of constructing a hydroelectric scheme on the Crocodile River at Kaapmuiden, in the Eastern Transvaal Lowveld, with a view to securing sufficient water to power irrigation activity for the farmers. The commission was not convinced of the merits of the plan and advised government not to give its approval until such time as a technical investigation of the scheme had been conducted. There was a growing enthusiasm for greater general access to electrical power. In 1938, residents of the Kimberley district discussed plans with the Irrigation Commission for the development of a grid system of power supply that could be of benefit for local irrigation farmers. Proponents of the scheme explained that if power was made available in large quantities and at low cost, it could be

545. Klunne (2013:305).

546. UG7/1929 (1929:34).

547. Singer (2011:23–30).

to the benefit of the irrigation sector along the Vaal River in the vicinity of Kimberley. The Irrigation Commission was in two minds about the proposal and recommended that in view of the information on pumping systems powered by petroleum that were also available, the government had to wait before taking a firm decision on the choice of the source of power. The technology had to be given the opportunity to develop properly.[548]

In 1939, the Irrigation Commission reported on the introduction of pumping technology for irrigation. There were diverse schools of thought on the matter. Some thought the cost was too high, and that only limited amounts of water could be pumped. There were also potential consumers who argued that the high cost of operations and the transportation of pumping technology made the proposal impracticable. Those in favour of using electricity for pumping water saw its prime advantage as being far superior to traditional manual gravitational leading. Pumping diminished the costs of constructing expensive canals and headworks. The commission was aware that with the advent of crude oil, the cost of fuel had reduced substantially.

Consequently, there was a proliferation of irrigation pumping schemes in the country. The Irrigation Commission pointed out that if the price of fuel were to be reduced further it would make numerous irrigation schemes in the Union productive. Now convinced, the commission was in favour of the technology and propagated the lowering of the fuel price if and where possible.[549] By implication electrical, or even petroleum power meant that water supplies could be put to better use in irrigation farming operations. If water turbines were unable to generate power, fossil fuels were an increasingly becoming viable proposition.

■ Conclusion

Coming to power in 1924, the Pact government came across as relatively slow in putting water to use for the upliftment of indigent whites in many parts of the country. However, as the spectre of a global economic depression deepened in the 1930s, the government quickly moved to create opportunities for the development of irrigation schemes and the construction of water storage facilities. The scale of work was notable and is representative of a vibrant panarchy development phase in the realisation of the department's food–irrigation hydraulic mission. The Vaal Dam, completed in 1938, was destined to remain South Africa's largest storage dam for some years.

Government's use of the Irrigation Commission was a convenient mechanism for creating a platform; it could then engage with the farming sector where irrigation was considered a ground-breaking technology to open up

548. UG9/1939 (1939:17).

549. UG14/1940 (1940:5).

new opportunities. Politically, the new government used the commission to gain knowledge and insight into how government funds could be made available for irrigation loans. The commissioners were useful in shedding light on a complex sector of South Africa's farming industry. The Irrigation Commission made numerous innovative recommendations, but the political leaders did not always respond favourably. In the 1930s depression era, the knowledge and expertise of the commissioners on matters of irrigation and water resources in South Africa proved to be most useful.

Research was another facet of the irrigation department's functions, and a particularly noteworthy project was the topographical survey that resulted in the 1:500 000 map of South Africa and enhanced the knowledge of South Africa's varied climatic conditions and their effect on the country's water resources. With the outbreak of the Second World War, the department was in a good position to make a contribution to the war effort in terms of human resources and valuable managerial and technical skills. The professional and scientific standards of the department's officials clearly made significant progress. The work done on meteorology and the map survey, as products of the hydrographic survey of South Africa, represented pioneering work. In years to come the planners of South Africa's water resources would rely on A.D. Lewis's project to work on the future mapping of the country's water supplies.

The inter-war years, especially 1930 to 1938, were notable for addressing South Africa's poor white question. The department played an important role in providing work for the unemployed on government water storage schemes and local government irrigation schemes. Although the labour was a form of state altruism, the department was a significant beneficiary. It was possible to secure funding for the development and construction of schemes for which no funds were available in former times. Moreover, it was possible to pave the way for the appropriate training of irrigation farmers. Numerous South Africans of colour participated in these government projects, but they did not benefit as much as their white counterparts.

By the 1930s, as the country's economy diversified, South Africa's water resources came increasingly under the spotlight. More water was needed to distribute to other sectors. Urban municipal and industrial demands for water grew to the extent that the Vaal Dam was developed to provide water for irrigation farmers at Vaalharts, but importantly also made provision for the mines and related industries, as well as the domestic consumers in the urban areas of the Witwatersrand. The Cape Province remained the major beneficiary of developments in terms of the department's water services, but central South Africa's Orange Free State and Transvaal provinces, as well as the coastal province of Natal, received their share of planning and construction of storage and irrigation schemes.

Section B

The emergence of an industrial–energy hydraulic mission

Chapter 4

Institutional water governance in the early era of apartheid (1945–1960)

Introduction

The emergence of South Africa's industrial economy in the 1940s was strongly influenced by the principles of a free market view of development. Attempts at introducing a socialist discourse in the 1920s were unsuccessful. State welfare support, the emergence of new white middle class, along with the marginalisation of the African working class, were prime drivers of the free market. In the 1930s, South Africa's foray into a semi-socialist, authoritarian state-controlled phase of economic development was influenced by Roosevelt's New Deal, but was constantly under the scrutiny of well-placed officials with strong links to the British Commonwealth, and an economy that favoured the free market.[550]

To be sure, certain apartheid governance mechanisms after 1948 drove the country to become a prominent industrial state on the African continent.[551]

How to cite: Tempelhoff, J.W.N., 2018, 'Institutional water governance in the early era of apartheid (1945–1960)', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 137-178, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.04

550. Dillard (1946:143–144).

551. Posel (2011:330).

But it was not the NP that sparked the industrialisation drive. Renfrew Christie argues that from as early as 1915 it was the Botha–Smuts government that was determined to put South Africa on an industrial growth path.[552] During and after the First World War, the country was increasingly forced to embark on industrial development. Britain at war and then in a phase of reconstruction, was unable to satisfy the growing demand for industrial goods and services,[553] and in the post-war phase, from 1924, the Pact government continued the early endeavours made under Smuts by supporting South African industrial development wherever possible.[554]

In the discussion to follow, attention is focused on how the emergence of the industrial phase of South Africa's economic development interfaced with the governance and planning of the country's water sector.

Emergence of the energy–industrial hydraulic mission

In the mid-1930s, there was talk among politicians and senior water sector officials about replacing the *Irrigation Act* of 1912. After 1945, the demand for water resources had increased, not only from farmers but also from other consumers. It was felt that the farming sector's dependency on state-provided water services had to be changed. Yet the mentality in the farming industry was that food production was so vital that agriculture had a priority right over water.[555] This was in part because the department had given such dedicated attention to the development of water storage facilities and irrigation schemes. The irrigation–food hydraulic mission remained firmly fixed in the minds of officials and farmers alike.

A number of large irrigation schemes went into operation in the 1930s. Most were costly and seldom operated at a profit. The trend was most evident in the government irrigation schemes of Hartbeespoort (1915–1925), Vaalharts (1933–1938), Loskop (1934–1938), Rust de Winter (1931–1934), Marico (1930–1935) and Pongola (1931–1934). However, the Department of Lands and the Department of Agriculture had a significant stake in the developments. The task of the Department of Irrigation was the construction and development of water conservation and irrigation infrastructure. As soon as the systems were installed, the department once again focused on the picture of all consumers. It comes as no surprise, then, that as early as

552. Christie (1978:94:115).

553. Tempelhoff (2003:129–138).

554. Feinstein (2005:117–118).

555. Horak (1978:330).

1938 the Irrigation Commission advised government to 'ease down' on further irrigation expansion.[556]

The view among departmental officials was that the schemes would take a considerable time before they reached productive capacity. Therefore, it made sense to give more attention to industrial development, particularly in the mining sector. Freund's recent assessment of pre-1948 South Africa suggests that the country's economy development did indeed make headway. The mining industry and the export of primary resources in the 1930s gave the South African economy substantial thrust; this meant it could sidestep the full impact of the worldwide economic depression. In the process, South Africa became less dependent on exporting farming produce.[557]

A more progressive approach to water governance, a basic requirement of an emergent state in a globalising world,[558] had its origins in the era of the Second World War when, in the early 1940s, Smuts' UP government began comprehensive development planning for post-war South Africa. Conley suggests that the first pointer of change was the development in 1943 of a regional water supply scheme – essentially a wartime project for defence purposes at the South African Navy's harbour at Saldanha Bay.[559] Even before its completion, the project – developed in collaboration with the military authorities – had all the makings of a multi-purpose non-irrigation scheme, aimed at supplying water to local industries, the operations of the South African Railways and urban communities in the region.[560]

Specialists in the fields of socio-economic development and regional planning, such as H.J. van Eck, T.J.D. Fair, and H.J. van der Bijl, advised the government in its drive to become directly involved in social and economic development. Of particular importance were town and regional planning projects, and a concerted drive to support mining and related industrial development. New institutions to emerge included the Social and Economic Planning Council (1942), the Industrial Development Corporation (IDC) in 1943, and the Natural Resources Development Council (NRDC), established in terms of the *Natural Resources Development Act* of 1947.[561]

The NRDC, in particular, was an influential role player in government's planning circles. The council had its origins in an advisory committee to

556. UG4/1938 (1938:5–6).

557. Freund (2011:193–196).

558. Solomon (2010:Chapter 13).

559. Conley (1988:223).

560. Visser, Jacobs and Smit (2008:130–161).

561. Journal of the Royal African Society (1942:231–233); Mabin and Smit (1997:204–205); Parnell and Mabin (1995:55–56).

government on the post-war economic development of the Orange Free State. Little wonder then that the Smuts government was swift in giving the nod to the development of the Free State goldfields. However, the project required water resources from the Vaal River – up until 1945 irrigation farmers of the Vaalharts scheme and the mining industry on the Witwatersrand goldfields had the lion's share of the water in the Vaal River system. By 1947, the available supply had to be shared.

The major drivers of change after the Second World War were economic forces that, in turn, sparked a number of management needs. L.A. Mackenzie, director of the irrigation department in 1947, supported industrial development, but with the proviso that, 'In a country [...] whose major obstacle to expansion is so obviously water, it follows that [...] development must be planned.'[562]

He wrote extensively on South Africa's water resources and irrigation, and prior to his retirement with superannuation in 1952 he was hard at work planning the future water legislation of South Africa.[563]

In 1947, the government's water think tank, the Irrigation Commission, conducted an investigation into the country's irrigation farming sector. The commission visited Australia and New Zealand and subsequently made a number of adjustments, such as scrapping irrigation districts, and the introduction of a more thorough departmental oversight of water consumption and loans to irrigation farmers.[564] The recommendations were based on the understanding that irrigation operations had to become more self-driven and independent. Government funding, the commission suggested, should no longer be taken for granted. Governance implied payment for departmental services, and judicious development planning.

The Irrigation Commission's views dovetailed with other, ground-breaking ideas circulating in the department. It was almost as if there was a spontaneous anticipation of the need for a new outlook in the water governance sector. For example, in 1947 Mackenzie explained that the *Irrigation Act* of 1912 focused primarily on the agricultural use of water, both in the domestic and irrigation sector. However, water supplies were becoming finite. There were ever-increasing demands from the mining, urban and industrial sectors for more bulk water supplies. The time was ripe, in Mackenzie's view, for the complete revision of the existing legislation in order to deal with changed circumstances.[565] Since the 19th century the authorities, under circumstances of rapid economic development, conceded to market forces that called for

562. Mackenzie (1947:2).

563. Hobbs and Phélines (1987:41).

564. UG40/1948 (1948:48–49).

565. Hobbs and Phélines (1987:39, 41).

the privatisation of water. As a rule, entrepreneurs were fast to respond to the demand for sufficient urban and industrial water supplies. The best examples were the new urban industrial areas of Kimberley from 1871,[566] and Johannesburg after 1886.[567]

In 1951, J.P. Leslie, chief engineer of the Rand Water Board and president of SAICE, warned against water privatisation. He explained:

> [*T*]he principles embodied in our legislation controlling the use of water provide only for the development of agriculture and throw the onus for providing essential water for urban and industrial use so much on the individual as to compel him to seek the friendly aid of undertakings, who by expensive legislation and conservation have secured some rights to water. These difficulties can only lead to haphazard planning and waste.[568]

Water sector managers were aware that the country's water resources were coming under duress and in danger of running low on supply. The traditional surplus storage facilities (the dams built between 1915 and the 1930s) no longer provided security of supply for all the country's water users. Mackenzie argued that the mining of mineral resources in the aftermath of the Second World War created development opportunities that exceeded all expectations. It deserved support.[569] In giving advice on water policy in the Western Cape Province, where in the 1940s there were concerns about the shift to an industrial bias, Mackenzie drew a fine distinction between essential water, and supplies that could be shared. He argued that if a war were to break out, South Africa could be compromised. As a result of a lack of water, the country could be cut-off from food supplies and be forced to rely on external sources. From a security perspective, this was undesirable. It was important to seek a balance and secure water supplies by means of well-planned allocations.[570]

Yet, as a result of rapid post-war development, it made sense to revise the irrigation department's agricultural–food hydraulic mission ensconced in the 1912 legislation. An industrial hydraulic mission was the next logical step. Essentially, the judicious planning for sufficient water allocations in the industrial areas, along with sufficient supplies of energy (electricity) in the industrial conurbations, meant that a diversified nexus of water, energy and food, had to be aligned with current and anticipated security requirements. Mackenzie's reasoning on a regional water policy for the Cape, as an example, defined the essence of the WEF nexus.[571]

566. Sabatini (2003:35, 46).

567. Cosser (1987:7–36); Zangel (2004:10–18).

568. Leslie (1951:27).

569. UG55/1947 (1947:11).

570. SAWHAR DH5/MKC/004 Mackenzie Collection (*c*. 1950–1952:1–2).

571. SAWHAR (*c*. 1950-1952:1–11).

The advent of National Party rule

After the Second World War, an important talking point in international political circles was the advent of European decolonisation in Africa, South America and Asia. Many colonial powers began to revise their colonial policies in Africa. In parts of the continent, like South Africa, the imminent transition was met with indifference, largely because of the relatively large European population resident in southern Africa for more than three centuries. Although South Africa's existing water legislation reeked of colonialism[572] it hardly, if at all, influenced the government to make adjustments to the department's development. In fact, the Department of Irrigation was responsive to the government's drive for rapid development. The department even supported the transition from the 1912-developed agricultural–food hydraulic mission, to a new focus on industrial development.

Government's standpoint was bolstered by the surprise victory of the NP in the May 1948 parliamentary elections. The party was more conservative than the former UP government, and had a staunch Afrikaner nationalist support base. Yet an anti-colonial mindset did not feature prominently in matters related to the country's water governance and economic development. To all intents and purposes, with the advent of the new NP government, the discrimination against people of colour enshrined in the legislation of the UP government remained intact. In the 1950s the government became even more discriminatory. The best examples of legislation kept intact were:

- the existing *Land Act* of 1913, which divided land between blacks and whites, with the latter being the greatest beneficiaries
- the *Natives Trust and Land Act* of 1936, which prevented Africans from freehold ownership of land of their choice
- the new (and particularly notorious) *Group Areas Act* of 1950, which made residential separation compulsory between racial groups. It also controlled Africans' right of access to 'white' areas, and – by implication – also to living conditions that included proper water supply and sanitation.[573]

The new prime minister, D.F. Malan, appointed J.G. Strijdom (1893–1958) as Minister of Irrigation. Strijdom was a passionate Afrikaner nationalist and enthusiastic farmer who, in his parliamentary maiden speech in 1929, spoke on the topic of water conservation and irrigation.[574] He continued to promote the cause of farming in the northern parts of South Africa, as he had done long before the NP's 1948 victory.[575] In the irrigation department there appears to

572. Tewari (n.d.:695).

573. Tewari (n.d.:702).

574. Van Rensburg (1977:785–793).

575. Basson (1980:599–600).

have been a streamlined transition to the evolving view of the new government. In 1948 the department did not submit any bills to parliament for approval. Instead, the first measures were submitted in 1949. One of the key pieces of legislation was the *Irrigation Commission Repeal Act* of 1949. In terms of this measure, the Irrigation Commission became defunct on 01 June 1949.[576] The commission's role was, in effect, taken over by Mackenzie's research section, which was subdivided into a research and a planning division.

As the responsible cabinet minister, Strijdom kept a clear focus on the objectives and the need for sound water management. He facilitated the government decision on 17 April 1950 to appoint a commission of inquiry into water legislation.[577] The commission of inquiry, under the chairmanship of Justice C.G. Hall, an expert on the evolution and development of South African water law,[578] reported in 1952 on its findings and made a number of far-reaching recommendations. They corresponded with discourses held in the 1930s, and became more relevant as the country started moving on an energy–industrial development path.

The commission recommended that the sensitive issue of riparian rights had to remain undisturbed, but required modifications to allow the state a greater measure of control over the country's water resources. The name of the irrigation department had to be changed to the 'Department of Water Development'. Henceforth the department had to have greater powers of oversight and more duties under the guidance of the responsible minister, in conjunction with departmental management officials.[579]

The representative role of regional water boards making recommendations on proposed water development schemes had to be halted. Instead, the investigation, construction and control of water conservation (storage reservoir) schemes and matters relating to the use of public waters, was to be in the hands of government. The payment for these projects would be the subject of negotiation between government and the responsible body charged with the construction, maintenance and control of schemes.[580] Government would henceforth have the power to expropriate land, servitudes and rights in respect of land set aside for the occupation of 'natives' in terms of the *Natives Trust and Land Act*, of 1936, as well as in respect of land owned by Europeans and Africans in their own right.[581] In view of the limited availability of water, no

576. UG65/1950 (1950:6).

577. Hobbs and Phélines (1987:41).

578. Hall (1939, 1947b); Hall and Burger (1974).

579. Water Law Commission (1952:13, 15).

580. Water Law Commission (1952:18).

581. Water Law Commission (1952: 20).

industry consuming more than 227 kL/p/d could be allowed to commence operations without first securing personal permission to do so from the minister responsible.[582]

In terms of groundwater, the commission was adamant that the extraction of groundwater from dolomitic formations was subject to the regulatory approval of the minister. The objective was to protect groundwater supplies from consumption by mining, and to make this vital resource available for general consumption. Operations related to borehole drilling and the extraction of water were to remain under the control of the Department of Water Development.[583]

Not all commissioners were of the same view. There was a minority report attached as an addendum to the main report, in which Justice C.G. Hall made alternative recommendations. Personally, he favoured the maintenance of a commission that was independent of the department, but responsible for reporting to the minister (similar to the Irrigation Commission established in the 1920s). He also opposed giving too much executive power to the department.[584]

In the deliberations of the commission, Hall argued, a national water resources commission had to serve as an active, overriding authority. His fellow commissioners – toeing the government line – did not favour a national commission, explaining that in effect, taking decisions on water resources and services would then mean that several government departments first had to give their consent to decisions taken by the Department of Water Affairs. Moreover, it implied the prior approval of several ministries.[585]

Hall favoured regional control, warning that central government officials could become exhausted from the vast amount of work in a centralised system. Regional authorities, he suggested, could report back to the central authority. Hall outlined a constitution for a national water resources commission consisting of three full-time members, and a number of part-time commissioners, from a variety of sectors of relevance to the department. In addition, there had to be regional control boards that would report to a central institution.[586] Hall's views were reminiscent of those of the former UP government. The majority of commissioners who supported significant change, toed the NP line. However, there was clear consensus in the commission for supporting industrial development and water allocation to the disadvantage of the irrigation

582. Water Law Commission (1952:18, 20–21).

583. Water Law Commission (1952:22).

584. Water Law Commission (1952:27–32).

585. SAWHAR DH5/MKC5/003 (1952).

586. Water Law Commission (1952:27–32).

farming sector. Therefore, in parliamentary debates and engagements with the farming sector at grassroots level, government had to play its hand in an ambivalent and dualistic manner.

The recommendations of the commission generated considerable debate. A Water Bill was first submitted to parliament during the 1954 session – shortly before Strijdom succeeded D.F. Malan as prime minister. Subsequently, P.O. (Paul) Sauer, became the new Minister of Lands and Irrigation.[587] With a new minister in the portfolio, one not as well informed as Strijdom, the Water Bill did not have an easy ride through parliament. It was complex legislation and the country's political parties went to great pains to protect their supporters' vested interests in farming and industry – the prime sectors affected by the future legislation.

After the first reading the bill was referred to a select committee, but the committee's work could not be completed in the 1954 session. Eventually, on 25 February 1955, the House of Assembly scheduled a discussion of the Water Bill for the 1955 session. Dr Albert Hertzog, son of the former prime minister, J.B.M. Hertzog, and influential leader in the NP, chaired the select committee dealing with the matter. The Hertzog committee resumed deliberations in February 1955, and by 31 March 1955 there had been no fewer than 13 meetings to discuss the bill,[588] which finally paved the way for the approval of the *Water Act*, on 12 June 1956.[589]

Departmental management and changing structures

Starting in the 1940s there were frequent changes in the top management of the Department of Irrigation. For three decades (1911–1941) only two directors, F.E. Kanthack (up to 1920) and A.D. Lewis (1921–1941) stood at the helm of the department. Lewis's successor, K.R. Shand, filled the post for only three months before going into retirement. Shand had been promoted to assistant director of irrigation in 1938, after the unexpected death of E.H. Hughes, who, until his death, had served under Lewis.[590] Shand's successor was T. Hopwood, who retired on 20 July 1944. He was succeeded by L.A. Mackenzie.[591]

A recent assessment of the terms of heads of the national department shows that the average term of office of leaders was 6.6 years (see Table 4.1).[592]

587. Scholtz (1987:716–720).

588. UG24/1956 (1956:7).

589. UG24/1956 (1956:7).; Hobbs and Phélines (1987:41).

590. UG12/1939 (1939:8).

591. Hobbs and Phélines (1987:39).

592. SAWHAR DH DWSa/Alumni1 (2017).

TABLE 4.1: Heads of department irrigation/water affairs 1941–1960.

Initials	Name	Appointed	Last day	Years	Months	Days
K.R.	Shand	24 September 1941	19 December 1941	0	2	26
T.	Hopwood	20 December 1941	20 July 1944	2	7	0
L.A.	Mackenzie	21 July 1944	30 November 1952	8	4	10
D.F.	Marais	01 December 1952	14 January 1956	3	1	14
P.K.	Goosen	15 January 1956	07 June 1960	4	6	22

Source: SAWHAR DH DWSa/Alumni1 (2017).

Interpreted from a historical perspective, it is evident that in times of intrinsic change in governance, the heads of department served for short periods of time.

In the period September 1941 to June 1960, the average term of the head of department was 4.8 years. L.A. Mackenzie and P.K. Goosen were the only departmental heads who served for relatively lengthy periods, and for considerably longer than the rest. D.F. Marais, who succeeded Mackenzie, retired due to ill health. He was succeeded on 14 January 1956 by P.K. Goosen, who died on 07 June 1960. His successor was J.M. Jordaan who, in 1961, in line with the new water legislation, became the first secretary for water affairs.[593] A notable feature of many heads of department was early retirement because of poor health. P.K. Goosen even died in the post. As the department's responsibilities increased, the workload of the chief executive official clearly required considerable input. It appears that this might have caused physical and mental strain and exhaustion. Other factors that might have contributed to the short terms in office as described above include the trauma of the Second World War, significant post-war social, economic and political changes in South Africa, and comprehensive changes in the department at the time. As will be seen below, in some cases short terms in office coincided with cabinet changes and the introduction of the new water legislation in 1956.

Mackenzie (1944–1952), who also retired early as a result of poor health, played a key role in directing the activities in the Department of Irrigation. While he was director he promoted research and data heuristics to inform government's water development plans for South Africa. He made a significant contribution on future water governance at the time of the establishment of the National Resources Development Council in 1947.[594]

Departmental staff shortages have a long history, dating back to Union in 1910. As late as March 1946, the lack of sufficiently skilled people in the department was acute. During the war, officials were called upon to undertake a number of projects for the Department of Defence. There were also those who had started

593. Hobbs and Phélines (1987:43).

594. Mackenzie (1947).

planning for post-war conditions. The result was that by the time the war came to an end there were ample job opportunities for people in the department.[595] However, as had been the case after the First World War, the department had to compete with the private sector for the services of civil engineers, who were in short supply. For some time in the aftermath of the war, the department had to grapple with an undersupply of expertise. Although the government had taken measures to ensure that departmental salary scales were improved to compete with the private sector, L.A. Mackenzie emphasised that the country was heading in the direction of rapid growth and development. The department, he warned, would only be able to meet the challenge if and when suitably qualified people were appointed.[596]

By 1955, there was significant growth in the number of officials in the department, but the shortage of engineers remained a problem. D.F. Marais, the director of irrigation, decried the fact that while the department had 123 posts for engineers there were only 91 in service. Furthermore, the number of experienced senior staff had diminished rapidly. After eight senior officials had resigned or retired, 11 new recruits were appointed to take up their posts. At the time there was also a severe shortage of draughtsmen. A total of 38 posts were approved at the beginning of the new financial year, but it was only possible to fill 29 positions.[597] The undersupply of critical human resources made it difficult for the department to respond to the growing national demand for water, at a time of rapid economic development.

To add to the department's woes, unskilled labour was in short supply. In the early 1950s the department made use of prison labour. The first convict labour was used in South Africa on the construction of the Ohrigstad Dam and later they were also used at the site of the future Floriskraal Dam in the Orange Free State. They worked well. In his reports and later reflections on a long career in the water sector, W.J.R. (Will) Alexander maintains that even the hired workers did not work as hard as the convicts that worked under him. By 1954–1955 convict labour at the Floriskraal and Bergvlei government irrigation schemes numbered 300 and 400 labourers respectively.[598]

The departmental construction teams used prisoners who were serving terms of two years or longer, but they were not considered the most productive labour force. The director of irrigation, D.F. Marais, reported in 1955 that in general convicts only completed about 50% – 60% of the work that black labourers were expected to perform. Alexander's view on prison labour on construction sites, was based on a humane view to dealing with the labour force.

595. UG55/1947 (1947:5).

596. UG55/1947 (1947:6).

597. UG55/1947 (1947:5).

598. UG55/1947 (1947:5).

Not all officials of the department were of the same conviction as Alexander. It was the policy of government that these prisoners be provided with labour and that it be calculated as a productive benefit. The director of irrigation warned that in modern construction projects, when expensive machines were used and trained operators were employed, the remuneration of staff could become expensive and it was required of convicts to perform better in the workplace. After experimenting with prison labour for some years, it was clear that these labourers could be put to good use, depending on the type of work that needed to be done.[599]

Water research

From the early 1940s, amid an upswing in comprehensive regional and urban planning by various government sectors, the Department of Irrigation, under the directorship of L.A. Mackenzie, positioned itself to play an active role by making well-informed contributions to planning in the water sector. The water research branch of the Department of Irrigation was established on 01 January 1946. Specialists employed in this division were responsible for projects that included:

- investigating the country's river systems
- assessing the rivers' potential for the development of the land and of industrial resources
- taking a wider perspective on the potential uses of water, especially in the country's industrial sector
- coordinating and increasing the tempo of basic research tasks.

Meanwhile, the workload of the Department of Irrigation increased to the extent that the existing staff component was unable to cope. In an effort to manage and stimulate research, the hydrographic branch (which later became the hydrological division) took over the task of studying the regional and national water resources supply.[600] By 1949 planning projects had reached such proportions that separate planning and research divisions were established in the department.[601]

Special measures introduced by the government, such as subsidy benefits for local authorities,[602] increasingly burdened the technical division of the department. It was impossible to give sufficient attention to all the work that

599. SAWHAR WAC7/11/1 General Correspondence: 1952–1967 (1958).

600. Hobbs and Phélines (1987:39).

601. UG65/1950 (1950:6); Hobbs and Phélines (1987:39).

602. SAWHAR ZKC (1986).

required attention.[603] The situation delayed the department's much needed regional survey of the Union's water resources planning.

A number of regional reports were completed on projects at the Great Letaba River (north-eastern Transvaal); the Matlabas, Magol and Palala Rivers[604] (northern Transvaal); and the Modder River scheme in the Orange Free State. Much of the department's work was focused on the Vaal River catchment – understandably a crucial area of concern at a time of rapid urban and industrial growth on the Witwatersrand. The Vaal River's water was reaching a point of over-consumption, so close attention was given to the possibility of creating more industrial development opportunities in the eastern part of the Drakensberg range, where for the most part the Union's water supplies were not fully utilised. Part of the research being conducted from 1949 onwards included historical research on the planning and development of completed irrigation schemes, with a view to making constructive decisions on future water planning. The department needed to consider improved designs, construction and management strategies to avoid repeating mistakes. The national water resources report was delayed until 1950, when a comprehensive and detailed map (up to the year 1945) was completed. The map provided key information on plans for the future water resource infrastructure.[605]

By 1954 the research division was responsible for basic research on issues regarding run-off, as well as on the storage, use and supply sources of the country's water. Researchers spent a long time locating and interrogating the available data previously collected by the hydrological and reconnaissance sections.[606] On the planning side, the section focused on the detailed examination and analysis of proposed projects. They also examined what had been identified as technically possible and economically feasible. The department's planners, in turn, looked at the details of the proposed works and final cost estimates. The work of the research division was clearly hampered by the shortage of engineers and draughtsmen. Little fundamental work could be done on water supply. Instead, the staff focused in on flood-expectancy studies for specific rivers, in response to requests received for storage dams. In the period 1954 to 1955, the department investigated a number of rivers. These included the Pienaars River at the farm Roodeplaat No. 314, Pretoria district and the Blood River at the Rooikraal Dam, Groblersdal district; the Sand River at the farm Allemanskraal No. 46, in the Winburg district of the Orange Free State; the Leeu River at Leeu-Gamka Dam, Prince

603. UG65/1950 (1950:6).

604. WP Z64 (1964:3–4).

605. UG65/1949 (1949:7).

606. UG24/1956 (1956:7).

Albert district, Cape Province; and the Buffelsjag River at the farm Somerset's Gift, in the Swellendam district of the Cape.

Despite the department's critical skills shortage, the planning division and researchers worked on dam site investigations and conducted fieldwork with a view to new projects. In between, there were surveys of projected irrigation works and water supply initiatives. The 1950s departmental reconnaissance and survey projects were a far cry from Lewis's earlier ground-breaking mapping of South Africa's catchments. The human resource skills were simply not available. The department even seconded some of its irrigation surveyors to the Department of Native Affairs, which meant the surveying section was reduced to a mere 16 members. Despite the staff shortages a number of field surveys followed. One of the more important investigations was a new survey of the Lower Orange River.[607] In time to come this work proved helpful for government thinking on water in the country's arid regions.

Water research at the CSIR

The CSIR, founded on 08 October 1945, formed part of J.C. Smuts' plan to enable South Africa to make industrial headway in the post-war period. The first president of the CSIR was Sir Basil Schonland, a South African working at the British Army's Operational Research Group during the war. Smuts had consulted Schonland before having him recalled in 1944 from active wartime service to return to South Africa and start up the CSIR. A number of hand-picked scientists and research leaders were sent overseas to become acquainted with international trends. When they returned to South Africa the CSIR established several institutes based upon their areas of research.[608]

In 1948 the CSIR identified the urgent need for a division of water research that was based in its National Chemical Research Laboratory. On 01 April 1958 the NIWR was established as an independent part of the CSIR. Among other objectives the institute's research programme was:

- to use the water resources of South Africa with a specific focus on water treatment and purification and the protection of all water resources against environmental pollution
- to make a contribution to the development of South Africa's industries, especially in respect of the purification of sewage and industrial effluent and the recovery of waste materials from the effluents
- to see to it that there was an effective measure of coordination on fundamental and technological research in these fields.[609]

607. UG24/1956 (1956:7–9).

608. Basson (1996:17–20).

609. SAWHAR WLC PAM3277/63 (1963a:1).

The CSIR water research group played an important role in foregrounding wastewater in the South African water sector. It was timely. Since 1910 local authorities were responsible for the sanitary treatment of their urban wastewater, especially sewage. The irrigation department focused on bulk water supplies to the farming sector. As early as 1937, largely as a result of a growing need for greater engineering expertise, a South African branch of the London-based Institute of Sewage Purification was established.[610] The institute's South African proceedings were primarily in the Johannesburg area. In the burgeoning metropolitan industrial area of the Witwatersrand the local wastewater treatment sector operatives gained access to some of the most advanced knowledge available. By the 1950s the knowledge dissemination spread countrywide to deal with a growing sewage and wastewater conundrum as a result of rapid urbanisation and development.

Organisation of the Department of Water Affairs in the 1950s

With the gradual phasing in of the *Water Act* of 1956, new structures started taking shape in what used to be the irrigation department. There was a new division of water utilisation, with two subdivisions – one for agriculture and another for industry. The department's design and planning section split up. A new hydrological division was created and a new administrative section came into existence to deal with permits for abstracting water, and a range of other departmental functions.[611] Much of the work conducted in the Department of Irrigation in the 1950s was related to improved water storage facilities.

Once the 1956 *Water Act* had been passed, the number of irrigation boards in the country's eight catchment circles increased. In the Cape Western Circle, there was a total of 64 irrigation boards by 1957, servicing a surface area of 53 018 ha. The Cape Midlands Circle, meanwhile, had 26 irrigation boards with a total scheduled area of 35 884 ha. In the Lower Orange Circle there were two irrigation boards, Steynsfurrow and Louisvale; together they covered a collective surface area of 1614 ha. In the Upper Orange River Circle eight irrigation boards were active. In the Vaal River Circle 10 irrigation boards served farmers in a region spanning 9033 ha. In the Western Transvaal Circle there were 18 irrigation boards (5792 ha). In the Eastern Transvaal Circle 34 irrigation boards operated in an area of 36 060 ha. Finally, the Natal Circle had five irrigation boards and these administered a surface area of 2628 ha.[612]

610. K. Murray (1992:28–29).

611. Hobbs and Phélines (1987:42).

612. UG74/1960 (1960:13–18).

Alongside the irrigation-related activities of the department, there was a growing demand for multi-purpose bulk water supplies and services. The 1956 legislation was intended to give account of the way in which government would manage the country's water resources.

The *Water Act, 54 of 1956*

The *Water Act* of 1956 focused on the need for effective water governance. Its stated aim was to 'consolidate and amend the laws in force in the Union relating to the control, conservation and use of water for domestic, agricultural and industrial purposes'.[613] Through the responsible minister and the senior state-appointed official, the secretary (formerly director) of the newly named 'Department of Water Affairs', the government intended taking firm control over water supplies, including private and public water (Section 2–3). Local authorities were entitled to take water within their areas of municipal jurisdiction for urban consumption purposes (Section 4–8 and 9). The state, in turn, took control of subterranean water and any water found underground (Section 27–33).

The system of water courts, originally outlined in the *Irrigation Act* of 1912, was maintained, but with greater responsibilities resting with the water authorities. It was the water courts that had to decide on legal matters relating to government water control areas in the various provinces and subdivisions of provinces, specifically with a view to accommodating the well-defined catchment areas.[614] In addition, the 1956 Act accorded the state the right to embark on the construction and control of government water works (Section 56–70), including the construction of dams, irrigation schemes, and the generation of electricity (Section 67). The duties and responsibilities of irrigation boards and water boards were meticulously outlined to ensure more effective governance in both agricultural and non-agricultural user sectors. The introduction of formal subsidies was a firm commitment by the government to make a contribution to the development of wastewater treatment works and water purification plants in the country's urban areas.

There were early indications of the legislation serving the cause of apartheid in the first published version of the *Water Act*. What could perhaps be interpreted as a pointer to future apartheid planning appears in Chapter 10, where Section 176 makes reference to the 'native areas' (territories earmarked for the future development of homelands). The reader is informed that these areas would not be subject to the stipulations mentioned in Chapters 3, 4, 7 and 9. These clauses had a bearing, respectively, on the control of subterranean water; water courts; water boards; and irrigation loans,

613. Union of South Africa (1956:1046–1305).

614. Hall and Burger (1974:123–124).

liabilities and subsidies (Section176). Interestingly, the first amendment to the *Water Act* followed within a year of its initial approval. The *Water Amendment Act,* No. 75 of 1957, stipulated that government had the right to expropriate land if and when it was for the purposes of establishing government-controlled water works.[615] This meant that all land, even land in the so-called 'native areas', could be expropriated for the development of government water works.

For departmental officials, the *Water Act* of 1956 revolved essentially around five key areas.[616] Firstly, the state took responsibility for the supply of large amounts of water for both irrigation and other purposes. In addition, the state was given the task of making available comprehensive funding for the development and implementation of such schemes (See the *Water Act* of 1956, Section 56 [3 and 63]). Secondly, in terms of governance, the state took the responsibility for the administration of a water permit system. In the case of industrial and urban water users the government-controlled the way bulk supplies of water were distributed to stakeholders. By implication the *Water Act* worked in the public interest by taking responsibility for water quality and combating pollution in urban areas (Sections 12 and 13).[617]

Thirdly, the new legislation gave the Minister of Water Affairs the right to declare any defined water control area a specified responsibility of the state. The state, through the *Water Act*, vested in the appropriate minister a larger measure of control of public water than before. It was the implementation of the principle of *dominus fluminis* (the absolute ownership of the resource was with the governing party) – a departure from the pure riparian rights principle.[618]

However, certain safeguards and qualifications remained in place to protect the rights of private riparian users (Section 62). Fourthly, beyond the specified government-controlled areas the rights of riparian users remained in place. The only difference was that under the *Water Act*, riparian owners had to have a special permit to extract water for storage in special facilities (Section 9B).

Finally, the new legislation made provision for local control. In former times local control was with local water boards and especially the irrigation boards, but in terms of the 1956 legislation, this control was extended to urban and industrial users. The new water boards provided bulk water supplies, mainly for urban and industrial purposes. A further stipulation was to extend the function

615. Hall and Burger (1974:8–10, 165–167).

616. Triebel and Van Niekerk (1994:35).

617. Thompson (2006:107–109).

618. The principle of *dominus fluminis* in water governance was prevalent in the Cape Colony prior to the British annexation of 1806. Its reintroduction in 1956 was a measure to bring under control what were seen as excessive claims to water resources by riparian property owners.

of water boards to include regional sewage schemes. Irrigation boards and water boards were under the direct supervision of the state.[619]

The *Water Act* even provided for natural disasters. In the case of floods, private users could stake their claim to storing ‘surplus water’ for personal use.[620] This measure was a form of ‘compensation’ for the appropriation of greater authority over available water resources. The growth of South Africa’s mining sector and the expansion of the industry implied the need to distribute water to a variety of consumers, some of whom were not in urban areas. Another reason given for the need to pass the 1956 *Water Act* was the high capital costs involved in increasing the scope of regional and multi-purpose water schemes. It meant that the focus had to be on using available storage facilities in the best interest of national development.[621] The widespread industrial development in various regions of the country required more reliable and direct governance oversight, with more storage facilities.

Water managers had to ensure that water quality did not deteriorate to unacceptable levels. In terms of industrial water pollution, the Witwatersrand gold mines were a good indicator of the kind of problems the water authorities faced in the 1950s. The Rand Water Board’s chief engineer, J.P. Leslie, reported in detail on efforts aimed at combating river pollution, as early as 1943.[622] Between 1911 and 1935 an imperial ton of rock crushed in the gold extraction process on the mines required 200 L – 300 L and 700 L of water. By 1946, the consumption of a typical crusher had increased to as much as 700L per imperial ton.[623]

In many respects the NP approach was similar to the water-related policies of the former UP government (1934–1948). The new government favoured ‘capitalist rationalisation, including the securing of foreign capital, loans and technical know-how’.[624] Subsequent neo-Marxist scholarship pointed to two dominant forms of capitalism in South Africa since the 1920s, namely, imperial capital (primarily in the mining sector), and national capital (primarily farming and the industrial sector). In the 1940s, evidently as a result of government support for the development of the Free State Goldfields (imperial capital) and the new NP government, which supported farming and industrial development (national capital), there was a signal change in the animosity and

619. Triebel and Van Niekerk (1994:35).

620. Thompson (2006:64–74).

621. Turton et al. (2004:378).

622. SAWHAR WLC PAM2305 (*c*. 1943).

623. Leslie (1951:18).

624. Legassick (1974:10).

strong competition of former times. The government and capitalist role players became partners in development.[625]

Providing water for industrial development became a government priority. It also meant that in the near future the government had to take steps against pollution in the form of industrial waste and toxic mine water.[626] Seen against the backdrop of the apartheid policy there was considerable 'social engineering' at the heart of all aspects of governance in the country from 1948 onwards. For one, the new industrial hydraulic mission also had wide-ranging social ramifications. The introduction in urban areas of separate townships for people of different races, the introduction of so-called 'homelands' in the rural areas of the country, as well as the move to create industrial decentralisation, meant that effective water governance would play a significant role in the government's plans.

Rural water in the era of emergent apartheid

After 1948, the government's attempts to persuade Africans to return to the land to engage in farming activities in the rural areas – preferably in the homelands – were futile. As their income from farming declined, African men chose, in growing numbers, to enter the wage labour system in the urban industrial areas. Here, many of them worked as migrant labourers to support their families, only returning to their homes periodically.[627]

From the 1950s the NP government's apartheid policy focused strongly on stemming the tide of African migration to the country's cities. For obvious reasons, this strategy did not work. Africans faced limited prospects to eke out a living in rural areas on the small amount of land available to them – only 13% of South Africa's surface area. Taking up employment in the cities, where their poorly paid labour was sought in the mining and industrial sectors, meant they would not be able to settle down with their families. In terms of the *Group Areas Act* of 1950, black South Africans who were employed in the 'white' urban areas were deemed to be 'temporary sojourners' – an arrangement that was later eased, but remained in principle discriminatory.[628] The prospect of irrigation – a 'white' technology 'held in high esteem by the African people'[629] – was designed to act as an innovative strategy for combating African urbanisation. Ironically, since 1910 previous governments, at critical points in time, had done little to promote irrigation in the country's African reserves.[630] After the

625. Davies et al. (1976:4–30).

626. Adler et al. (2007:33–41).

627. Wickens (1983:61).

628. Posel (2011:329).

629. Comaroff and Comaroff (1986:1–22).

630. UG9/1932 (1932:34–35).

Second World War, there was a renewed government drive to provide water for residents in African reserves. In 1945 to 1946, the Department of Native Affairs spent £126 925 on securing water supplies in the rural areas. Funding came from government's mainstream policy framework to give attention to land reclamation in the reserves – a project vigorously supported by the Department of Irrigation.[631]

Although the department supported the policy, it remained committed to a strategy developed by A.D. Lewis in the 1930s, to construct water storage dams in areas where erosion caused severe damage.[632] The department was even instrumental in securing water supplies from the Vaalharts scheme to the Taung reserve, where 6800 ha of land came under irrigation and provided 318 garden plots for the benefit of an African community of about 2000 people.[633] From 1948, as part of the government's apartheid strategy, measures followed to improve farming – specifically irrigation farming – in what were to become known as the homelands. Agriculture was seen as being the future mainstay of local food production. To make this policy work, water was vital.[634] From first-hand experience, the NP leadership was familiar with the benefits of earlier strategies of using irrigation schemes to eliminate poverty among indigent white people.[635]

However, in respect of the African population's access to water and irrigation, Van Koppen and Schreiner are critical of government's support for an authoritarian approach.[636] The Tomlinson Commission, appointed by government to determine the economic viability of the African reserves, referred to irrigation as one of the potential 'low-hanging fruits of poverty eradication'. But it suggested there was a need for 'firm control' by state officials over participant farmers. Officials, according to the report, had to be strict in the administration and governance of the system.[637]

Former officials of the Department of Irrigation were more optimistic. They were convinced that – especially in the Transkei region – there was considerable promise for farming activity but then, they urged, water coming down the steep slopes of the Drakensberg range, had to be managed properly.[638] There was even a suggestion that attention be given to locally generating

631. UG14/1947 (1947:5, 9, 10).

632. Department of Irrigation (1951:9); UG15/1936 (1936:9).

633. UG14/1947 (1947:6).

634. Turton et al. (2004:414).

635. Seekings (2007:375–394); Tempelhoff (2006).

636. Van Koppen and Schreiner (2014:543–548).

637. UG61/1955 (1955:120–122).

638. Department of Irrigation (1951).

hydroelectrical power.[639] Based on a report by the Department of Irrigation[640] and *in situ* investigations, the Tomlinson Commission recommended a number of irrigation projects.[641] A strong argument was that the south-eastern parts of South Africa were most favourably situated for securing water resources.[642] In contrast to the western parts of the country, notable for their aridity, the south-eastern areas of the subcontinent clearly favoured rain-fed irrigation schemes.

However, the hardship caused by frequent and persistent drought conditions often had long-lasting consequences for rural African people in the eastern parts of the Cape Province. Countrywide estimates suggest that in the 1940s in the tribal trust lands (predecessors of the apartheid era homelands) the per capita daily domestic consumption of water would have been about 10 L. Traditionally, settlers and migrant peoples tended to settle close to natural springs and streams.[643] But these conditions did not preclude them from suffering hardship and circumstances of compromised water security. In the Eastern Cape, drought conditions in the period 1945 to 1951 were so bad that a quarter of the livestock belonging to indigenous farmers in the hinterland of East London, perished. The impoverished farmers had little hope for the future; many rural people reasoned that life in an African township on the outskirts of East London held better prospects than remaining on the desolate land.[644]

Later, better support followed. In 1954 to 1955 the Department of Irrigation's survey officials were seconded to the Department of Native Affairs to help develop new irrigation schemes.[645] The department also became heavily involved in borehole drilling in the reserves.[646] By 1956 to 1957 most drilling done on contract by the Department of Water Affairs was for the Department of Native Affairs in the rural parts of the country.[647]

The report of the Tomlinson Commission recommended that farmers in the future homelands be settled on smallholdings of between 1.3 ha and 1.6 ha.

639. UG15/1949 (1949:15–16).

640. Department of Irrigation (1951:n.p.); UG27/1953 (1953:3).

641. Perret (2002:5–6).

642. UG27/1953 (1953:3).

643. SAWHAR WLC C1464h (1994:104).

644. Lodge (1983:56).

645. UG24/1956 (1956:9).

646. UG55/1947 (1947:15).

647. UG74/1960 (1960:10).

Their size was adjudged as 'sufficient' to provide for the needs of a household.[648] Earlier experiments suggested that new irrigation farmers had to begin their subsistence agriculture on small pieces of land. Advisers suggested that officials of the Department of Native Affairs and the water authorities had to collaborate closely on these projects.[649] The results were seldom favourable. According to the 1951 census data, South Africa's white farmers produced on average 11.85 bags of maize per morgen (0.85 ha), while their African counterparts were said to produce only 2.25 bags on land of the same size. Lower production rates were attributed largely to physical and economic constraints.[650]

There were even more drawbacks. When a number of white farmers in the north-eastern Transvaal experienced encroachment on certain irrigated lands, government swiftly came to their support. After 1948, the number of African communities who had traditionally been resident in the fertile valleys of the northern Drakensberg, between Tzaneen and Duiwelskloof, increased significantly. Their presence threatened the activities of local white irrigation farmers. The issue became critical when the authorities realised that the local native reserve areas had not been demarcated properly. Native Affairs officials argued that whites should enjoy preferential treatment because of their 'superior knowledge' of farming with water. Local African farmers, according to the officials, were predominantly active in the field of 'cultivating tomato crops', which were in any case entirely 'subsidised by government'. In turn, presumably in a gesture of magnanimity, the white farmers indicated that they would be prepared to dispose of some of their lands to African communities who had close ties with local traditional leaders.[651]

When, in 1954, construction began on the Ebenezer Dam in the Wolkberg region, where the mountain catchment fed into the Letaba River,[652] operations on white-owned irrigation farms in the Letaba region, between Tzaneen and the Kruger National Park, were the prime beneficiaries. White riparian farming operations flourished in the Lowveld's mild winter climate conditions.[653] The same could not be said of all homeland areas in the region.

In 1956, the Tomlinson Commission reported that 122 irrigation schemes had been started up in the African areas, servicing a total surface area of 11 400 ha and offering livelihoods to 7538 plot-holders. The northern parts of

648. Tapela (2008:182); Perret (2002:283–300).

649. UG15/1949 (1949:7, 14).

650. UG61/1955 (1955:85–86).

651. UG61/1955 (1955:85–86).

652. Van Robbroeck (*c.* 2016d).

653. Uys (1996:51–59).

South Africa's African reserves were said to be most productive, with more than 5000 ha under irrigation. Then followed the western parts of the country's reserves with 4300 ha, and Natal with 1500 ha. The Ciskei and Transkei only managed to put 173 ha and 103 ha respectively under irrigation.[654] Government planners were optimistic, and predicted that eventually an estimated 36 000 families could be settled on 54 000 ha of irrigable land in the homelands.[655] Most of the early projects were river diversion schemes and water was conveyed in irrigation canals without linings. After 1950, the state started upgrading existing smallholder canal systems by means of weirs or dams, and lining the canals and furrows with concrete. African farming prospects then improved.[656]

African irrigation farming was not successful in all parts of the Union. By the mid-1950s a total of 28 of 37 new small farming irrigation schemes in the country had either collapsed or fallen into disuse. There were also exceptions. In the north-western Transvaal, irrigation seemed to have sparked off enthusiasm among African farmers. In the Nebo district, free labour helped to build 60 earthen irrigation storage dams. By 1951 to 1952 the initiative had yielded 113 000 bags of wheat produced by African farmers. There were also promising reports from the Olifants River area. In the Letaba district a local black cooperative venture pushed its income up from £9218 between 1948 and 1950, to £21 629 in the years 1951 and 1952. Further north, in the Soutpansberg region along the Nyelele River, two small farming irrigation schemes made headway, but the farmers' earnings were significantly less than those of their counterparts on the Olifants River.[657]

The extent to which the government managed to turn African irrigation technology into a profitable enterprise in the early apartheid era is difficult to determine. The jury is out on how successful it might potentially have been. In the new millennium, estimates suggest that in the 'homelands', there were at least 317 irrigation schemes that provided water to 50 000 ha of arable farming land.[658] Most would become dysfunctional after 1994 when the new democratically elected government withdrew subsidies and support.[659] There is consensus that farming and reclamation initiatives by the authorities since the 1950s in the Transkei, for example, were seldom successful.

654. UG61/1955 (1955:121).

655. Perret (2002:287).

656. Van Averbeke, Denison and Mnkeni (2011:799).

657. UG61/1955 (1955:121).

658. SA Irrigation (2007:10).

659. Tapela (2008:182); Backeberg (2004:362).

Moreover, research shows that these initiatives rarely contributed to the conservation of the local environment.[660]

Municipal water schemes: Subsidies

While those farmers who consumed irrigation water increasingly became subject to a pro rata tariff rate for water, government extended a helping hand to municipal authorities in the rapidly growing cities of the country. In the years following the Second World War, the Minister of Irrigation had the right to grant subsidies to municipalities for the construction of municipal water supply schemes.[661] In 1946, parliament passed legislation to the effect that subsidies would be made available to municipal water supply schemes constructed by the department. The response was rapid; the department was inundated with requests from various local authorities for the construction of their water supply schemes and it was unable to cope with the demand because it had not been equipped to serve this purpose.

In an effort to overcome the problem, the department's management arranged that water supply schemes for municipalities could be built with state subsidies. The proviso was that the department had to first scrutinise and approve the proposed infrastructure plans. The *Finance Act, 48 of 1947*, Section 27, was amended, as was Section 4 of *Act No. 49 of 1935*. The amendment made it possible for the allocation of 33.3% on a municipal water supply scheme, with the proviso that the scheme would not exceed £30 000. In the financial year 1947 to 1948 the department helped process 13 applications, to the value of £212 903, for which the state paid out £70 903. In total, development of all the proposed water works was estimated to cost £2.9m, of which the state had to provide a substantial sum.[662] In the next couple of years, more than 150 local authorities approached the department about upgrading their existing plants.

By 1957 the standardised procedures for government were still firmly in place and government paid seven subsidies to municipalities, to the value of £38 083, on water supply schemes costing £30 999 or less. Subsidies for larger municipal works were also on the list. Another 10 municipalities received subsidies, to the tune of £290 838, for larger water schemes. In the years that followed government maintained its commitment to these municipal water and sanitation infrastructure works.[663]

660. Hendricks (1989:306–325); Crush and Jeeves (1993:351–360); De Wet (1990:440–447).

661. Hobbs and Phélines (1987:39); SAWHAR ZKC (1986:Section 1.10).

662. UG65/1949 (1949:5–6).

663. UG74/1960 (1960:1).

Africans and water in the urban areas: 1900s–1960

The introduction of the policy of apartheid in the country's urban areas after 1948 had a marked effect on potable water and sanitation wastewater in the urban areas designated for Africans. To understand the process, it is necessary to review the water and sanitation services provided for people of colour that date back to the beginning of the 20th century, when there was a consistent flow of African migrants to the country's urban areas.

In many cases, African townships established on the periphery of the so-called 'white' urban areas in the segregation era (1905–1948) were little more than what would today pass for informal settlements. There were some attempts at introducing rudimentary sanitary measures to allay fears that these settlements were responsible for pandemics such as the bubonic plague in Cape Town's slums in 1902 and in Johannesburg in 1904. Another health scare was the worldwide influenza epidemic of 1918. These attempts at improvement, defined in terms of Maynard Swanson's 'sanitary syndrome', were undertaken by local authorities. They created so-called 'model townships', evidence of what Belinda Bozzoli describes as a mentality of white 'welfare paternalism'[664] at places like Klipspruit (1904) and Pimville (1904) outside Johannesburg, Lady Selborne near Pretoria (1905) and New Brighton (1903) on the outskirts of Port Elizabeth.[665]

The sanitary syndrome, in Swanson's terminology, was based on the perception held by some white South Africans of this period that because of their impoverished economic status, people of colour were carriers of contagious diseases that posed a threat to non-African urban residents. The model townships system – to create living conditions for Africans that were considered to be sound from a town planning perspective – remained a principle for apartheid era town planners. The provision of relatively good water and sanitation facilities was intended to safeguard whites' sanitary conditions from being compromised. Until the early 1920s, authorities dealing with informal housing on the periphery of urban areas only focused on the 'problem' from a public health perspective.[666] Symptomatic of the state of affairs, was that in the 1920s residents of the black township of Sophiatown in Johannesburg had to carry water supplies in buckets from the nearby white residential areas to their dwellings.[667]

The *Native Urban Areas Act* of 1923 had the objective of improving the welfare of urban Africans by the provision of housing and other social services.[668]

664. Bozzoli (1996:4–11).

665. Mäki (2008:294); Swanson (1977:387–410); Stadler (1979:119).

666. Maylam (1995:19–38); Harrison (1992:15); Mäki (2008:Ch. 4 & 5).

667. Kgomosotho (1997:18).

668. Brits (1993:159–160).

In terms of this legislation, local authorities were given permission to erect formal housing for people of colour in areas known as 'locations'. As a rule, local authorities were slow to help demolish the existing shack dwellings and to sponsor the construction of decent housing for African residents. The period from 1929 to 1948, according to Harrison, marked a peak in the rate of black urbanisation in South Africa. In Johannesburg, for example, the number of black residents increased from 244 000 in 1939 to 400 000 by 1946.[669]

In the 1940s, government prided itself on what it termed 'good native management'. This meant that employers secured labour from the country's African reserves to work in the mining, industrial and farming sector. There were even initiatives to improve conditions in the reserves by promoting education and training in farming techniques as well as providing improved irrigation farming.[670] But there was a sting in the tail.

Water supplies in the rural areas and the urban slums on the periphery of the large industrial centres remained hopelessly inadequate.[671] By this time Africans were an important component of the country's labour force, with black trade unions becoming influential role players.[672] From the 1940s onwards, the government had the responsibility of ensuring that there was sufficient African labour for the urban industries and for the agriculturalists in the rural areas.[673] Albeit a 'silent' role, the absence of adequate water supplies, played an important role in shaping the fate of many African families in the urban areas. They became vulnerable to contagious waterborne diseases in areas where there were hopelessly inadequate sanitary arrangements. Later the unhealthy conditions became one of the reasons the authorities used as a rationale for the notorious 'forced removals'.[674]

The Second World War caused significant disruption of social welfare services in South Africa. The construction of new houses came to a standstill. In 1944 a number of sub-tenants living on plots in Orlando on the outskirts of Johannesburg left the area, with its overcrowded housing, and settled on vacant land on the periphery, using rudimentary materials for the construction of squatter shacks. When the municipality of Johannesburg provided more land, local leaders became active in the squatter communities. One of these

669. Harrison (1992:14–22).

670. UG14/1947 (1947:9).

671. Gale (1949:395).

672. Jeeves (2004:5).

673. Davies et al. (1976:46–47).

674. Maylam (1990:78); Kgomosotho (1997:23); Nauright (1998:77).

emergent leaders was James Mpanza who headed up the Sofasonke squatter movement.[675]

This early form of African unrest with its politically motivated squatting strategies exacerbated urban living conditions. The lack of sanitary health conditions and access to water resources added to a growing conundrum for the municipal authorities. As the housing crisis worsened, the municipality, in collaboration with the government, stepped in to provide water, sanitation and health services in the townships.[676] In some cases where the municipality hesitated to provide water services, local leaders threatened to start tapping the water mains or putting up their own windmills.[677] The water from windmills was usually supplemented with supplies secured from wells dug in the yards of shacks. The informal strategies of water procurement meant that the water was not necessarily of a potable standard. The denser the populations of these settlements became, the more contaminated the groundwater became with sewage and wastewater.

In and around other urban areas, living conditions for black people were deteriorating. The police were powerless to act against illegal practices that desperate residents began to instigate. For example, squatters in the Vereeniging area took to securing water from adjoining properties, not always with permission of the owners. Some people even wittingly resorted to taking water from local wells, where the groundwater was prone to severe pollution.[678]

The trend spread to other urban centres. In Sophiatown, residents had difficulties in securing water resources because local landlords, who had some influence with the municipal authorities, were not in favour of extending water services to residents.[679] By 1948 Pretoria was literally 'hemmed in' by squatter villages that had mushroomed on the outskirts of the city. In Cape Town it was estimated that two thirds of the black population lived in the inner-city in slums and the shanty towns on the periphery of the city.[680] Proper water and sanitation services in these areas were an exception to the rule. And of course population growth compromised water security in a variety of ways.

In the period 1946 to 1951, in the urban areas of the Vaal River catchment – a significant part of the major urban population growth region in southern Africa at the time – the population increased from 2.2 million

675. Oakes (1995:356).

676. UG15/1949 (1949:19); Van Tonder (1990:95–96).

677. Stadler (1979:100).

678. UG15/1949 (1949:19–20, 33–34).

679. Stadler (1979:117).

680. Harrison (1992:15).

to 2.7 million residents.[681] It was in this era that the development of separate townships for accommodating African residents began.

By 1950, South Africa's Witwatersrand, where most of the country's gold was mined, had a population of 2.3 million, who consumed 342 ML of water per day.[682] In the southern parts of the Transvaal, the lack of sufficient water had already halted further development by the mid-1950s.[683] Furthermore, there were grave concerns that downstream Vaal River water users, such as residents in the new Orange Free State goldfields and the city of Kimberley in the Northern Cape, could experience water shortages.[684]

For geographer Monica Cole, it was clear that the development of new townships for Africans placed significant stress on local authorities. They were unable to secure sufficient water supplies, especially in the Witwatersrand conurbation.[685] The historian, Sheila van der Horst, with good reason, warned of potential 'conflict and competition, sharpened by cultural, colour and linguistic differences' under the difficult urban conditions. It was evident, she argued, that foreign investment in local industries had been insufficient to provide adequate public services such as electricity and water supplies for residents.[686]

Between 1948 and 1956, 12 African townships were completed in the urban areas of South Africa; others were still under construction.[687] However, local authorities were wary of making sufficient services and infrastructure available in the townships, knowing that most residents would be too poor to pay for services. This meant that service delivery of potable water, sewerage and waste removal hardly existed – or was hopelessly inadequate – and this state of affairs posed a health hazard.[688]

In 1951 it was estimated there were about 314 000 African families permanently resident in the urban areas in the country. There was an a shortfall of about 167 000 dwellings for them. At the time the cost was calculated to be about R70 million.[689] In the case of Soweto, the passing of the *Bantu Building Workers Act* of 1951 made it possible to train black workers to help with the construction of houses and related buildings in the new township.

681. Badenhorst (1962:97).

682. Leslie (1951:18).

683. UG61/1955 (1955:109).

684. Tempelhoff (2003:205–206).

685. Cole (1957:263).

686. Van der Horst (1955:71, 78, 80).

687. UG37/1958 (1958:4).

688. Eloff and Sevenhuysen (2011:1–25).

689. Dubb (1977:86).

The legislation only allowed Africans to undertake skilled work in the construction sector if such employment was in designated African areas.[690] At the same time there were financial constraints and a demand for additional funds to cover the cost of water supply and sanitation.

Besides the fact that provision had been made in 1953 by local authorities to secure funding from the state, a Bantu Services Levy Fund was established with a view to making money available to pay for essential services in the townships, *inter alia* water and sanitation. The levy system required that everyone who employed an African person over the age of 18 years (with the exception of private domestic servants) had to pay two shillings and sixpence per week for each employee. These monetary contributions were scheduled to finance essential services in the African residential areas.[691] Initially the levy system was unpopular with employers, but by 1955, according to the Native Affairs Commission (a body set up by the government to do its bidding) the resistance had dwindled and funds were in fact being used for site-and-service schemes. As many as 49 773 residential plots were provided with services.[692] Government monitored the fund closely and there was strict control over how the money was spent.[693]

The development of new townships for urban African residents created considerable hardship. By 1956 on the Witwatersrand, as many as 88 015 people who had been classified as illegal squatters were removed from urban areas to townships. According to the Native Affairs Commission, only 3916 families still had to be relocated.[694] Meanwhile there were ongoing strikes and boycotts organised by disgruntled urban Africans who were angered by the authorities' determination to eliminate the shanty towns and inner-city slums. Many residents were forced to relocate from townships such as Johannesburg's Sophiatown, Pimville, Newclare and the Western Native Township. Similar conditions prevailed in District Six in Cape Town and Cato Manor in Durban.[695]

With the decline of the urban slums, large new townships, also known as 'locations' in the vernacular, proliferated on the periphery of the South African urban landscape in the 1950s. These included Soweto in Johannesburg, KwaMashu and Umlazi in Durban, and Nyanga and Gugulethu in Cape Town.

690. O'Malley (n.d.).

691. Dubb (1977:86).

692. UG54/1956 (1956:86).

693. UG55/1955 (1955:11).

694. UG37/1958 (1958:5).

695. RP72/1962 (1962:6); Eloff and Sevenhuysen (2011:1–25).

In the first decade under the NP, the government made some headway in providing the housing needs of people in the country's urban areas.[696] The way government wanted to deal with the urban sprawl and the heavy consumption of water in regions that were destined to run dry, was to promote the idea of what it euphemistically called 'decentralisation'. NP ideologues argued that it was a sound economic strategy to create 'border industries', on the fringes of African homelands, and thereby reduce the wide divergence in per capita income and employment levels between the four main urban industrial areas of the country and the country's rural areas. At the same time, they maintained, South Africa's land, water and labour resources, could be utilised more effectively.[697] In the longer term the decentralisation strategy did not live up to expectations. It did little to stem the tide of African urbanisation. Nevertheless, the strategy remained a priority well into the 1970s.[698]

African resistance to apartheid in the 1950s

On the surface, it appears that water did not play a direct role in African resistance to the apartheid state before the 1960s. However, water has a deep, but hidden power. It shapes the way people respond to its availability. In the post-apartheid era (after 1994) water and sanitation service delivery problems were prime drivers of community protest, and these demonstrations became increasingly violent.[699] It is quite possible that the lack of reasonable access to water in the 1950s was a driver in urban African protest action against local authorities. While the *Water Act* of 1956 might have been used to ensure that whites benefited from the available water supplies in both the rural and urban areas, it also contributed to deep-seated dissatisfaction among South Africans of colour. They did not have adequate access to water. In the political environment of the 1950s that message came across in a pronounced manner. Water stress, like hunger and poverty, is a hidden driver of community anger and violent protest.[700]

The African response to the government's increasingly repressive policies after 1948 saw the formation of a solidarity movement supported by the ANC, the South African Congress of Trade Unions, as well as by members of the soon-to-be banned South African Communist Party (SACP). A National Action Council was responsible for drafting the Freedom Charter, scheduled to be made public at a Congress of the People, which would be attended by an

696. Harrison (1992:16).

697. Lumby, Matete and Rwelamira (1995:81).

698. RP34/1970 (1970:76–82).

699. WWF-SA (2016:62–81); Bernstein (2010).

700. ActionAid (2016:21–21).

estimated 2884 delegates from all parts of the country; they gathered at Kliptown near Soweto on 26 June 1955.[701] Police later broke up the gathering and arrested many of those in the crowd. Ultimately the Freedom Charter, underlining the principle that the country belongs to all its people, became the cornerstone of the African liberation struggle in South Africa, and still serves as a compass for the government in framing its democratic revolution.[702]

In December 1956, the first court hearings of what became known as 'the Treason Trial' began, and 156 activists allegedly at the helm of the Congress of the People were charged with plotting to overthrow the government. The trial dragged on interminably and eventually, in 1961, all those charged were acquitted.[703] The use of the judiciary to address the discontent of South Africa's black majority acted as a delaying mechanism for the apartheid government. Ironically, the annual Native Affairs Commission report for 1956 (only published in 1958) reported to parliament that:

> A spirit of cooperation and good feeling between the various racial groups was noticed everywhere and with that the Commission can only envisage a greater and happier South Africa in which there will be room for all the groups.[704]

Subsequent to the protest of 1955, government rapidly forged ahead in its attempts to transform the country's urban landscape. In its report for the period 1957 to 1960, the Native Affairs Commission claimed that all illegal squatter camps had been removed from the perimeters of the major urban areas in the country. As far as the commission was concerned, it was only in the cities of Durban and Cape Town that work was still required to develop residential areas for Africans. Sufficient land, it maintained, had already been set aside for this purpose.[705]

Then, in March 1960, the Sharpeville massacre revived the spirit of black protest – with dire consequences for South Africa's international image and, by implication, the country's economy. Government insisted it could deal with the situation; it boosted its spending on defence, and forged ahead in providing housing for the African population as no government had done before. In 1961, M.D.C. de Wet Nel, the minister of Bantu administration and development, announced a five-year plan for Johannesburg. The government would set aside R75m for the development of more than 81000 houses, to be built over an area of 127 km^2. Provision had also been made for sufficient water supply, in the

701. Oakes (1995:387–389).

702. Saul and Bond (2014:53, 55).

703. Oakes (1995:387–389).

704. UG37/1958 (1958:6).

705. UG36/1961 (1961:6).

form of sinking 1531 boreholes.[706] But all this proved to be too little, too late. That same year the ANC announced that it would turn to an armed struggle to fight for the freedom of the African majority, and Umkhonto we Sizwe the armed wing of the ANC was formed, led by Nelson Rolihlahla Mandela.[707]

Dam construction

Dam construction in the 1950s was representative of a trend that would persist in the department's planning for the rest of the century. While it became an accepted principle that water storage planning had to provide for the urban and industrial development of the country, this did not necessarily mean that the water for agricultural purposes would be diminished. In later years, water demand management became a key factor in shaping water consumption. However, into the 1950s government schemes providing for industrial and urban water also took into consideration potential growth in the agricultural sector. These were typical multi-purpose schemes that would increasingly require more sophisticated management of water allocations to a broad spectrum of bulk water consumers in all parts of the country.

As long as there were clear indications of development, there had to be sufficient water supplies. It was not merely a matter of taking away from one to give more to another. Politicians might have articulated the trend as such, but in the department all planning was focused on meeting the demand in an era of growth.

Hybrid measures and construction schemes

In the 1950s, before the introduction of the *Water Act* of 1956, the department submitted hybrid bills for the attention of the legislative assembly. For the greater part of the 20th century, South Africa's legislative processes were in many respects derivatives of Britain's system. Hybrid measures in parliamentary procedures were used under circumstances where legislative measures, deemed to be in the interest of the public, had to be taken in matters where significant interests could be affected.[708]

One hybrid bill under discussion in the 1950s was the Great Fish River Irrigation District Adjustment Bill, which had been introduced in the sitting of 1954. Parliament referred the bill to a select committee after its second reading. As a result of the evidence submitted in opposition to the bill, it was decided that it was necessary to have further discussions with the parties concerned in order to reach a compromise. Two meetings were held in Cradock in 1954 with

706. RP72/1962 (1962:5).

707. Keller (2013:107–121).

708. Le Roux pers. comm., 02 September 2016.

a view to establishing a multi-purpose project with more consumers, but there was no favourable outcome forthcoming. At the 1955 parliamentary session, it was decided not to proceed with the bill, but instead to have further talks between the interested parties immediately after the session so as to settle outstanding issues.[709] By this time, irrigation farmers had to pay a pro rata tariff for the irrigation water they used, and the government started extending a helping hand to municipal authorities. In the post-war years the minister had the right (subject to certain conditions) to grant subsidies to municipalities for the construction of municipal water supply schemes.[710]

Surprisingly, dam construction made significant headway. A notable feature was the development of multi-purpose water storage facilities. A growing stakeholder sector of bulk industrial and urban consumers now required the new Department of Water Affairs to provide for their needs. The need for dam storage facilities in South Africa was largely the result of population growth, along with the physiography and meteorology of the country.[711] South Africa was a hive of development in a water-stressed region of the subcontinent. The hydrological and meteorological data generated by the department since the 1910s suggested that the country's future was intrinsically linked to dam construction. The department's management remained determined to promote dam construction projects.

Pongolapoort

After the NP came to power in 1948, the government supported plans for the development of more farming opportunities for their supporters, most of whom were Afrikaners. There appeared to be considerable potential in the field of sugar farming. As early as the 1930s, poor white labour in the Ermelo and Pongola region had been used in dam construction, but not much came of the plan. In the 1950s there was renewed interest. A number of factors were in favour of using the Pongola River. Sugar production in South Africa had made rapid strides since it began in Natal in 1850.[712] By 1914 almost 5700 ha of land in Natal had been planted with sugar cane. By 1958, the annual sugar production reached more than 975 000 tonnes, and by 1962 this rose to 1.2 million tonnes.[713]

At that time Natal was responsible for all South Africa's sugar production. The prime region for production was along the tropical coastline with isolated

709. UG24/1956 (1956:5–7).

710. Hobbs and Phélines (1987:39); SAWHAR ZKC (1986: Section 1.10).

711. Triebel and Van Niekerk (1994:32).

712. Richardson (1982:515–527).

713. Altona (1963:518).

areas inland in the province.[714] For a long time, experts realised it would be possible to cultivate sugar cane along the Pongola River. The Makatini Flats, one of the most biodiverse regions in South Africa, was said to have the potential of opening up roughly 43 000 ha to 68 000 ha of land for irrigation, if and when, the Pongola River's water could be dammed up.[715] One problem was that the Pongola formed part of Mozambique's Maputo River, which stood to lose significant amounts of water. It jeopardised some of the fertile irrigation lands already in use in the Portuguese colony at the time.[716]

Another problem was transboundary misunderstanding regarding effective water use between South Africa and Swaziland. Relations between South Africa and this neighbouring British Commonwealth territory were at a low ebb as a result of the emergent apartheid system in South Africa. The reservoir of the Pongolapoort Dam (later to be renamed the Josini Dam) backed up into Swaziland. The problem was resolved when the South African government and the Kingdom of Swaziland reached an agreement for the development of the Lavumisa Irrigation Scheme in Swaziland (in 1973). In terms of the arrangement Swaziland acquired access to water supplies of at least five cubic feet per second (cusecs) from the Pongola reservoir. Subsequently, treaties concluded in 1980 and 2006 finalised the project, which, in the early phases, was estimated to cost South Africa about R30m.[717] A third problem with the Pongola project was environmental concern about the desiccation of the highly populated and biodiverse Makatini Flats. The consequence was that up to the early 21st century, although the Josini Dam had been completed, the flats were never put to use for the irrigation of sugar plantations.[718]

Irrigation and water schemes: Gamtoos Valley

Ever since the 19th century the Gamtoos Valley in the Eastern Cape had been a desirable farming area. In the early 20th century, F.E. Kanthack described it as the 'most favourable part of the Union' for irrigation.[719] By the 1950s, about 4800 ha of this land was under irrigation and was managed by the irrigation boards of Kougapoort, Goedehoop, Reenen, Rademeyer, Hankey and Loeriesrivier.[720] As farming operations increased, the department had to provide support in securing more water for distribution to the irrigation farmers.

714. Behrmann (1963:33).

715. Roberts (1962:125–126).

716. Romano (1964:245–251).

717. Roberts pers. comm., 04 March 2017; Ashton et al. (2006:25).

718. Van Vuuren (2012:161–162); Turton et al. (2004:360).

719. Turton et al. (2004:147–148).

720. WP F57 (1957:5).

The additional irrigation provided increased the potential of more than 8500 ha of land.[721] The Tweerivieren Dam, about 5 km upstream from the confluence of the Kouga and Gamtoos rivers, in conjunction with the Beervlei Dam, upstream on the Groot River, were intended to bring greater water security, neutralise severe flooding events and improve irrigation farming along parts of the Gamtoos and Groot River.[722]

Floriskraal Dam

The construction of the Floriskraal Dam, in the Buffels River Government Water Scheme, commenced in 1953; it was situated in the Buffels River, 22 km south of Laingsburg at the confluence of the Buffels and Geelbek River. The crest of the dam was 34 m and at its deepest point it was 17 m. The dam was completed in September 1956 and the first water was stored in November of that year. The estimated cost of the project at the time was £520 000.[723]

The Sand–Vet scheme: Erfenis and Allemanskraal

The Sand–Vet government scheme was first explored by survey teams of the Department of Irrigation in the period 1935 to 1937, in the era of Lewis's comprehensive catchment map of South Africa. Plans for the construction of a dam on the Vet River, the Erfenis Dam, about 15 km from the Orange Free State town of Theunissen, coincided with the development of the Allemanskraal Dam, south of the Orange Free State town of Ventersburg, on the Sand River. Collectively they formed the Sand–Vet complex. These were multi-purpose storage facilities. They provided water to the Sand–Vet Government Irrigation Scheme, as well as to the Orange Free State (OFS) goldfields. Construction work began in 1946.

Irrigation department director, Mackenzie, predicted that the scheme would irrigate about 17 000 ha, with a further 86 000 ha north of the Vet River that could later be brought into the system for irrigation purposes.[724] Work on the project came to a halt in 1948, only to be resumed in 1956.[725] Because of problems experienced with the soil types in the Vet River, a cement intrusion process was used in the construction of the Erfenis Dam wall. Steel-framed containers were filled with horizontal rocks and then

721. UG74/1960 (1960:3).

722. WP F57 (1957:3).

723. UG74/1960 (1960:20); SAWHAR WAC8/l/1 Department of Water Affairs (1960).

724. Mackenzie (1947:1915).

725. SAWHAR WAC8/l/1 Department of Water Affairs (1960).

with cement.[726] Both dams were completed in 1960. The Allemanskraal canals irrigated farms on both sides of the Sand River up to its confluence with the Vet River from where, in conjunction with the Erfenis Dam's canals, it provided irrigation water over a distance of more than 40 km, to farms with suitable agricultural soils.

The construction of the Sand–Vet was an important irrigation and water scheme for the OFS. For the first time, there was tangible evidence of comprehensive planning and resounding success in the primarily farming province's forays into the field of irrigation. A government commission in 1950 reported that with the exception of the irrigation scheme in the areas of Koffiefontein, Jacobsdal and the Modder River, and a few minor irrigation board schemes, there had never been such comprehensive irrigation scheme developments in the province.[727] It was therefore with great enthusiasm that the Department of Irrigation embarked on the resumption of the construction work on the Sand–Vet scheme in 1956.

A youthful and dedicated civil engineer, Will Alexander, was appointed to work on the Erfenis project. He had joined the department in February 1950 and spent time on construction projects at the Floriskraal Dam and the Leeu-Gamka canals, before cutting his teeth at Erfenis where he proved himself to be an innovative and exceptional engineer.[728] Alexander was responsible for the *Korhaan,* a quaint monthly newsletter for the community of dam builders on the Erfenis. He later used extracts from the newsletter to describe daily life in a construction settlement. From a personal perspective he made humorous observations, such as how the Pretoria office had queried his request for stationery (file folders) – worth a few pounds – while its officials and workers were involved in a major dam building project.[729]

Alexander reports in an entertaining narrative how the 39 families (comprising officials of the Department of Irrigation and the Department of Prisons) lived together in relative harmony. There were 230 white workers on the project and 410 African workers. The workers, with their families on the site, numbered more than 1500 people – all intricately connected with the dam construction project. Unlike the departmental offices in the urban areas, life on a construction site called for the engineering staff to take responsibility for the wellbeing of the 'workman and his family'. The community lived at a distance from urban amenities. So, the government paid the staff a 'recreation allowance' of £150 for hiring 'bioscope films' and purchasing the likes of sports equipment.

726. SAWHAR ITC/articles (2013:6).

727. RP34/1970 (1970:7).

728. SAWHAR WAC7/12/14 Personal correspondence (1950–1968, 1955:3–4).

729. SAWHAR WAC7/11/1 General correspondence (1952–1967c:11).

At the Erfenis construction site there were two tennis courts, four jukskei courts, a badminton court (in the community hall), and a squash court. There were also rugby and cricket fields where regular challenge games were held against teams from other construction projects. To secure more funds for developing the community's recreational facilities a variety of fund-raising activities were organised. These included dances, bazaars, *braaivleis* evenings, picnics and a popular '*tiekie-aand*'. Some of the funds raised went to organise a Christmas tree event on the last Saturday before the works closed for the holidays. There was also a 'dry canteen', where workers purchased groceries, toiletries, some clothing and even blankets. In the canteen, small change was added to the children's money boxes. It was not a wealthy community, but there was a sense of belonging and the aspiration to improve their lives.[730]

Alexander provides meticulous details of his responsibilities as assistant engineer. He drew a flow chart of the way the accountant, works foreman and mechanical foreman operated under the resident engineer.[731] He also reflects on how he spent his time as resident engineer of the project. He appears to have been concerned about the fact that there was no time for research. Administrative matters took up 50%, construction supervision required 20%, and 15% of the time was spent travelling.

Other schemes

The OFS goldfields regional water supply scheme was the first scheme undertaken by the Department of Irrigation that did not make provision for irrigation activities. In fact, irrigation played no part whatsoever in its planning. Similar schemes to follow were the Umgeni (1963), Pietersburg (1963), Usutu (1964), the Vaal Gamagara (1964), Potgietersrus (1964), Buffalo River (1970), Springbok (1970) and the Caledon–Bloemfontein regional water supply schemes.[732] While the department embarked on many comprehensive schemes, a concerted effort was made not to neglect smaller projects. Works on schemes such as the Nyelele Dam, Bronkhorstspruit Dam, the Klipdam–Barkly canals, the Albasini scheme and the Umfulozi drainage scheme continued simultaneously.[733]

The river systems of the Vaal and Orange

In the 1950s the department's management increasingly referred to the rivers of the Orange River and the Vaal as 'systems'. They were notable for the large

730. SAWHAR WAC7/11/1 General Correspondence (1952–1967a:13–14).

731. SAWHAR WAC7/11/1 General Correspondence (1952–1967b:15–22).

732. Anonymous, 'A historical overview of the Department of Water Affairs', (in Hobbs & Phélines 1987).

733. Hobbs and Phélines (1987:39–40).

quantities of water used for a variety of purposes. As the knowledge of the river systems increased and modelling became commonplace in the field of hydrology, river systems acquired a special meaning, more than a decade before the introduction of computer systems in the Department of Water Affairs. For the purposes of this discussion the focus is on the Vaal River system. The Orange River system is discussed in the next chapter.

In an incisive study in 1994, Triebel and Van Niekerk divided the development of the Vaal River system since Union into a number of phases. Their classification of the first two phases are of relevance here.[734] They identify the first phase as ending in 1940. In this phase the Rand Water Board built the Vaal Barrage (completed in 1922–1923). Upstream of the Barrage the construction of the Vaal Dam was completed in 1938. The dam was intended to feed the Vaalharts Irrigation Scheme, but also supplied the residents of the Witwatersrand. At the same time the Vaal River catchment saw the construction of several dams, of which the most important were the Vaalharts weir on the Vaal River, the Wentzel Dam on the Harts River, and the Kalkfontein Dam on the Riet River.

The second phase of development took place between 1940 and 1960. By the end of the 1940s, the Department of Irrigation had plans in place to provide water from the Vaal Dam, if and when the supplies of the Orange River became unreliable. In such cases, water from the Vaal Dam was used to secure supplies for irrigation farmers in the Northern Cape from Buchuberg to Kakamas.[735] In this phase the Department of Irrigation concentrated primarily on the middle and lower Vaal. There were additional dams for irrigation and urban use on some of the Vaal River tributaries. Some of the most important developments were Mockes Dam on the Modder River, for water supply to Bloemfontein; and the Erfenis Dam and Allemanskraal Dam on the Vet and Sand River, which were primarily for irrigation purposes.

The reason scant attention was given to the Upper Vaal River, in terms of irrigation, was because the department had singled out the need for using the available water supplies primarily for the purposes of industrial development. Irrigation from the Drakensberg down to the Witwatersrand was simply out of the question. Later, when the first water transfer between the Vaal River and the Crocodile catchment began, it became one of the first major industrial water transfer schemes in South Africa, and the first water supply to the northern areas of the Pretoria–Witwatersrand–Vereeniging region (PWV). This measure was intended largely for mining industrial development and therefore became a multi-purpose project. But in the 1940s, water for farming remained part of the department's prime hydraulic mission. One example was the

734. Triebel and Van Niekerk (1994:32–43).

735. Mackenzie (1947:5).

Source: RP39/1989 (1989).
FIGURE 4.1: In 1950 the wall of the Vaal Dam was raised to secure a greater water capacity.

development of the Vaal–Rhenoster project, aimed at supplying water from the Vaal and the Rhenoster River to the southern parts of the western Transvaal and also to the northern OFS. The proposed scheme included the construction of a tunnel from the Vaal Dam to the Rhenoster valley, where good soil for irrigation farming was available. By 1947, attention was given to the further development of the Klipdam–Barkly extension of the Vaalharts Irrigation Scheme, as well as the Sand–Vet scheme – intended for sufficient water and consistent supplies to irrigate relatively small plots of land on a large number of farms over an extensive area in the north-western parts of the OFS, where stock farming prevailed.[736]

The Vaal Dam's wall was raised in 1950, as can be seen in Figure 4.1. A total of 60 crest gates were added. At the time the Vaalharts weir was also raised with the addition of fish-belly flap gates. In the process, the OFS goldfields received their water from the Balkfontein weir in the Vaal River.[737] Based on the ongoing research in the department since the 1940s, the OFS goldfields scheme became an intrinsic part of the Vaal River Development Scheme. Work began on the project in 1947. The scheme consisted of a low-lifting pumping station

736. Mackenzie (1947: 5–6).

737. Triebel and Van Niekerk (1994:36).

near Bothaville on the Vaal River, which was later used to provide water to the purification plant at Bothaville and, further away, to the new town of Welkom.[738] Since 1948, D.C. Midgley had been working at convincing the irrigation department that it would be best to keep the Vaal Dam as full as possible at all times to prevent water loss. His logic was based on calculations to the effect that the fuller the dam was, the smaller the percentage of water from the available content would evaporate.[739] By 1952, Midgley was busy with a new focus on the hydrology of South Africa.[740]

Midgley's ground-breaking study was completed prior to the advent of computers. Calculations were done manually; an adding machine or a slide rule, and graphical techniques were commonplace. The available data was rudimentary. Of the roughly 400 flow records available, only about half were useful, while only 30 sets of records were available for a period of more than 30 years. In cases where there were no data, annual flows were measured in terms of simple graphical correlations between flow and the so-called 'district rainfall'. Long-term MAR figures were available and used to plot, on log paper, against the catchment's mean annual precipitation (MAP) to get to a point where it was possible to derive a relationship between MAP-MAR for ungauged catchments.[741] The relationship between the storage reservoirs in the catchment were derived with the mass curve, or Rippl (1882) diagram.[742] This was said to give the yield for the recorded period. The storage yield curves were rendered dimensionally by MAR and were then sorted into groups displaying similarities and means of curves. For each a climatological zone was outlined.[743]

In the early 1950s, the department started with measures to increase the capacity of the Vaal Dam. In his 1958 inaugural lecture at the University of the Witwatersrand, Midgley recommended that the boundary of the area from which the Vaal Dam drew its water should be widened. He pointed out that there were a number of augmentation sources, like draining the Eastern Escarpment, taking water from the Caledon River, the Orange and even the Okavango River (which, at the time, had a mean annual flow four times that of

738. Mackenzie (*c*. 1947–1948:8).

739. Midgley (*c*. 1962:128).

740. Pitman (2011:659).

741. RP39/1989 (1989:659).

742. Cf. Civil Engineering (n.d.); Defined as: 'For a potable water reservoir, (the Rippl diagram of mass diagram) is the simultaneous plots of the cumulative inflow and cumulative water consumption/demand, termed "draft" in units of volume (y-axis) vs. consecutive hours, days, months or years (x-axis). In these types of problems, water demand will be at a constant rate to generate a straight, constant sloped line on the plot.'

743. Pitman (2011:659).

the Vaal River at Vaal Dam).[744] He recommended that water be stored in the dolomites in the Vaal basin. This would mean a substantial amount of water storage without a significant loss of evaporation. Another proposal he made was to store water in the Vaal River at Schoemansdrift, for use at the Vaalharts Irrigation Scheme. Further, he suggested that the Tugela River had the best prospects when compared with the supplies of the Olifants and Blyde rivers. Moreover, the Tugela was within reasonable reach of the Vaal system, making it easier and cheaper to transfer water supplies.

In respect of water from Basutoland (Lesotho), Midgley was of the opinion that the water had to be transferred via Caledon. Hydroelectric power could be generated and the additional water could be used at Vereeniging in times of need. He saw the linkage of dams in the area of Ficksburg and Wepener in the OFS as a potential solution.[745] In his view, the Vanderkloof Dam should be developed so that water would run with gravity down to the Orange River. The Upper Vaal River had to be reserved for use on the Witwatersrand, with the Vanderkloof Dam taking over the supply of water to the Vaalharts scheme. For Midgley, the Witwatersrand held the key to the development of South Africa. It would not be a good idea, he suggested, to inhibit the growth of the region by restricting its lifeblood from the Vaal River. Key to the complex system was that South Africa's industrial heartland, the Pretoria–Witwatersrand–Vereeniging region, had to have security of water supply. This prioritisation was conducive to a future industrial–energy hydraulic mission.

■ Conclusion

The first major transition in South Africa's water governance system occurred after 1945. The ability of the authorities and government to see the need for a shift towards an industrial hydraulic mission was of particular significance. Irrigation technology and the farming sector, the prime beneficiaries of the country's water supply up to the mid-1940s, had reached a point of saturation. The realisation set in that it would take considerable time for the existing irrigation schemes to reach fruition. At the time there was a growing awareness that South Africa's natural resources were worth a great deal and could take industrialisation to new heights. The transition to the use of water schemes for industrial purposes and to drive progress via municipal water processing plants in the rapidly growing urban areas, were the correct steps to take in the 1950s – a period of rapid economic growth in many post-war economies in the Western world.

744. Midgley (*c*. 1962:130–133).

745. Midgley (*c*. 1962: 133).

The advent of a new government, with the NP at the helm, did not augur well for race relations at a time after the Second World War, when the UN, inspired by the resounding international support for the Universal Declaration of Human Rights (1948), advocated the complete eradication of racism. In South Africa, the signs of the time did not register favourably for sound race relations. The Sharpeville protest action and subsequent violence of March 1960 escalated and became a spectre of confrontational incidents that gained in intensity by the 1970s. However, the passing of the new *Water Act* in 1956 was a significant accomplishment for the newly named Department of Water Affairs. Many of the weaknesses of the *Irrigation and Conservation of Waters Act* of 1912 were addressed in the new legislation.

Chapter 5

Political isolation and the industrial–energy hydraulic mission (1960–1969)

Introduction: Development and the industrial–energy hydraulic mission

As the decade of the 1960s dawned, South Africa drifted increasingly into international political isolation as a result of its apartheid policies, which flew in the face of the process of decolonisation and African independence on the continent. The Sharpeville massacre of 21 March 1960 was a setback for the government. An estimated 69 people were killed and hundreds were injured when police opened fire on a community protest against passes, organised by the Pan Africanist Congress and the ANC. The event sparked off an international furore, subjecting the South African government to severe international criticism from the newly independent African states' representatives at the UN. As South Africa moved towards international isolation, the state's security systems were on heightened alert.[746]

How to cite: Tempelhoff, J.W.N., 2018, 'Political isolation and the industrial–energy hydraulic mission (1960–1969)', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 179-223, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.05

746. C. Hoskyns (1964:469–470); Smith (1993:251–298); Stultz (1969:4–5); Lodge (2011); SAWHAR WLC PAM5547 (1968a).

The writing had been on the wall for some time. Less than two months before Sharpeville the British prime minister, Harold Macmillan, visited South Africa and told parliament in Cape Town that the 'wind of change' was blowing through Africa. In one of the most important post-war policy shifts, Britain was in a phase of reformulating its presence as colonial power in Africa. Apartheid South Africa's departure from the British Commonwealth was due to a line of political thinking at odds with that of a colonial power that had maintained a strong presence in Africa since the early 19th century. Influential British policy experts supported a more morally acceptable shift towards decolonisation and non-racialism, to prevent a repetition of the fiasco in the former European colonies of the Belgian Congo and the French in Algeria.[747] Decolonisation and the way that former colonial powers viewed Africa was a hard blow for South Africa.[748] In economic terms the effects were disastrous. In the years after the Second World War, South Africa had been an attractive destination for foreign investment. Rapid economic growth, development and modernisation were salient features of the country's economy. This enabled the state to run a persistent deficit on its current account to boost growth in the two crucial development periods of 1946 to 1959 and 1964 to 1973.[749] In contrast, the years 1960 to 1964 were notable for slow economic growth.

Developing water resources and international exposure

One way to meet what appeared to be the short-term economic challenges of the day was to secure lucrative foreign loan investments for the development of the country's infrastructure. South Africa's burgeoning mining sector was more than sufficient security for foreign investment. By the mid-1960s economic growth was sound and the country's water infrastructure experienced previously unsurpassed growth. For example, in 1961 to 1962 the department spent R15m in loan funds from the treasury.[750] In 1962 to 1963 the loan expenditure allowance for the department was increased by R1.9m. Then, in 1964 to 1965, there was a net increase of more than R7m, as a result of the general growth in respect of government water schemes (R4.7m) and construction equipment (R2.5m).[751]

747. Myers (2000:555–575); Ovendale (1995:455–477).

748. Johnson (1982:26–27, 47); Legum (1960:233–242).

749. Feinstein (2005:148).

750. RP33/1963 (1963:2).

751. RP30/1966 (1966:2).

By 1965 to 1966 the Department of Water Affairs was spending R9.3m of its annual R10.1m revenue funds allocated by the treasury. In terms of loan funds, the department used an impressive R43.9m of a total of R48.1m at its disposal. This represented a net increase of R17m in the loan expenditure over the previous year.[752] The economic injection into the country's water sector made a significant contribution towards bolstering much needed growth and development.[753] There was great opportunity for state investment in water, at a time when the political leadership sought avenues of positive expression of intent to invest in the country's future.

The department's water infrastructure planning, especially in respect of the Orange River Development Project (ORDP), was not as over-hasty and impulsive as Bourblanc and Blanchon would have it.[754] As will be detailed below, there is evidence of long-term planning that had been going on behind the scenes for some time. Agreed, there were mistakes and costly, over-ambitious projects in the ORDP that had to be put on ice. This was the price that had to be paid for the complex nature of projects identified by the planners, and the limited technologies at their disposal at the time. Only once they had started physically working in the planning field, were there firm indications of sound, dedicated planning. Perhaps the most important driver was that the government of the day was enthusiastic, and the engineers and senior management of the department were passionate to engage in what was clearly a development bonanza.

Many speculative ideas floated in the public and private realm on the future development of the Orange River. Henry Olivier, an influential and well-connected engineer, recollected how in the late 1950s he had been contacted initially by D.J. Scholtz, the member of parliament for Namaqualand, about an exciting dam project on the Orange River. The people in Scholtz's constituency were eager for the construction of a dam in the Lower Orange at Vioolsdrift. They wanted hydroelectricity. Scholtz represented a relatively small – and primarily white – community scattered over a vast semi-desert area. Some lived close to the sea on the north-western coast of South Africa; others were resident in the vast interior livestock-feeding areas around the town of Springbok – a lucrative long-term mining area.[755]

For the local and regional community, a reliable electricity supply meant that local farmers and industry could make headway in agricultural pursuits which, along with the scattered mining operations in the region, could contribute to progress. Olivier visited the area in December 1959 and identified

752. RP34/1967 (1967:1–2).

753. Roberts (1963:420).

754. Bourblanc and Blanchon (2014:2381–2391).

755. Olivier (1975:110).

a site in a gorge below Vioolsdrift with a substantial quantity of water and a low saddle on the bank that would limit the height of the dam to about 150 m, to produce a reservoir of up to 160 km.

After submitting plans, Olivier was invited for a meeting with the prime minister, H.F. Verwoerd. Verwoerd explained that Water Affairs' officials had been working on a series of project plans for the upper and middle reaches of the Orange River. There were also demands for diverting the Orange River's waters to the Eastern Cape. Verwoerd was not keen on the Vioolsdrift scheme, and explained that the residual flow at the drift would, in time, become negligible. Thus, the scheme could not be contemplated.[756]

Regional water in southern Africa

Another major driver for development was inter-regional competition for status in southern Africa. South Africa's water development plans were part and parcel of government's plans to stake the country's claim as one of the leading countries on the subcontinent. Developments in neighbouring territories, therefore, certainly caught their attention. Despite mounting continental political uncertainties, there were notable regional hydropower and water storage infrastructure developments. Southern Rhodesia's (Zimbabwe's) recently completed Kariba Dam with its impressive hydropower capacity feeding off the Zambezi River,[757] as well as Portugal's plans for Mozambique's Cabora Basa scheme,[758] were exemplary. They set the bar for standards of modernist development at work in the regional water and energy sector.

There was more to the apparent grandeur and political optimism in Mozambique and Rhodesia. Major international capital lending institutions were apparently eager to invest in water storage and hydropower.[759] In fact, there were more funds available for development in 1960s Africa than there would be by the early 2000s.[760] The hydroelectric ambitions of Mozambique and Southern Rhodesia clearly tended to ignore potential economic risks, political instability and what would later, from an environmental perspective, be described as negative social ecological development.[761]

756. Olivier (1975:110).

757. Reeve (1960:140–146).

758. Isaacman and Sneddon (2000:597–632).

759. Olivier (1976:22–24).

760. Moore (2001:909).

761. Balon (1978:20–48).

In years to come there was considerable cynicism towards contemporary science reportage on the impact of the Kariba scheme, to the effect that great care was taken to relocate tens of thousands of people in anticipation of large hydro-construction projects.[762] Investment in water infrastructure sent out superlative signals of confidence in the future of white political governance on the subcontinent. In the case of South Africa, the government's objective of projecting itself positively to the outside world created an opportunity to promote a sense of Afrikaner nationalist pride, based primarily on the accomplishments of a white-ruled South Africa.

A pro-West stand

While the newly independent African states either opted for non-alignment or closer collaboration with the Union of Soviet Socialist Republics, South Africa remained a firm supporter of free market economics and the West. This despite the fact that Britain maintained distinct (although sometimes blurred) reservations in its dealings with apartheid South Africa. At the time, the US became an attractive role model for the South African government and the local water sector. There were long-standing commonalities between the US and South Africa. Among South Africa's benchmarks were:

- the development of the arid American western frontier since the 19th century
- the phenomenon of a poor class of people of European descent that needed to be lifted out of poverty in both countries
- the world economic depression (1930–1933)
- the development of major water-related development schemes (the Hoover Dam and the Tennessee Development Authority)
- dealing with rapid post-1945 water infrastructure demands.

Senior South African water governance officials, such as A.D. Lewis (1921–1941)[763] and J.M. Jordaan (1960–1968), were well informed on developments in the US at critical periods when local water infrastructure developments reached new heights. Jordaan visited the US shortly after the Second World War, where he held extensive talks with officials in the US Bureau of Reclamation, the US Army Corps of Engineers and the New York Water Control Authority. He spent some time visiting several projects in the federal states in the west and south-east of the country and New York.[764] Upon his return to South Africa, Jordaan published a comprehensive report on water governance in the United States.[765] In the 1960s it made political

762. Tobias (1958:148:150).

763. Lewis (1915).

764. SAWHAR DH8/J003 (1996:25).

765. SAWHAR DH8/J0043 Jordaan Collection (1950).

sense to take note of one of the foremost states of the world taking the lead in the Cold War against communist expansion, on behalf of the capitalist Western countries.

Window of opportunity for international exposure

Although the South African government would not admit it openly, there was a keen desire for international recognition and for developing partnerships in the water sector. Any international institutional ties were desirable. One ‘small’ opportunity, destined to be of significant benefit for the country’s water sector, was membership of an exclusive international community of expertise in dam technology. Plans had already been set in motion in 1960 for South Africa to become a member of the ICOLD. This organisation, with its headquarters in Paris, originated in 1928 as an offshoot of the World Energy Conference (WEC) – a London-based organisation focusing on energy.

Since its formation, ICOLD’s objectives had been to promote progress in design, construction, operation and maintenance of large dams internationally, by collecting data and promoting research and investigating relevant issues in the field. An important task it set itself was to promote greater safety in dam construction and development.[766] In September 1965, South Africa was admitted as a member of ICOLD at the executive management meeting of the organisation, held in Lausanne, Switzerland, as a direct result of the initiatives taken by the well-known Cape Town-based engineer, Ninham Shand.[767]

Membership of ICOLD was of great importance because of the significant increase in South African dam construction at the time. The local water sector embraced the opportunity of becoming part of ICOLD. On the side of the state, the Department of Water Affairs secured international collaboration. Professional institutions supporting collaboration included SAICE and the South African Association of Consulting Engineers.

On the research front, international collaboration was embraced by the CSIR as well as all the universities with engineering faculties. With the establishment of the South African Commission on Large Dams (SANCOLD), the country was fully integrated with ICOLD. The activities of SANCOLD, in which the Department of Water Affairs played a prominent management role,[768] were integrated with ICOLD at the level of standing committees, and the relevant fields of investigation came under scrutiny by the organisation’s specialist members in all parts of the world.[769] Soon South African engineers

766. The International Commission on Large Dams (n.d.).

767. SAWHAR ITC/articles(a), (1985:501).

768. SAWHAR DH11/D394 J.G. du Plessis Collection (n.d.:297).

769. Van Robbroeck (1990:200).

featured prominently, as senior management members, in the organisational structures of ICOLD. Collaboration tended to be professional and internationally respectful of existing political conventions. There was an awareness of the complexity of apartheid in the international political environment, but professional engagements between experts in the field of large dams and their management were prioritised in organisational deliberations.

There was also a reward for South Africa's loyalty to ICOLD over the years. In 1978, South Africa hosted a meeting of ICOLD's executive committee. ICOLD's management decided on South Africa, instead of Egypt, after the government of Mexico refused the secretary of water affairs, Dr J.P. Kriel, a member of the ICOLD executive, permission to attend an ICOLD meeting in that country. ICOLD's view was that in matters of international science there was no place for petty politics.[770] In 1994 and 2016, once South Africa had made the successful transition to a non-racial democracy, the country hosted the triennial congress of ICOLD.[771] The organisation proved to be of substantive value to South African engineers and the Department of Water Affairs. It was one of the best international gateways for access to information on the latest technologies on large dams and their construction, at a time when the country's dam construction development was rampant.

New golden era of dam construction and innovation

Key to understanding South Africa's robust shift towards the construction of large dam projects in the 1960s are the developmental demands of the day. The Vaal River began to play a prime role in terms of planning for industrial and urban development in the interior of the country.[772] Despite the relatively insignificant 8% of the total water run-off in the country,[773] this river catchment region had been a major role player in South Africa's economic, financial and mining development since the 1930s.[774]

It was on the Witwatersrand that trendsetting urbanisation processes gained momentum and set the tone for the rest of the country. The country's leading minds in development studies and regional planning were instrumental in promoting the demand for sufficient water supplies to feed

770. SA Water Bulletin (1976:1).

771. Geringer (1995:24–27).

772. Braune and Rogers (1987).

773. Braune and Rogers (1987:1).

774. Cole (1957:250–252).

what was rapidly becoming southern Africa's largest conurbation. Since the 1950s the engineer, D.F. Roberts, who had made a thorough study of South Africa's water resources, advocated a strategy for the Upper Vaal River's water to be reserved for industrial development, mining expansion and urban use. No other river catchment in the country, he argued, was as vital to the development of South Africa. He even recommended halting water supply for agriculture. In his opinion, all the Vaal's water had to be earmarked and allocated for urban and industrial development purposes.[775] In 1961, another influential engineer, Des Midgley, referred to 'island' centres of urban development of the Witwatersrand complex and the banks of the Vaal River. Similar centres had been identified in many places on the African continent by development planners.[776] Midgley used their example and pointed out:

> These centres are the major social and economic growing points of the continent and it is upon them that advancement of the underdeveloped areas is heavily dependent. [*Experts*] clearly emphasize the importance and tremendous capacity for growth of these island centres, of which the Witwatersrand is by far the most powerful.[777]

As astonishing as it may seem, at the time, 30% of South Africa's white population and 10% of the white population of southern Africa south of the Congo–Zambezi divide resided on the Witwatersrand, in an area of about 12 950 km^2. Moreover, at least 25% of the country's population was resident in the Pretoria–Witwatersrand–Vereeniging region.[778] In Midgley's view, the best way to manage the country's water was to ensure 'maximum utilisation efficiency, and at all costs avoid a situation that would prescribe the loss of nearly one third of the usable water resources'.[779] For South Africa, investment in water infrastructure was representative of a fluid confidence, shaped by many political uncertainties. As was the case in other southern African areas with white minorities in control, there was a keen awareness of the need for economic development. At the same time, it was an open secret that there could be messy problems in future.

The key to success was to forge ahead and continue with plans for development. Water infrastructure development was all about the ability of government to embark on a creative industrial–energy hydraulic mission to boost social and economic growth.[780] There was clearly a subcontinental need

775. Roberts (1954:119–124).

776. Fair and Mallows (1959:125–138).

777. Midgley (*c*. 1962:125).

778. Fair and Mallows (1959:125–138).

779. Midgley (1962:127).

780. Banister (2014:205–208); Ovendale (1995:168–181); Obertreis et al. (2016:168–181).

for water and electricity. Of vital importance for the economic development of South Africa was the inflow of foreign capital in the form of long-term loans for the construction of the ORDP.[781]

Orange River Development Project

In 1962, when the South African government announced the ORDP, it was billed as a comprehensive project, aimed at creating development opportunities in parts of the country notable for low population density and underdevelopment. The identified areas to benefit from the project included the OFS, parts of the Northern Cape, the Karoo, the north-western Cape, as well as the Eastern Cape. These areas did not have substantial readily accessible water supplies. The new project had the potential for irrigation farming and, above all, to meet the demand for electricity. Until the early 1960s, the largest power consumers were in the highly urbanised areas of the Pretoria–Witwatersrand–Vereeniging (PWV) conurbation; the Cape Peninsula and its immediate hinterland; the southern Cape's Mossel Bay, George and Knysna region; as well as isolated urban areas in the interior, such as Upington and Kimberley. The Eastern Cape's port cities of Port Elizabeth, East London, and inland Grahamstown, as well as Natal's Durban–Pinetown–Pietermaritzburg urban region required secure electricity supply services if they were to be drawn into a new network of development.

South African urban areas were notable for selective access, specifically for whites, to some of the best municipal electricity, water and sanitation infrastructure services in Africa. Modernisation in the 1960s was all about urban areas with industrial activity and essential services. The Witwatersrand, with sound infrastructure services, such as water supply, sanitation and electricity, was a good example for promoting development and modernisation in other urban centres.[782] Urban communities of colour were secondary beneficiaries. In the background there was a looming demographic problem. Between 1951 and 1960 the number of Africans in South Africa's urban areas increased by almost 50%, to 3.4 million. By the end of the 1960s, people of colour already outnumbered whites in all the major cities of the country. They comprised 64% of the population of Johannesburg, 62% of Cape Town's population, and 71% of the population of Durban.[783]

As Johnstone suggests, the apartheid system seemed to have a cunning, inbuilt mechanism for accommodating the necessary African labour it required in the urban industrial areas. There was always the threat that

781. Department of Water Affairs and Forestry (1986b:Section 9.5).

782. Leslie (1951:17, 18).

783. Johnstone (1970:125).

'surplus' urban people could become subject to removals to the rural areas. Even in cases where rural communities were obstructing rural development, people were summarily relocated to the so-called 'homelands' where they had to find employment in the border industries – white-owned industries on the South African side of the 'homeland' border. In the case of removals, the relocated communities often had no access to basic services such as water and sanitation. Circumstances of this kind generated considerable international criticism of the government's policies.[784] Government continued to support rural development, indirectly trying to boost the economy of regions beyond the existing industrial urban centres. Opening up the arid parts of the country by supplying water, the Orange River Project was originally intended to benefit the coloured people of the country.

The ORDP, the largest regional water project in the history of South Africa at the time, was a textbook example; it slotted neatly into the development pattern that 21st century water theorists defined as the security element of the WEF nexus. Energy was vital. Government and the private sector collaborated closely in matters of water supply and energy, and forged significant international partnerships. The British and European construction industry also invested in the ORDP. Even in the non-hydro-related energy sector there was international support. To the disdain of anti-apartheid activists, threats of oil sanctions against South Africa resulted in the French-based Compagnie Française des Petroles, along with British Petroleum and the Dutch-owned Shell company, participating in support of South Africa's state-owned refineries.[785]

Because of the threat of oil sanctions, South Africa embarked on a search for oil deposits. In 1965 the government formed the Southern Oil Exploration Corporation to coordinate the search for oil and award concessions. Before the end of the decade it had spent more than US$26m. Increasingly, the focus was on offshore oil supplies, because the mainland did not produce positive results. South African scientists became well acquainted with oil exploration and worked in close collaboration with American companies.[786] For its part the Department of Water Affairs was willing to collaborate with the private sector, consulting firms and contractors, for example, as well as designers and planners, to participate in projects on water resources and hydroelectrical power. In the process, new skills and expertise were transferred to the local water sector. This trend was influenced by principles of international best practice,[787] especially in countries of the West. New economic and social development

784. Johnstone (1970:127).

785. First, Steele and Gurney (1972:39–40).

786. Blyden (1970:17–18).

787. SAWHAR WLC PAM5548 (1968b:210–212).

projects instilled optimism and promoted the growth of a South African cultural capital of modernisation.

Between 1959 and 1965, various parts of the country were unable to adapt comfortably to lapses in the regular water supply. The unexpected intensification of drought conditions posed a threat to the country's development. Modernist development and determinist planning under conditions of drought provided an ideal opportunity for government to invest heavily in planning the country's water sector.

A racial political agenda was part of the social contract on the country's water resources. In defiance of its opponents both inside and outside South Africa, the government was determined to make its apartheid policies take effect, with the creation of the first independent homelands in its so-called Bantustan system. Critics of the government were ever-watchful and reported on matters of inequity that impacted negatively on South Africans of colour. For example, the academic, Gwendolyn Carter, was quick to point out the plight of people living in townships and the way apartheid authorities manipulated them unfairly. Because South Africa's African people were resident in townships outside the urban areas there was a form of 'coercive control' over them in terms of infrastructure. According to Carter, it was only in 1960 when the local authorities cut-off the water supply to the Cape Town township of Langa, that the local protest against the Sharpeville uprising came to an end.[788] Comments of this nature ensured that the government remained aware that its draconian actions were subject to external scrutiny and criticism. The water sector also had to take note of this.

The ORDP epitomised mid-20th century modernist hydraulic engineering and water management. Little wonder then that terms such as the 'taming',[789] 'mastering', or even 'dominating' of water were associated with reporting on projects at the time. By the 1970s, it was said, in ideological terms, to have been part of an Afrikaner nationalist mindset in which the leaders used 'social engineering' for drumming up enthusiasm and working with systematic thoroughness, in what was thought to mark a new era in the history of South Africa.[790] Despite the negative connotations of such statements, there were a number of positive elements. Viewed from a 21st century perspective, the ORDP was a good example of addressing security issues related to the WEF nexus. Unlike the Vaal River system, which only engaged partially with the nexus, the security issues related to water, energy and food formed an intrinsic component of the Orange River scheme. The food component of the nexus

788. Carter (1963:151).

789. Midgley (1959); Department of Information (1971).

790. World Commission on Dams (2000:4).

was later questioned by engineering experts, but over the long-term the project remained compliant with the WEF nexus.[791]

Ever since the plan was first mooted, the ORDP was subject to criticism. However, seen from a social hydrological perspective, it made good sense; and politically its development was of vital importance. When the NP came to power in 1948, government compromised its traditional support base in the irrigation farming sector and did a political somersault by siding with the mining sector, allocating a significant portion of the water resources of the Upper Vaal River system to the burgeoning mining sector and urban growth on the Witwatersrand and the OFS's goldfields. The ORDP was an opportunity to make amends for what some white rural farming voters saw as an 'unseemly' decision. The corrective measure once again secured the support of the conservative Afrikaner farming constituency that urgently required water supplies and infrastructure at a time of persistent drought.

The marketing strategy of the ORDP reminded the public that European colonists had had a romantic fascination with the river as the northern frontier of the then Cape Colony since the 18th century. The idea of 'the river' as a boundary line became entrenched after its naming in 1779, in honour of the royal House of Orange in the Netherlands, by Robert Jacob Gordon (1743–1795), a Dutch Cape colonial official of Scottish descent.[792] By the 20th century the sentimental history of the apparent cultural appropriation of the river further entrenched white confidence in taking charge of South Africa's largest water catchment to place the country on a firm development path.

Departmental views on the future ORDP

For officials of the Department of Water Affairs there was a sense of pride in the early accomplishments of the department. Recollections of A.D. Lewis's 1913 reconnaissance of the Lower Orange River still formed part of the institutional memory.[793] Lewis's progressive thinking and planning remained very much alive. He was remembered for his far-sighted vision in the late 1920s to recommend using the Orange River to address issues of water security risk in the Eastern Cape.[794] In fact, the shelved plan was revived during the Second World War when, in 1944, the Department of Irrigation started surveying the area, culminating in a preliminary report in 1948. Borehole drilling explorations followed in 1953, to determine empirically the geological nature of the areas

791. World Commission on Dams (2000:47).

792. Barnard (1950:351–360).

793. Lewis (1915:); Cornell (1921:241–252).

794. Conradie, Messerschmidt and Morgan (2000:150).

the proposed water supply route would pass through.[795] At the time there were several survey reports on the potential of the Orange River, and investigations into the viability of constructing a storage dam close to the settlement of Bethulie in the OFS.[796] A great deal of careful planning was invested in the ORDP, spanning several decades of work by engineers and experts in the field.

Political leaders' buy-in to the ORDP

Political role players were, however, slow to buy into the project. Only in 1957 did the cabinet discuss a confidential report on the matter.[797] At the same time, government garnered the views of various experts. Most reports were favourable, with intense debates on alternative strategies and locations for development. Once the decision was made to go ahead with the programme, the project became part of an elaborate political exercise. The essential message was that, at a time of substantive political uncertainty, South Africa's government was determined to persist with infrastructure development.

In the face of rapid continental decolonisation, government was determined to drive development, in the hope of boosting confidence in the country. Securing comprehensive water supplies in a water-stressed region of the subcontinent was part of a long-term commitment to development as a means of attracting foreign investment in the country's economy. Government was intent on addressing the problem of a deep geographic disconnect between available water resources and favourable locations of potential economic development.[798]

The water sector had to meet the challenge and make a contribution towards addressing the conundrum. On 23 March 1962 the Minister of Water Affairs, P.K. le Roux, announced the Orange River Project in parliament. He compared the scheme with the Tennessee Valley Project of the 1930s in the United States of America, and explained:

> In the history of all newly civilised countries a stage is reached when large imaginative water development projects must be launched in order to encourage the growth of the developed area, to promote the establishment of industries and the generation of electricity and to create a refuge for the future population increase and thus to maintain the rate of progress in the country as a whole.[799]

The project was a morale booster for white South Africans. In an era of rapid political change in an unfriendly, decolonising Africa, the Orange River Project

795. SAWHAR WAC2/2/2/6 Scientific Aspects (1965:4).

796. Moolman (1946:674).

797. SAWHAR WAC7/1/1–14 ORP and OFT: White papers and regional planning 1924–1971 (1962:1–9).

798. Turton, Patrick and Rascher (2008:323–324).

799. SAWHAR WAC7/1/1-14 ORP and OFT: White papers and regional planning 1924–1971 (1962:2).

was government's resilient contribution to positive development. There were many reasons for promoting the project. Government was eager 'to cover the [sparsely populated] bare midriff of the country with industry, mining and agriculture'.[800] It was one way to store up a significant portion of South Africa's water supply that would otherwise pass through the Orange River before flowing 'unused', into the Atlantic Ocean.[801]

The project was about taking charge of managing water supply, and stabilising irrigation activities along the Orange River and the Fish River in the Eastern Cape. Technological interventions made anthropogenic water transfer systems seem natural. The project, quite rightly, was even flagged as an effort to prevent natural floods from causing great damage to human structures in river catchments. Strategically, there was a need for water supply and additional electricity infrastructure in the form of a hydropower back-up for local urban settlements in the region where the project would be situated. An agricultural expert, I.P.J. du Plessis, told delegates at the Diamond Jubilee Congress of the South African Association for the Advancement of Science in July 1962, that from a demographic perspective, the project was necessary because it would divert 'the growing population of the eastern high rainfall and coalfields area, into the wide open plains of the healthy central arid western regions' of the country.[802]

From an infrastructure perspective, a major factor in developing the project was the growing need for energy generation and the potential value of hydropower development schemes.[803] The project had to be executed as soon as possible. Originally, the plan was for the Orange River Project to play itself out over a period of 30 years. But because of financial constraints and changing priorities there were adjustments made to construction plans – reducing the project's time-span to less than two decades.

Critical public participation and consultation

Even in the early days the ORDP was not above criticism. In fact, in July 1963 the South African Association of Science held a conference in Bloemfontein to deliberate on the scheme.[804] The event, attended by 180 delegates, was typical of what would pass nowadays for public participation. It was valuable in that many of the country's leading scientists, engineers and planners made a point

800. Supplement to Financial Mail (1969a:11).

801. Olivier (1975:109–110).

802. Du Plessis (1963:50).

803. SAWHAR WLC W89 (1975:7).

804. Van Vuuren (2012:196).

of participating in the discussion on the eve of this significant step forward.[805] The project was criticised from an economic perspective for its strong deterministic intent. It should perhaps have been planned in phases, so that planners could formulate the blueprint in the light of events, when there were distinct demands for greater agricultural output and more electrical power.[806] Even a civil servant, Dr C.J. Jooste, warned against giving specific attention to larger urban areas. Small towns seldom shared in the benefits of economic growth. He castigated the complacency of allowing more electricity to flow merely to large urban areas. It had to reach the small consumers.[807]

In total, 12 sets of recommendations emanated from the conference. For example, it was pointed out that there was a need for the use of systems analysis for optimising the national value of the Orange River Project and that computer technology would enable a re-examination of certain aspects.[808] The economic implications of the scheme had to be explored in terms of the relative value of water for utilisation in a variety of purposes, such as agricultural, pastoral, hydroelectrical, industrial, and regional development processes. It was also argued that state expenditure of such massive proportions should be used to regulate and benefit the economic life of the country as a whole. In terms of labour resources, precautionary measures were necessary to prevent the scarcity of human resources in other fields, which implied that there had to be proper recruitment of labour.[809]

Public participation and discussion clearly had a beneficial effect. In good time the ORDP transcended the partisanship of parliamentary politics. A standing cabinet committee, consisting of all the ministerial portfolios with an interest in the construction of the ORDP was supported by an Orange River Development Project Advisory Council of 18 members, representatives of Escom, the IDC and several other fields of professional expertise.[810] The membership of the council suggested that political affiliations did not play a role. Yet no people of colour served on the council. What was unique was that for the first time government made use of international contractors for the design and construction of major units in the scheme. These included the Verwoerd (later Gariep) Dam, and the Orange–Fish tunnel.[811]

805. Biesheuvel (1963a:446–447).

806. Van Waasdijk (1963:472).

807. Jooste (1963:473–479).

808. Biesheuvel (1963b:307).

809. Biesheuvel (1963b:307).

810. Supplement to Financial Mail (1969c:19, 21).

811. Hobbs and Phélines (1987:45).

Water for central South Africa

The ORDP was a preliminary phase in the development of water supply in central South Africa. In the 1950s planners had in mind the Oxbow scheme (later also known as the Lesotho Highlands Water Scheme) but the approaching independence of the states of sub-Saharan Africa, as well as the independence in southern Africa of the British protectorates of Bechuanaland (Botswana), Basutoland (Lesotho) and Swaziland were imminent.[812] The time was hardly ripe for transboundary river catchment collaboration with a representative cultural framework.[813]

For the future Namibia, the use of the Orange River was not a vital concern. The territory still functioned as a protectorate under South African supervision, and in terms of water governance, the Department of Water Affairs and the sister department in Windhoek collaborated closely. Bechuanaland did not appear to have a direct interest. There was some cultivation of lucerne at Vioolsdrift, but the northern bank of the Orange River was not considered conducive to irrigation.[814] In the bigger planning framework there was consensus that the Vaal River's water was over-allocated. Therefore, the Orange River had to be developed to secure water and to provide hydroelectricity in regions where there was no electricity grid.[815] In the spirit of planning priorities, attention had to be given to multi-purpose schemes. This was also evident in the water plans for the Eastern Cape. Apart from water storage and support for irrigation, 20 hydroelectric power stations would dot the course of the Fish River and downstream on the Orange River, to generate as much as 177 MW of power. This idea attracted considerable international interest.[816]

Early projections for the ORDP were over-optimistic, but in principle the plans were sound and worth the R300m the South African government intended to invest in the scheme.[817] The government envisaged that the project would create 9000 new farms with 197 000 ha for white farmers and 3427 ha for African farmers. By accommodating these farmers in the plans for the Lower Orange River, observers saw the government's plans for creating a homeland-styled region for South Africa.[818] Many residents of the arid interior were descendants of precolonial Khoi and San, as well colonial

812. White (1965:261–270).

813. Lepawsky (1963:548).

814. Hanssen (1966:36).

815. Stallebras (1963:448–454).

816. Young (1964:18).

817. WP X62 (1962:16–17).

818. Fair and Manfred Shaffer (1964:272).

'coloured' people. Government was well disposed to plans for ultimately also delineating 'homelands' for so-called coloureds.

The country's agricultural sector was set for growth. In terms of 1969 estimates, the expectation was that the completed Orange River scheme would contribute as much as R114m p/a in farming production to the economy.[819] In addition the scheme boosted the South African diamond industry, which had lagged significantly after the Second World War. The 1960s revival saw the sector reopen old mines in response to an increased demand for industrial diamonds.[820] The mouth of the Orange River, on the border of South Africa and South West Africa (Namibia) boosted new offshore diamond mining opportunities, so the development of the Orange River Project was an exciting prospect. Diamond mining was not the only beneficiary. In the interior of the Northern Cape, by 1973, a 130 km pipeline connected the O'Kiep copper mining operations to the Orange River, providing them with reliable supplies of water for the first time in more than a century of copper mining in Namaqualand.[821]

Safety and security issues were important. Midgley described a prime element of the project as the need to transform the intermittent water supply of the Orange River. The river fluctuated between a trickle and comprehensive floods, to a more evenly functioning river with a perennial distribution system that could supply water deep into the Karoo and the Kalahari and even the Cape Midlands.[822] When work started on the scheme in the 1960s only 15% of the water potential of the river was used – primarily at the Buchuberg Dam.[823] The promise of more consistent supplies boosted development. By 1965 to 1966, new urban settlements started in the proximity of the construction of the H.F. Verwoerd dam, and the Vanderkloof Dam, as well as the tunnel sites of the Fish River and the Bloemfontein pipeline.[824] Nearby existing towns became hubs of commercial activity for consumers working on construction.

Since the passing of the *Water Act* of 1956, government was in a position to subsidise urban development and modernisation. It meant that urban areas situated in the proximity of the ORDP would become beneficiaries of additional services. Municipal wastewater and water purification treatment works could be subsidised. The project had the potential to provide water supply and sanitation as well as electricity infrastructure; it would provide more than

819. Supplement to Financial Mail (1969b:13, 15).

820. Whittington (1963:194–196).

821. Jolly (1973:760).

822. Midgley (1963:461).

823. SAWHAR WAC8/4/2 ORP Brochures (*c*. 1968:9).

824. RP34/1967 (1967:5).

450 ML of water to the urban centres of De Aar, Bloemfontein, Kimberley and environs, towns along the Fish River and the Upper Sundays River, as well as to Port Elizabeth.[825]

Additionally, ‘instant towns’ emerged when construction teams moved in for long-term projects and this boosted urban settlements such as Oranje Krag, 8 km from Norvalspont; Oviston near Venterstad; Mishaft and Teebus, along the route of the Orange–Fish Tunnel; Vanderkloof, at the site of the new dam; Orania, the urban hub that served the Vanderkloof canals; Welbedacht, close to the site of a new dam scheduled to provide water to Bloemfontein; and Uitkeer, between the towns of Cookhouse and Somerset East in the Eastern Cape.[826]

The farming sector stood to benefit the most from the ORDP. Realistically, the water supply from the scheme was far more than could be used merely in the catchment of the Orange River. Sites totalling a surface area of 211 604 ha in the catchment had been identified as prospective beneficiary areas. This included land in the proximity of Vanderkloof, Riet River, the confluence at Prieska, the Beervlei–Brak River, irrigable land at Luckhoff, the Sak River and Witsand, the existing and new irrigation developments between Buchuberg and the Augrabies Falls, as well as an identified area along the Orange River between the Augrabies Falls and Alexander Bay. Outside the Orange River watershed, the areas to benefit from the scheme were the Great Fish River, the Lower Sundays River, a new development area along the Great Fish River, as well as scheduled land in the Upper Sundays River Valley – in total more than 96 800 ha of land. The Orange River scheme was potentially capable of creating irrigation opportunities for more than 308 412 ha of farming land.[827]

The prime components of the original Orange River scheme were the Gariep (formerly H.F. Verwoerd) Dam; the Vanderkloof Dam; the Vanderkloof canal system; the Torquay Dam; and the Orange–Fish Tunnel, as well as the provision of hydroelectrical power, water for Bloemfontein, and ancillary works.

Gariep Dam (formerly H.F. Verwoerd)

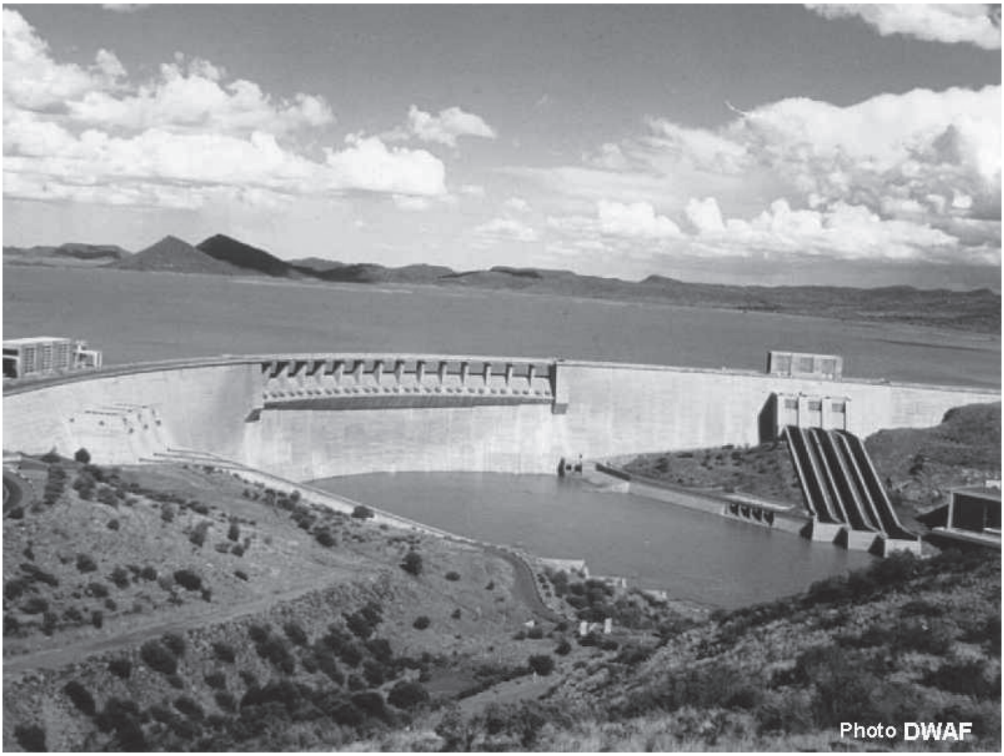
The Gariep Dam (Figure 5.1) was the main storage facility of the Orange River scheme. It was built in a gorge, upstream of Norvalspont. The crest of the dam extended over a distance of 905 m and reached a height of 88 m (90.5 m above the foundation at the highest point).[828] At the time of its completion the dam’s storage capacity was 5500 MCM. The Gariep was the first construction

825. WP X62 (1962:7).

826. Department of Information (1972:52).

827. WP X62 (1962:6).

828. SAWHAR WAC8/4/2 ORP Brochures (*c*. 1968:16); Department of Water and Sanitation (n.d.b).



Source: Department of Water and Sanitation (n.d.d).
FIGURE 5.1: The Gariep Dam.

project of its kind to be put out to tender by the department. Previously, all construction work had been done by the department. This was a significant change from a dispensation where departmental officials had been responsible for the planning, design and construction of all major water projects in the country.

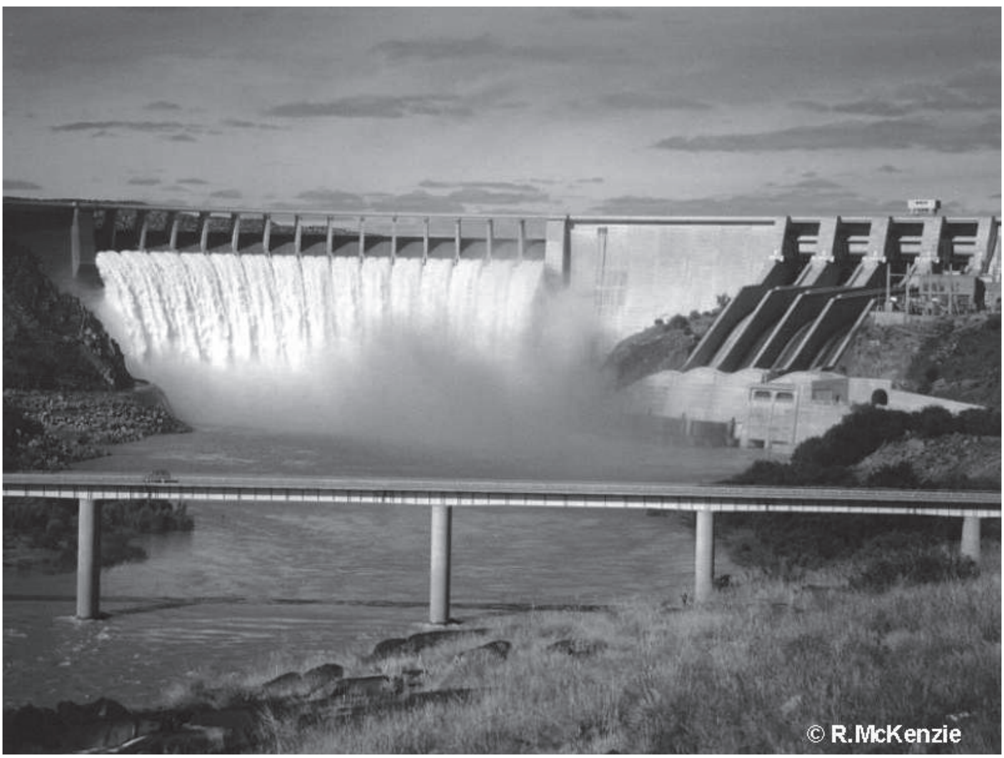
The project was notable for the multinational collaboration in its making. The construction was awarded to Union Corporation/Dumez Borie Dams on 21 April 1966. The construction of the gates of the dam was the responsibility of Société BVS.[829] The construction project was officially opened on behalf of the government on 18 November 1966, by the newly appointed prime minister, B.J. Vorster. He succeeded H.F. Verwoerd, who had been assassinated by Dimitri Tsafendas at parliament in Cape Town earlier that year. The official event to mark the beginning of the construction project was attended by 250 invited guests and 1500 members of the public. Five years later, on 03 July

829. Hobbs and Phélines (1987:45).

1971, four days prior to the stipulated date, the dam started filling with water. The official opening of the Gariep took place on 04 March 1972. The dam project received the award for the most outstanding civil engineering project of the year 1972 from SAICE.[830]

Vanderkloof Dam (formerly P.K. le Roux)

The Vanderkloof Dam (Figure 5.2), 130 km downstream of the Gariep, was built about 16 km upstream from the Havenga Bridge across the Orange River, between the towns of Luckhoff and Petrusville. The dam is smaller than the Gariep, but with a 108 m high crested concrete arch. At the time of its construction the dam was the highest in South Africa. The crest extended over a distance of 756 m and the reservoir had a full capacity of 3160 MCM. The dam's catchment was 88 500 km^2 of which 70 390 km^2 was situated in the catchment of the Gariep Dam.[831]



Source: Department of Water and Sanitaiton (n.d.e).
FIGURE 5.2: The Vanderkloof Dam.

830. SAWHAR WAC8/1/2 Department of Water Affairs (1966); Hobbs and Phélines (1987:45).

831. SAWHAR WLC W522 (1977:22).

As a result of the financial crisis that arose in 1967, with substantial inflation pushing prices up, the government was forced to shelve the Vanderkloof Dam project temporarily. The problem was that the private sector had made significant financial investments in advance to boost the dam's multiple benefits. Because of this, the project remained in a caretaker phase until 1969, when – under severe criticism – the government gave the green light for the construction work to resume.[832] Originally the objective was to put the project out to tender. However, a cabinet decision transferred the responsibility for the project to the Department of Water Affairs. International participation in the project was confined to a consortium of overseas consultants responsible for the planning and design of the project.[833]

The Vanderkloof Dam originally had two sets of outlets (four gates) capable of discharging up to 8500 m^3/s. One was intended for irrigation and the other for generating electricity. The water was mainly intended for the arid parts of the Northern Cape. At the time of construction work, the proposed irrigation canal was the longest irrigation system in South Africa, extending over a distance of about 80 km. The hydropower canal section of the project extended over a distance of about 35 km. This canal was designed to release water into the Riet River Valley and a further 80 km downstream to the town of Koffiefontein, from where it provided water for the Riet River irrigation area.[834]

Originally the right canal was intended to provide water supplies to the Brak River Valley in the Prieska–Britstown area as well as the Carnarvon–Leegte, the Beervlei area, the Sak River valley and the Koa River valley. As a result of economic constraints, the plans were altered and the canal extended only to a point near Hopetown. Little came of the plans to extend the canal from Hopetown for irrigation along the left bank of the Orange River. This extension was shelved because extensive investigations suggested that the development would be uneconomical. The cost was deemed too high.[835] Consequently, all irrigation along the left bank between Vanderkloof Dam and Hopetown was supplied directly from the river, using pumps.[836]

The hydropower capacity of the Vanderkloof Dam consisted of two 120 MW generators capable of generating up to 240 MW of electricity at a flow rate of 400 m^3/s. The underground machine hall of almost 50 m in height was situated downstream of the dam's foundations to avoid the weakening of the

832. Anonymous (1969d:21, 23); WP N71 (1971–1972:3).

833. Department of Water and Sanitation (n.d.e).

834. SAWHAR WAC8/4/2 ORP Brochures (*c.* 1968:18, 21).

835. WP H84 (1984–1985:3, 14).

836. WP N71 (1971–1972:5, 10).

dam structure. Exhaustive tests were conducted before construction work began. Some 150 boreholes were drilled in the general vicinity of the power generating site to a depth of between 30 m and 60 m, followed by a further 97 boreholes over a length of 4000 m, and a trench of 1500 m to ensure that the safety of the dam structure would not be compromised in the process of generating power.[837] The completion of this project in 1977 marked the end of the first phase of the ORDP.[838]

The Torquay Dam

The Torquay Dam was supposed to be the third component of the dams in the Orange River scheme; it was set for construction about 40 km upstream of the Orange–Vaal confluence, north-west of Hopetown, with a storage capacity of about 3922 m^3.[839] It was to have formed part of the left bank canal of the Vanderkloof Dam. Plans for the Torquay project had been in circulation since the early 1950s and created great expectations in the farming sector. It raised the hopes of those trying to make headway in an arid land, where conditions were harsh. Their discontent when the project was shelved was destined to become part of the local historical discourse of the region well into the 21st century.[840]

The reasons for shelving the project were many. It was a time when a number of talented engineers left the department to take up positions with international engineering consultancies. The Torquay project also coincided with a reduction in the size of the construction division of the Department of Water Affairs – a division that at one time employed as many as 33 000 people. The Torquay canal that was never completed was intended to stabilise the high flow of canal water for irrigation purposes. Ultimately, the high cost of the project was decisive in shelving its construction. Furthermore, engineers realised there were better alternative dam sites downstream.[841]

The Orange–Fish Tunnel

As early as 1928, A.D. Lewis pointed out that an 80 km canal from a point on the Orange River between Norvalspont and Bethulie could transfer water to the Brak River – a branch of the Fish River. From there the Sundays River could

837. SAWHAR WLC W444 (1976b:17–18).

838. Department of Water Affairs (1987:31).

839. SAWHAR WAC8/4/2 ORP Brochures (*c*. 1968:21).

840. Van Jaarsveld (1982:206–208).

841. Thompson pers. comm., 13 October 2016.

be reached too.[842] At the time the project was considered too costly, and like all projects of this nature, it had to remain dormant until the demand for water increased. In the case of the Eastern Cape, the irrigation lands had steadily increased since the 1860s to the extent that before the end of the Second World War in 1945, the department once again prioritised the potential of an inter-basin transfer scheme. In 1948 a feasibility report to parliament followed and, in 1953, investigations were conducted on the rock formations by means of drilling experiments.[843]

Key to the start of the tunnel system was the construction of the H.F. Verwoerd/Gariep Dam wall at Norvalspont, which would ultimately determine the level at which the draw-off to the Eastern Cape would be scheduled.[844] The tunnel inlet was near Venterstad and then ran on to Teebus some 80 km southward. The project survey required a series of boreholes to be drilled in various locations at even points (1219.2 m apart) over the distance of the proposed tunnel. Government approved the project in 1962, and a consortium of consultants worked on the construction from 1963 to 1967. In January 1968, the department signed a contract for the construction of the tunnel inlet to the value of R18.7m. The contract was awarded to the consortium Batignolles-Cogefar-African Batignolles.[845] The Orange–Fish Tunnel extends over a distance of 82.8 km and has a diameter of 5.35 m. At the time of its completion in 1975, the tunnel was the world's longest continuous water tunnel.[846]

When the ORDP began in the 1960s, modern local tunnelling technology was still in its infancy. In the case of the Orange–Fish Tunnel the Anglo-American Company's subsidiary, Shaft Sinkers – because of its mining experience and familiarity with local conditions – collaborated with British, French and German partners in the project.[847] Despite comprehensive experience and skills, the tunnelling posed numerous problems. There was no known method for using a single strategy. There always seemed to be problems that caused delays and setbacks.[848]

At one stage Shaft Sinkers reported they were experiencing problems they had not foreseen – most of which were outside their field of expertise. Then a local construction company of high repute, LTA, ran late on calculating the

842. UG9/1930 (1930:27–28); SAWHAR WAC2/2/2/6 Scientific Aspects (1965:1); Conley and Van Niekerk (2000:136).

843. SAWHAR WLC W89 (1975:6).

844. SAWHAR WLC PAM5364/72 (1972:3).

845. RP49/1969 (1969:8).

846. Conley and Van Niekerk (2000:136).

847. Olivier (1975:111).

848. SAWHAR WLC PAM5364/72 (1972:4).

escalation of costs. When the project reached the halfway stage and it became evident that costs would escalate, LTA threatened to pull out. Things went from bad to worse. Both the upstream French-led consortium and the downstream Italian-led consortium realised that they were bound to incur severe losses. The South African economy was in recession and by the second half of the 1960s was in dire straits. Government resorted to putting on hold a number of costly state-funded projects. The Orange–Fish Tunnel project was one of the first to be affected. In an effort to save the operation, Henry Olivier began talks with senior people in the Department of Water Affairs and also the ministry. LTA's situation was precarious. If the project collapsed they were bound to remain in South Africa and bear the burden of a bad reputation. The foreign companies knew they could withdraw, but it was also evident that they were bound to lose a great deal. After significant deliberations between all stakeholders there were renewed estimates. The project cost rose by more than twice the original budgeted amount.[849]

The first estimate for the construction of the tunnel was R55m. Then the diameter of the tunnel, as a result of engineering recommendations, was increased by about 30 cm, which was estimated to incur an increase of about R1.1m on the price.[850] In its second supplementary report to the legislative assembly in 1968, the Department of Water Affairs informed the government about the significant increase in the cost of the tunnelling project and explained why some of the alterations had been made to the design. It assured the government that the project would go ahead because the contracts had been awarded after a comprehensive, competitive process.[851]

Originally the plan was for all the phases of the ORDP to run simultaneously. As a result of the financial constraints, the Vanderkloof scheme was delayed, but the tunnelling project could go ahead.[852] Government was more than aware of the importance of the project and stood firm in its support even when the costs, as a result of the immense problems experienced, increased to R385m by 1971 to 1972. The project was completed in 1975.

Bloemfontein's water: The Caledon–Modder transfer scheme

One of the prime urban beneficiaries of the ORDP was the city of Bloemfontein. It formed part of a concerted drive by government and the Department of Water Affairs to maintain its firm commitment to the development of the

849. SAWHAR WLC W178 (1976a:41, 43).

850. Anonymous, (1969d:21, 23).

851. WP L68 (1968:11–12).

852. World Commission on Dams (2000:82).

country's urban areas. The city, the sixth largest in South Africa up to the 1960s, was in a phase of critical water stress as a result of rapid development. Strategically, the project was sound. US intelligence researchers reported that it meant considerable industrial growth for Bloemfontein. The prospect of reliable water supplies boosted business confidence and the city's location, effectively in the centre of South Africa, positioned it well as a communications hub for the country's rail, air and road transport network.[853]

From the outset, the ORDP made special provision for securing a good and reliable water supply for Bloemfontein.[854] The sources were to be either the rivers of the Caledon or the Orange.[855] Originally the plan was to transfer water by canal from the Vanderkloof Dam. But the plan was then shelved. Instead, a smaller scheme was envisaged on the Caledon River, one that could be completed before the Vanderkloof project. The plan included the construction of the Welbedacht Dam on the Caledon River. Then followed the Caledon–Modder transfer scheme, with the purpose of providing water to Bloemfontein by means of a 115 km water pipeline. The transfer would take place after the water had been purified at a treatment plant situated below the Welbedacht Dam. The pipeline investigation began in February 1964, followed by the identification of a final pipeline route and reservoir sites.[856] To ensure the quality of the pipeline, the project team decided on using prestressed concrete instead of a steel pipeline.[857] The project was completed in 1973.

This project also had its fair share of problems. Because of siltation, the capacity of the Welbedacht Dam declined from 115MCM to 16MCM within the space of two decades. Then the Knellpoort Dam was added to the system in 1988. To prevent the silting, the new storage dam was an off-channel system situated in a small catchment area. Water was then pumped from the Caledon to the Knellpoort Dam from the Tienfontein pumping station via a 2 km channel with a silt trap, to prevent the Knellpoort from silting up.[858]

Hydroelectricity

An important component of the ORDP was the plan to generate hydroelectricity. Its significance lay in the fact that in a country with abundant coal supplies, generating hydroelectrity was similar to smuggling sand in the Sahara.

853. Kaplan et al. (1971:55).

854. WP X62 (1962:32).

855. SAWHAR WAC8/4/2 ORP Brochures (*c*. 1968:49).

856. RP18/1965 (1965:36).

857. RP30/1966 (1966:41).

858. Department of Water and Sanitation (n.d.b); Van Vuuren (2012:231).

However, government planners were keen on experimenting with new trends in hydroelectricity in Africa. As early as 1961, Escom showed interest when the Department of Water Affairs made the recommendation that a hydroelectrical facility was to become part of the ORDP.[859] In time to come, key role players on hydroelectricity and the Orange River scheme were Henry Olivier, Des Midgley and Hendrik van Eck. They were visionaries. Only after the completion in 1960 of the Kariba Dam, with its impressive hydroelectrical capacity, did the potential significance of electricity generation sink into public consciousness. Olivier subsequently became more involved in the planning of the Orange River scheme and made recommendations, in collaboration with Escom, to secure buy-in from the electricity utility.[860]

Importantly, the region served by the ORDP scheme had no integrated power grid. Local thermal power station operations were costly. Coal had to be transported over long distances to serve local urban areas. Experts made the government aware of the potential for electricity consumption with, for example, the South African Railways being in a position to electrify its railway line between Klerksdorp and Beaufort West, via Kimberley, Bloemfontein, Port Elizabeth and East London.[861] In the rural parts of South Africa village community settlements with populations of about 1500 residents, of whom about half were white, tended to offer substantial capacity for electrical services. In 1966, Richfield suggested that in terms of municipal government, the Cape Province's small urban settlements were in a good position to afford electricity supplies. The province's local and provincial government authorities had a longer history than those in any of the other provinces in the country.[862] Expert assessments of this nature gave the planners of Escom and the Department of Water Affairs more confidence in hydroelectricity. It was feasible to do business with well-established local and regional government authorities.

The Orange River Project became South Africa's first major hydropower initiative.[863] In 1964, less than two years before construction work began on the Gariep Dam, Water Affairs Secretary, J.M. Jordaan, recommended to government that adjustments be made in the planning for the Gariep and Vanderkloof dams. Escom wanted to extend power supply to the north-western and other areas of the Cape Province. The department's planners were confident it was feasible for both dams' hydropower plans to be upgraded. It was more profitable and would meet the country's growing need

859. SAWHAR WLC PAM3091/72(b) (*c.* 1972:18).

860. Conradie, Messerschmidt and Morgan (2000:152).

861. Stallebras (1963:452).

862. Richfield (1966:356–360).

863. Department of Water Affairs (1987:29).

for electricity. Whereas the original plan made provision for 171 MW, the recommended upgrade of the scheme had the capacity to generate as much as 300 MW.

Moreover, Escom, who in the original plan would merely have been a beneficiary, now offered to come in as a project partner. The utility could make a substantial contribution to the construction of increased hydroelectricity capacity.[864] There was one problem. The raising of the Gariep Dam wall meant that part of the road and railroad, as well as the existing railway bridge at Bethulie, would be inundated. Needless to say, government came in for heavy criticism. The railway bridge, completed in 1959 at a cost of R7m, had to be replaced within the space of a decade. Experts were critical of the financial implications.[865] But the plan forged ahead regardless. Over the long-term this proved to be the right decision. The Gariep power station facility was situated 300 m downstream of the dam wall. After considerable deliberation, a Francis-type vertical shaft system capable of consuming as much as 2000 m^3/s, was used for generating power.[866] An important feature of the turbines was that they were capable of providing stable operating conditions for a high-voltage transmission system.

The views of the cosmopolitan engineer Henry Olivier, with global insights on dam schemes in many parts of the world, played a significant role in creating awareness of the value of hydroelectricity and comprehensive thinking on the Orange River Project. In a report for the commission of inquiry into Water Matters (1966–1969) Olivier pointed out that between 1955 and 1966 a total of 34.75 billion kWh had been generated in the country. Within the space of one decade South Africa's electricity consumption had more than doubled. Estimates suggested that consumption was set to grow annually by between 6% and 8% as shown in Table 5.1.[867]

Hydropower clearly had a contribution to make – even if it meant, symbolically, that small town power consumers no longer had to turn off a stove every time they boiled a kettle to make a cup of tea.

Another influential supporter of hydropower was Des Midgley, whose state-of-the-art modelling on the future river run-off of the Orange for the next 40 years, suggested that the scheme was a sensible move.[868] His argument was based on a comparison of alternative sources of energy which, apart from coal, also considered oil and nuclear options. Midgley argued in favour of

864. WP AA64 (1964:1–11).

865. Supplement to Financial Mail (1969d:21,23).

866. SAWHAR WLC PAM3091/72(b) (1972:20).

867. SAWHAR WLC PAM5547 (1968a:11).

868. Midgley (1963:461–467).

TABLE 5.1: Olivier's 1968 analysis of South Africa's capacity for electricity growth.

Year	Generation of Electric Energy in the Republic of South Africa, 1930–1966	
	Units Generated (Mill. of kWh)	**Growth Rate (percent p/a)**
1930	2454	-
1935	3773	9.0
1940	7168	14.0
1945	8329	3.1
1950	11187	6.2
1955	17172	9.0
1960	22561	5.6
1965	32772	8.0
1966	34758	6.0

Source: SAWHAR WLC PAM5548 (1968b:116).

hydropower even if it were only for use in peak times. There would certainly come a time, he argued, when water power would be of considerable value.[869]

Conradie, Messerschmidt and Morgan shed significant light on the mindsets of the leading proponents of the project. For example, Olivier did not care too much for irrigation on the Orange River. He argued that there were other fertile and less arid regions in South Africa that could be put to better use for irrigation farming operations. Hendrik van Eck, a pioneer of planning industrial development in South Africa since the 1940s, was a native of the Orange River region. He was apparently eager to unlock the inherent potential of what seemed to be an arid, inhospitable region.[870] Midgley, an academic engineer, who had cut his youthful engineering teeth in the Department of Irrigation, was one of the top academic minds in the country's water sector. He certainly had good insight on departmental thinking and how the country's private sector would regard development opportunities.

The major points of criticism of the scheme was that most of the water to be impounded and stored for users had a bearing on the farming sector.[871] This was despite the fact that at the time only 30% of the country's economically active population was employed in that sector.[872] The addition of a greater hydroelectricity capacity in the mix of the ORDP silenced many critics.

Hydropower represented visionary thinking about the future. Olivier's hydropower arguments were most convincing. He explained that in 1966, generating 99.9% of electricity by thermal power stations meant burning 189.7 million tonnes of coal. At the time 19 820 ML of water annually flowed

869. SAWHAR WLC PAM1889 (*c.* 1965:20–40).

870. Conradie, Messerschmidt, and Morgan (2000:152–153); SAWHAR WLC PAM5547 (1968a:7–11).

871. Supplement to Financial Mail (1969a:11).

872. SAWHAR WLC PAM5547 (1968a:5).

into the sea without being used.[873] The potential value of hydropower was immense. When the system started operations in 1971, the four generators at the Gariep Dam were each capable of generating 90 MW (360 MW in total) with a flow rate of 200 m^3/s.[874] In today's terms, it sounds like a drop in the ocean. However, it was one small step that would inspire future planning for renewable energy in the years to come. The 1960s initiatives to introduce a hydropower component in a state water project made an important symbolic statement on an early phase in the maturation of the Department of Water Affairs' energy–industrial hydraulic mission. It endured for the next three decades.

Inter-basin water transfer systems development

In the second half of the 20th century South Africa's water sector enjoyed international recognition for its ground-breaking work in the field of water transfer systems. Although the natural aridity of the country's interior was a major driver of innovation and adventurous engineering, much of the credit has to be given to the negotiation skills of engineers in convincing government to support inter-basin transfer infrastructure development. The almost deterministic spirit of idealism that had been rampant in governance quarters since the early 1960s, and the success of these projects, boosted confidence to take transfer systems to the next level. Although they have low ratings in environmental terms, and a reputation for requiring substantial energy resources, some of the inter-basin transfer projects in South Africa have earned international recognition well into the 21st century.[875]

Cape Town was one of the first areas in South Africa to make use of water transfer systems to provide for the growing needs of the population of the Peninsula, but it was only in the 1950s, as a result of the demand for electricity and water resources, that the Department of Water Affairs started working on water transfer systems. In fact, the *Water Act* of 1956 specifically made provision for the development of transfer systems.[876] The first modern 1950s project undertaken was in the grasslands of the Inkomati catchment, in today's Mpumalanga. However, the country's water engineers gained the most valuable experience of the complex nature of transfer systems with the construction of the Orange–Fish Tunnel, completed in 1975. By the end of the 1960s, in view of the anticipated shortfall of water supplies in the next decade, and better

873. SAWHAR WLC PAM5548 (1968b:116).

874. Department of Water and Sanitation (n.d.c).

875. Muller (2016:251–278).

876. World Commission on Dams (2000:104).

engineering knowledge on transfer systems and their construction, water planners argued in favour of innovative inter-basin systems rather than conventional dam storage facilities, to provide the anticipated increased demand for water supplies.[877]

Eastern Transvaal

In the eastern Transvaal (now Mpumalanga) water was needed for Escom's power stations. By the 1950s the demand grew for more electricity in a connected grid system that had been started by Escom to link up power supply between the eastern Transvaal, the Witwatersrand and parts of the OFS.[878] There was also a call for the water of the Olifants River to be supplemented, because the irrigation water use at the Loskop Dam had taken the largest share of the available water supply by the 1950s. In 1956 to 1957 the Department of Water Affairs began with plans for a dam on the Komati River, with a portion of the water intended for downstream users.[879]

The project for the construction of the Nooitgedacht Dam (1957–1962) began in the Komati River, near Carolina. The dam was responsible for containing the water of the Komati River for use by the Komati power station, located south of Middelburg. The water had to be pumped over a distance of 250 m from the dam to the Olifants River catchment.[880] Shortly afterwards, construction work started on the construction of the Vygeboom Dam, downstream in the Komati River, to provide the water needs of the power stations of Hendrina and Arnot. The water was pumped from the Vygeboom to the Nooitgedacht Dam over a distance of 469 m. The system was capable of providing the water needs of three power stations as well as those of a number of smaller consumers. Soon it was providing up to 86% of the water required for the Duvha power station. By 1986 the transfer system transferred 131MCM/a to the Olifants River catchment area (please see Figure 5.3).

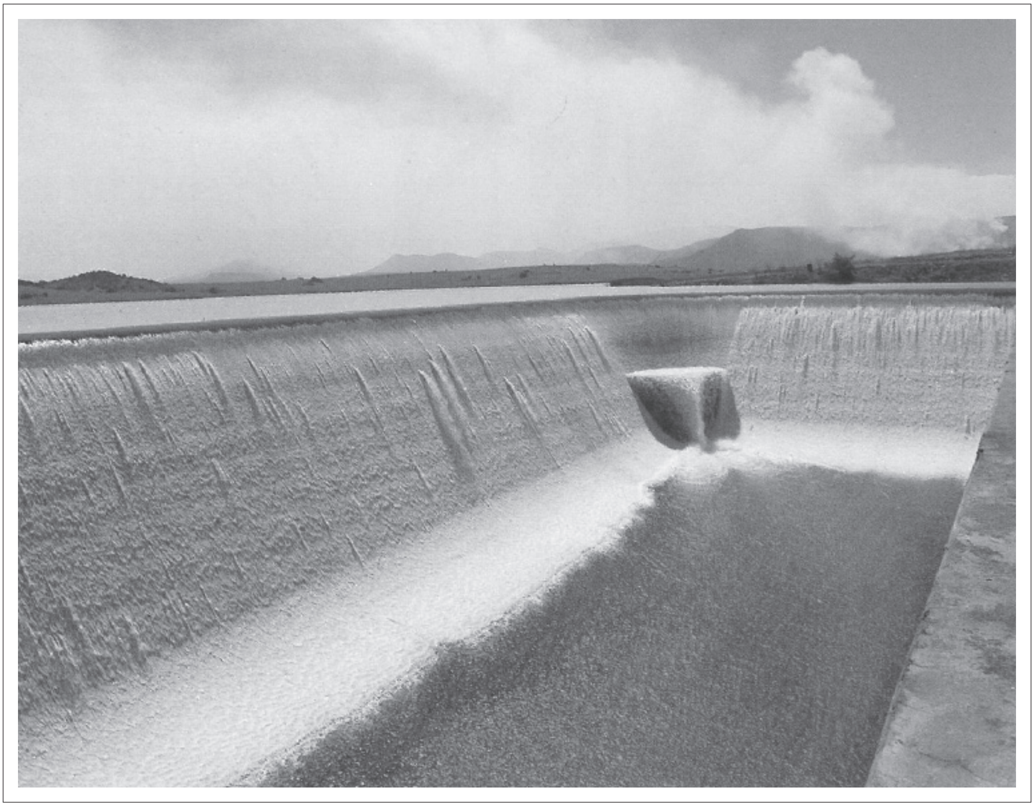
The next scheme began with the objective of securing water for the Camden power station near Ermelo, which was expanded into a more comprehensive facility. For the purposes of this project it was necessary to secure water from the Usutu River. The first phase of the project was the construction of the Jericho Dam and the Jericho–Camden pipeline, with the objective of providing Escom with about 45 ML/d of water to generate 1600 MW of electricity. The second phase involved raising the crest of the Jericho Dam by 4 m, and the construction of the initial phase of the Westoe Dam on the Usutu River, with

877. Van Robbroeck (1979:31, 34).

878. WP D57 (1957/1958:2).

879. UG74/1960 (1960:3).

880. Department of Water Affairs and Forestry (1986b:8).



Source: Department of Water Affairs (1986:9).
FIGURE 5.3: Spillway section of the Vygeboom Dam in 1986.

the aim of ultimately contributing 136 ML/d. The final phase required the raising of the dam wall of the Westoe Dam; the construction of additional balancing reservoirs on the divide at the crest of the watershed; the upgrading of the pump house at the Jericho Dam; erecting administrative buildings at the Jericho Dam; and the duplication of the pumps and the pipelines.[881]

Construction work began in 1962 on the Jericho Dam in the Mpama Spruit, a tributary of the Usutu River near the town of Amsterdam. Here the goal was to supply about 45 ML/d to the Camden power station. Prime motivations for the step were that Escom in future required 136 ML/d that the Komati system on its own was unable to supply, and the favourable high elevation of the Usutu.[882] Then followed the Westoe diversion weir, as well as the Morgenstond

881. WP G68 (1968:2).

882. WP G63 (1963:3–4).

Dam in the Usutu River, which flowed under gravity to the Jericho Dam.[883] From there the water supplies were pumped to the Onverwacht reservoirs on the watershed between the Usutu River and the Vaal River.

Soon the storage facilities of the Jericho and the Westoe dams across the watershed, as well as the transfer capabilities of the Westoe tunnel pipeline, had to be increased to provide the greater demand for water by Escom.[884] From the local reservoirs, the water flowed under gravity in pipelines down to the power stations of Camden, Kriel and Matla. The construction costs of the larger scheme rose considerably from the initial R5.3m to R7.4m by 1966. More and deeper blasting was necessary for the transfer pipelines and to provide for duplicate pipelines that would connect the water supply with more power stations and water resources.[885] There were further cost increases and minor works in the second phase of the project.[886]

The final phase of the government's Usutu water scheme included:

- raising the Westoe Dam by 5 m with the installation of crest gates
- the construction of two balancing reservoirs on the divide at the crest of the watershed
- permanent offices at the Jericho Dam
- duplication of pumps in the Jericho pump station as well as the duplication of the Jericho–Camden pipeline.[887]

Then followed the construction of the Morgenstond Dam in the Ngwempisi River, another tributary of the Usutu River. There was also a pumping station at the Morgenstond to transfer water to the Jericho Dam, from where water was distributed to several power stations. By the mid-1980s the Usutu scheme was capable of transferring 103 MCM.[888]

Research in the 1960s

In the 1960s, the Department of Water Affairs maintained a high rate of research-oriented work output. This was in line with general trends in scientific research in a number of fields in South Africa. Despite its political isolation, South Africa made substantial progress in several critical areas.[889] Hydrology, generally outlined at the time as the 'processes governing the

883. WP J64 (1964:3–4).

884. WP I65 (1965:3–5).

885. WP V66 (1966:2–4).

886. WP R67 (1967:3–4).

887. WP G68 (1968:2).

888. Department of Water Affairs and Forestry (1986b:9).

889. Greenberg (1970:157–163).

depletion and replenishment of the water resources of the earth' and water in 'all its occurrences in nature – the atmosphere, in the lakes and river beneath the earth's surface', captured the imagination of researchers.[890] The pioneering work by Midgley on the surface waters of South Africa was representative of a new and innovative form of hydrology. In 1955 he was appointed professor at the University of the Witwatersrand, where he rapidly rose to prominence, working in the highly respected hydrological research unit he had set up.[891]

Midgley's views informed much of the research in the Department of Water Affairs.[892] There was a growing interest in hydrological research, and the principal hydrologist of the department, J.F. Enslin, reported in 1959 on the selection of suitable catchments for hydrological research.[893] The 1960s saw officials of the department, at the Roodeplaat Dam near Pretoria as well as in the department's various specialised laboratories, working on issues relative to drought, greater monitoring efficiency and computerisation in many fields. J.S. Whitmore explored the field of agrohydrology, subtly pointing to its relevance in a country where drought conditions and floods had a negative effect on farming. It was important to be aware of the hydrological cycle and gain insight into how the limited water resources of South Africa could be used to maximum effect.[894]

Officials focused increasingly on more specialised areas of knowledge. Dedicated teams worked on dam site foundations. Materials enjoyed attention too, with an emphasis on borrow pits, soil investigations for construction projects; silt analysis, and tests on concrete cubes for prospective construction in departmental projects.[895] By 1965, the department had launched various investigations based on empirical studies of relevance to the day-to-day management of the country's water resources. There was an ongoing investigation into the dolomitic areas of the West Rand. It was evident that the subsidence in the area was a consequence of pumping water from the operational gold mines, which had an effect on the water streamflow. The department's researchers were aware that many years of research lay ahead in dealing with what would almost certainly become a major problem.[896]

890. Midgley (1970:380).

891. Bozzoli (1997:111–112).

892. Midgley (1952).

893. Department of Water Affairs (1959).

894. Department of Water Affairs and Forestry (1961).

895. RP18/1965 (1965:304).

896. RP30/1966 (1966:11).

Of prime importance was the establishment of a division of hydraulic engineering by SAICE, on 23 March 1965. The keynote speaker at the event, held at Kelvin House in Johannesburg, was the internationally renowned engineer, Henry Olivier. His cosmopolitan approach and ability to define the intrinsic value of water in the era of the Green Revolution, was captivating. He spoke of the growing worldwide demand for food supplies as a result of rapid population growth, and how this was exerting pressure on water resources in developing countries.

Olivier was familiar with South Africa's water. He knew about the government's need for engineering expertise in the early planning phases of the Orange River Project. He spoke with an infectious optimism of the opportunities for engineers in an era of exponential rates of dam construction.[897] From a technical perspective, Olivier articulated two components of the WEF nexus, water and energy (electricity), in pointing out that:

> [*W*]hereas it may be possible to halt the population explosion or to alter the times when television programmes are switched off and tea kettles on, thereby easing the electricity load, it is not foreseeably easy to alter and predict, for instance, the incidence and rates of rainfall, rate and extent of scour and degradation of rivers or the rate of transpiration of plants.[898]

From the outset, SAICE's division of hydraulic engineering made a point of arranging events relevant to South African engineers, by bringing in experts from overseas to open debates on issues under investigation in South Africa. In 1966, the division presented a symposium on estimated evapotranspiration, with contributions from eight eminent United States experts.[899] SAICE's investment in the intellectual capital development of civil engineers in the water sector was conducive to promoting good research.

Innovation in dam construction: Double curvature concrete

In the 1960s, the Department of Water Affairs began the construction of a number of concrete double curvature arch dams, an innovation on the traditional arch-type dam dating back to Roman times. The first of these dams was built in the US at the beginning of the 20th century.[900] In South Africa, dams built using the same design include the Stompdrift Dam on the Olifants River in Oudtshoorn, the Wagensdrift Dam on the Bushman's River (at Estcourt), the Myamvubu River Dam; the Paul Sauer Dam; and the Gamtoos

897. Olivier (1965:203–212).

898. Olivier (1965:203).

899. Civil Engineering (1966:294).

900. Chanson and James (2001:39–51).

and Pongolapoort dams.[901] All these dams were essentially concrete shells, very thin in cross-section and notable for their sophisticated design. The new-style dam building was introduced mainly because of a larger allocation of design staff who were equipped to handle complex work and the analyses required for constructions of this nature.

The focus in the department was on research and the integration of design and planning. However, many of the prime sites for dam construction had already been identified and put to use, so the new dam designers and planners had to seek new sites in areas where the water supply was less than optimal. Fortuitously, technology had meanwhile made significant strides forward and the department's designers now had access to aerial photography, a stereo plotter that could draw contours from aerial photographs, a new computer facility, and a laboratory facility for concrete materials.

In 1963 to 1964 there were extensive aerial surveys of the future Gariep (Hendrik Verwoerd), Vanderkloof (P.K. le Roux) Dams, the Orange–Fish Tunnel, Sanddrift Kloof Government Water Scheme, Hex River Valley, the Hex–Breede River, and the Hendrik Verwoerd–Bloemfontein pipeline route.[902] In total, between 1964 and 1965, the department's researchers completed three technical reports on the value of pumping tests to determine groundwater supplies; the discharge coefficient for angle iron gauging weir tests; and groundwater prospecting methods used in South Africa. Technical notes issued by the department included, the effect of protective screens on Class A Symons Pans; Piché and Livingstone atmometers; the calculation of mean annual run-off from short-term records; the design of a substandard evaporimeter; and the drought conditions in 1964.[903]

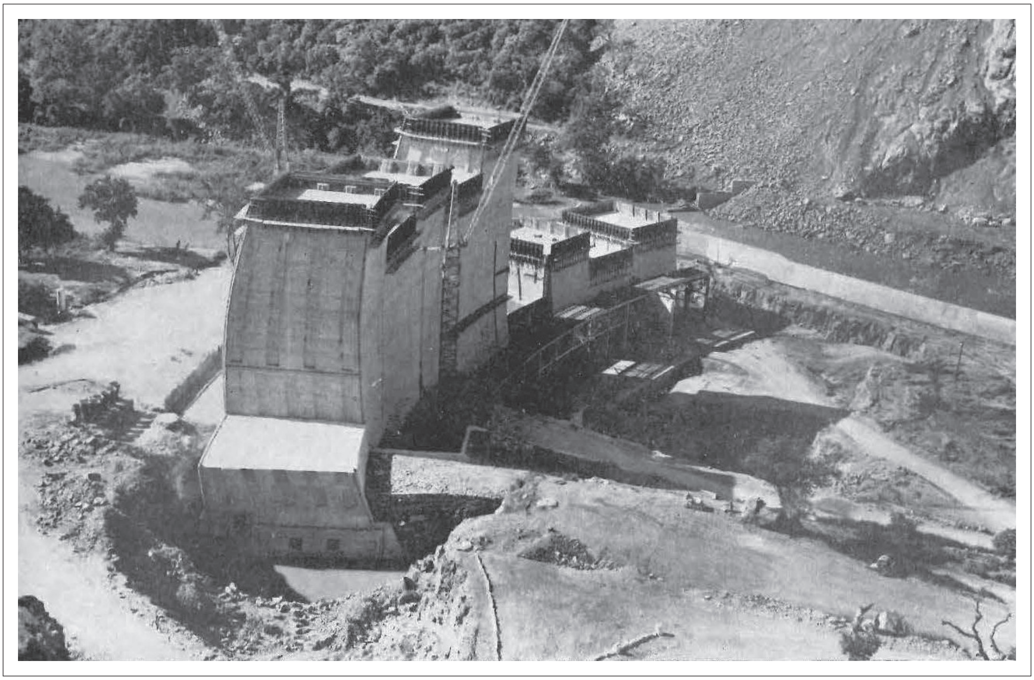
Furthermore, access to sophisticated computer technology boosted research in the field of dam construction, creating an enabling environment for more comprehensive pre-construction planning and modelling. But, as explained below, there remained a demand for yet greater and more specialised computing capabilities. Researchers spent time on radioisotopes for flow-gauging; they used cetyl and stearyl alcohol to inhibit evaporation from large dam surfaces;[904] conducted analyses of groundwater levels in boreholes; worked on the recovery of moisture from low clouds; and determined the correlation of stratification of water in dams with physical and chemical conditions. There were also examples of innovative *in situ* planning on dam construction sites. Reference has already been made to the large crushed rocks encased in

901. Hobbs and Phélines (1987:43).

902. RP18/1965 (1965:15–16).

903. RP30/1966 (1966:12).

904. Department of Water Affairs (1971).



Source: RP18/1965 (1965:37, 47).

FIGURE 5.4: The Pongolapoort Dam wall was the first to be built making use of ice cubes. The ice was used to prevent the concrete from setting too rapidly in the South African heat.

steel-framed boxes, that were used in the 1950s in the construction of the Erfenis Dam in the Free State.[905]

Another innovative strategy employed by engineers in 1963 to 1964 was in the construction of the Pongolapoort Dam, which entailed special preparation of the foundation of the dam, which was 21.3 m wide and 3.04 m deep in solid rock. The rock started at a depth of 3 m below the river bed. In the processes of laying the concrete, the construction team had to use a cooling plant to make it possible to lay 535 m^3 of cooled concrete per shift as can be seen in Figure 5.4. The concrete was transported from the mixer station to the dam wall by means of trucks that carried a 3.05 m^3 concrete mixer. The innovation received a most positive mention in the annual report to parliament of Water Affairs Secretary, J.M. Jordaan.

There were a number of other problems experienced in the construction phase of the project. The rock in which the foundation had to be laid was extremely brittle. Special measures were therefore taken to prevent the disturbance of the surrounding rock in the process of cutting the way for the foundation. Secondly, on 05 July 1963, the worst floods in half a century

905. SAWHAR ITC/articles (2013:1–10); Alexander (2014:22–23).

came down the Pongola River. The coffer dam, which had previously withstood flooding, was totally submerged in 5.8 m of water. After the floods the coffer dam was filled with silt, sand and debris. It required a re-excavation of the site. Once all the necessary clearing-up work had been done, the construction team resumed laying the foundation, and by the end of 1963 a total 33 163 m^3 of concrete had been laid.

Although by the 1960s South Africa had built up a highly respectable status in the field of dam construction, there was still room for improvement. Having numerous international experts and leading engineering companies involved with the Orange River Project made it possible to transfer new skills to the South African component of the technical water sector.[906] For example, international experts in the later 1960s were of the opinion that dam planning, design and construction had to focus more on multi-purpose schemes with a view to optimising the national benefit. There were recommendations that more basic data be collected in preliminary investigations of specific schemes. It was all about securing greater versatility and more diversified opportunities for the consumption of water resources. The planning of engineering construction projects now had to complement advanced economics and financial techniques of analysis.[907]

Advanced research: Materials laboratory

In the years 1965 to 1966, the department's materials laboratory was responsible for looking at foundations and borrow pits at the dam sites of Vaalkop, Magoebaskloof, Glen Connor, Westoe, Oppermansdrift and Klipvoor. They also conducted silt analyses on more than 2000 samples collected from rivers, including the Amatikulu, Breede, Hartz, Kaap, Little Fish, Klaassmits, Kornetspruit, Crocodile, Magalakwin, Nels, Nyalazi, Orange, Vaal, Vlekpoort and Umhlatuzi. In addition, there were ongoing tests on the cement and aggregate on 27 of the department's construction sites. Tests were conducted on concrete mixes at eight of the schemes. On behalf of the Geological Survey of South Africa, the department conducted tests of sand grading on 148 samples. Rock drilling tests for the elasticity of rock were done *in situ* at the Kat, Sanddrift and Pongolapoort Dam sites.[908]

Computer technology

The 1960s are memorable for the department's first foray into the field of working with the new technology of large computer systems. It began when

906. Supplement to Financial Mail (1969a:11).

907. SAWHAR WLC PAM5548 (1968b:174–176).

908. RP34/1967 (1967:3).

engineers in the design office started working on the potential use of computer technology in the department. Subsequently, computer technology featured prominently in the fields of design, financial systems, building up databases, a data network system and a future geographical information system.[909]

By 1964 the department's engineers were using new software programmes to measure discharge tables from multiple notch and flume type gauging stations. Tables were soon calculated with the support of the department's IBM computers.[910] The ORDP and communications with overseas engineers and scientists had a stimulating effect.

The department's management took note of the eagerness of its staff to use computer technology and responded by making substantial investments in the very latest advanced technology. In 1965, the department acquired two IBM card punching machines for the hydrological division to file streamflow data in the computing system. It also conducted a modelling investigation into what was said to be the silting up of Richards Bay.[911] At the same time the department began its own software programme library. Tenders were put out for a calculator, with numerous specifications and recommendations. It was anticipated that in due time the capacity of the machines would be put to full use. The department's annual report for 1966 includes information on how the existing computer and the department's programmes were improved.[912] Several hydrologists received special training on the use of computers. In addition, the liaison section maintained a punch-card cross-reference index to all literature on the hydrology of South Africa and related subjects. The list included indexes and abstracts of recent publications. In the 1960s, women played a key role with copying and turning analogue date into digital data. The 'women technical assistants' introduced by the department in 1965–1966, were responsible for typing in data on the punch-card system. Later they would be described as 'punch-card operators'.[913] At the time, the University of the Witwatersrand also assisted the Department of Water Affairs in the calculation of streamflow gauge discharge tables and the computation of streamflow data, with the support of data stored on the existing computer systems.[914]

909. SAWHAR DH11/D1654 (1987).

910. RP18/1965 (1965:12).

911. RP30/1966 (1966:12).

912. RP34/1967 (1967:4).

913. By the 1980s, as many – mostly female – librarians, had mastered various IT skills, the notable divide between male and female data operators became less pronounced. It needs to be noted that in the mid-1960s women played an important role in securing digital data in the department, mainly as a result of their typing skills.

914. RP34/1967 (1967:11).

In 1967, the department acquired a new computer and the efficiency of the work increased rapidly. Its operational use increased from 20% to 95% of the available time. The department's special library for software had meanwhile increased to 230 programmes in 1968, of which 30 had been written by programmers and 22 by other members of staff. In total 167 programmes were supported by IBM and 11 by various exogenous bodies.[915] The leaders in the field of computer-assisted research in engineering were at the University of the Witwatersrand, where Midgley gave invaluable guidance to several postgraduate students who were destined to play a significant role in the country's water sector in the future.

In 1968, Olivier emphasised what he considered to be a major problem in the water sector – that the rate of technological development was so rapid that there were universal concerns about existing approaches and procedures. He advised that care should be taken in more practical matters, such as water rights, and that these were frequently even more difficult to abrogate than those related to technology.[916] Olivier was probably unable to grasp the magnitude of computer-related technological developments that would ensue in the next three decades.[917]

The next year Midgley and W.V. Pitman completed their assessment of South Africa's water resources, on a mainframe computer – the first major assessment since Midgley's previous study in the 1950s, this time with computer support. The system made use of punch cards. In the study, they used the Department of Water Affairs' catchment division system of primary, secondary and tertiary subdivisions. They further subdivided the tertiary catchments into quaternary units. In addition, they also used a MAP of each catchment to overlay the grid of the whole country, making use of 138 flow records, although the amount of data used was less than that in Midgley's 1952 study. They recognised the need to take note of risk and worked on determining the relationship between reservoir storage and yield. Each record they had was scanned independently, so it was possible to develop independent data ranging from 1 to 96 months. By incorporating the data with the percentage of MAR it became possible to detect regional similarities and regional groupings for a set of average curves.

Midgley and Pitman were able to determine the relationship between MAR and MAP. They assessed each gauged catchment and the zones of similarities for each regional group. Later a simulation model was developed from rainfall data between 1920 and 1976. Rain gauges were considered to be sparse and consequently 1976 was the last year of a complete set of data. After 1981, the

915. RP49/1969 (1969:7).

916. SAWHAR WLC PAM5547 (1968a:1–2).

917. Kelly (2017:Chapter 1).

compilation of regional storage-draft-frequency curves was done in a similar way to the 1969 study.[918]

Mapping

In the mid-1960s, mapping underwent significant development. The department made extensive use of transparencies of the 1:250 000 map of South Africa to indicate the revised annual rainfall of the country. Parts of the same map were used to point to the rainfall at rain gauges in the catchment areas of all the main rivers where there were flow stations. They could identify the areas in the country where there were deficiencies in the available supply of rain gauges in catchments.[919]

By 1965 to 1966 the department's researchers had compiled an index to South African river names, based on the latest 1:250 000 topocadastral map series.[920] The research output was substantial. In 1965 there were 65 hydrological reports on water supply projects and other investigations.

Research on distribution of water supply

In the case of overseeing the water supplies of the Orange and Vaal River systems the department's officials did not need to supplement the supplies of the Lower Orange River circle with water from the Vaal Dam. At the same time, they monitored the water level of the Vaal Dam and the extraction rates of the Rand Water Board from the dam, and started managing the release of water from the dam to downstream users in a more controlled manner. Following complaints received, the department began to monitor the quality of water in the Lower Breede River in the Western Cape and commenced with similar testing activities in the Lower Orange River.[921] The department was in the process of collecting data systematically on water supply and usage by all the major consumers in South Africa.[922] There were ongoing investigations into the management and proclamation of subterranean water control areas. Furthermore, in this decade officials in the department started drawing up plans for issuing water permits to consumers.

918. Pitman (2011:659–660).

919. RP18/1965 (1965:12).

920. RP34/1967 (1967:10).

921. RP30/1966 (1966:12).

922. RP18/1965 (1965:12).

Research on rainfall, run-off and evaporation

The department's researchers focused primarily on rainfall, run-off, evaporation, groundwater, water use surveys, training, and liaison. Up to 1966 the country's drought conditions were uppermost in the minds of water sector workers. In terms of rainfall, officials began to use a new method of analysis. It was now possible to compare droughts of varying intensity and duration. Moreover, the data could be linked up to a computer system. The objective was to determine the periodic re-evaluation of severity of drought conditions. The results were used as a guide to determine how flood relief would be administered.[923] In considering run-off, staff in the research section relied on about 60 key prototype stations for intensive measurements. At these points, they investigated rainfall and the concomitant run-off and a number of hydro-meteorological and environmental factors. They looked at surface flow of water over various ranges and found that the diminishing volumes of many dams were not necessarily as a result of the drought conditions, but instead were caused by intensified land use developments in catchments of the country's summer rainfall area.[924] The researchers also came to the conclusion that:

> Clearly, values of mean annual run-off and assured yield, which are the main design criteria in the planning of storage, if determined from past records, will not represent conditions prevailing today, but progress is being made in developing statistical methods for reappraising the run-off records.[925]

They were thinking in terms of far more comprehensive data systems and potential modelling and began to use radioisotopes to determine the location and rate of movement in a density current when conducting experiments at the Nooitgedacht Dam site. At the Pienaars River Dam they measured the water temperature for more than a year and determined the existence of a pronounced thermocline in summer and a complete circulation in early winter. In respect of evaporation, field trials were conducted on reducing evaporation by using cetyl alcohol.

This system's advantage was its powerful spread of a film layer which tended to heal itself, if and when it was ruptured, and did not have any harmful effect on the water. Moreover, the application could be suspended at will when it was no longer needed. The major disadvantage of the system was the fragility of the film. It tended to drift with the wind and only lasted for a few days after application.[926] The first experiments, in the early 1960s, showed that in the case

923. RP34/1967 (1967:9–10).

924. RP34/1967 (1967:9–11).

925. RP34/1967 (1967:11).

926. SAWHAR ZKC (1986:Section 3.30).

of South Africa, alcohol-assisted evaporation control on large expanses of water did not work well.[927] Tests were conducted by researchers on standard evaporation pans. They found substances like cement and plastic beads to be about 50% efficient at reducing evaporation, but the material proved to be brittle and expensive and only suitable for small storage dams. Researchers then experimented with silicone fluid which reduced evaporation by as much as 80%, but after the first month of its application, the evaporation was once again limited to a negligible level. In some areas they used screens to protect the evaporation pans and applied standard wire mesh to the rims of the pans. These tests were conducted at the Pienaars River Dam.

Groundwater research

In terms of groundwater research, the department's officials broke new ground when they took groundwater samples in the Kalahari, concentrated it and dispatched it to Europe for Carbon 14 (C_{14}) dating and tritium analysis of the rainwater content. It was apparent that the Kalahari was a massive storage area of ancient fossil water. Their objective was to determine if the groundwater supplies being consumed formed part of the ongoing local recharge and if the supplies would replenish at all. At one stage the groundwater specialists worked in collaboration with the South African Weather Bureau to develop a systematic programme of analysis of the tritium content of rainwater. Researchers worked on strategies aimed at understanding whether the tritium content of the atmosphere in the southern hemisphere could be expected to rise as a result of the gradual drift of fall-out from the northern hemisphere. They were of the opinion that regular monitoring of rainwater could help determine the source and rate of groundwater recharge.[928]

Meanwhile, academic researchers like Midgley created awareness of the need for effective drought planning in the development of water resources. In many respects the drought, coming at the time when the Orange River scheme was under construction, provided researchers and planners with first-hand experience and an awareness of potential strategies for dealing with drought conditions.[929]

Surveying water use patterns

In surveying water use, the department's researchers worked from a network of river gauging stations that had registered data for many years.

927. Midgley (1962:125–126).

928. RP34/1967 (1967:10).

929. Midgley (1963:461–467).

However, there had been no systematic survey prior to 1960 when the first quinquennial questionnaire was sent to all major water users. By 1965 to 1966 researchers began working on the next questionnaire. They were interested in drawing comparisons between the mean annual run-off and the quantity of water used during any given year. The researchers were of the opinion that successive surveys would enable them to determine the rate at which water was consumed by different sectors of the economy. Research and liaison coincided with interactions between Water Affairs' officials and colleagues in other government departments. In particular, the Coordinating Committee for Hydrological Research had officials from as many as five departments collaborating on research. The committee also facilitated contact with research organisations overseas.

Research information was disseminated widely. By 1966, the public relations division of the department prepared and distributed a series of technical reports and notes on research results of work done by the department's hydrological division.[930]

Consultants and research for the department

Private sector involvement in South African water research has a long history, dating back to the 19th century. In the first half of the 20th century consulting engineers were responsible for important local research in the development of water purification, wastewater treatment works and related infrastructure. These consultants were inevitably involved in research both internationally and locally. Moreover, their empirical investigations often meant that they acquired an outstanding knowledge of local hydrological conditions – sometimes superior to that of the department's officials at the circle offices. Consulting engineers at the local level were frequently the pioneers and unsung heroes of local schemes that served rural communities at the peri-urban and urban level throughout the country. The development of the Orange River Project made South Africa's water sector managers aware of the value of outside experts on water matters in an era of rapid development. Indeed, outsiders were often in a good position to make independent assessments.

An interesting step taken by the Du Toit Commission, appointed by the government in 1966, was to call upon Henry Olivier in June 1967, to prepare a report on guidelines for the formulation of pricing structures, and the evaluation of economic benefits for ranking or comparison of multi-purpose water resources projects. In February 1968, Olivier was asked to broaden his focus and provide a general review of institutional, administrative and legislative arrangements associated with water resources development, and to make

930. RP34/1967 (1967:10).

recommendations for special consideration under present and foreseeable conditions in South Africa.[931]

Olivier consulted widely. He had communications with Dr P.S. Breytenbach and officials in the ministry of planning; Dr J.P. Kriel, the secretary for water affairs; Dr G.J. Stander and J.W. Funke of the CSIR; Messrs J.K. Siertsema and C. Nemetz, of the Economic Research Unit of the Department of Agricultural Economics and Marketing; and Prof. Des Midgley at the University of the Witwatersrand. Olivier's three assistants, E.P. Delaney, P.A.C. Hallier and Z. Kovácz were specialist engineers who collected data and helped him analyse pertinent datasets of South Africa to compare with similar trends and developments in the US, Australia, Pakistan, India and a number of other countries. In addition, they held interviews with officials in the Department of Water Affairs, the Department of Agricultural Economics and Marketing, the South African Weather Bureau, the CSIR, and the Department of Agricultural Credit and Land Tenure. Several key officials serving in the municipalities of Cape Town, Johannesburg, Port Elizabeth and Durban, and experts at the universities of the Witwatersrand and Potchefstroom, were also consulted in preparation of the report.

■ Conclusion

To all intents and purposes, water sector developments in South Africa in the 1960s resembled a panarchy cycle of social ecological resilience. The country was becoming increasingly isolated internationally. Despite limited access to the latest developments in the water sector elsewhere, the Department of Water Affairs had access to the skill sets of international engineering and construction companies. Officials had learnt a great deal from exposure to the ORDP, but they were able to make some creative contributions of their own to technologies such as tunnelling and groundwater technologies. In the field of dam construction there were even more indications of home-grown innovations. The construction of large dams and the development of advanced water transfer systems in the 1960s, paved the way for more new ideas. In the field of research, much of the work of the department, in collaboration with universities, the CSIR and consulting engineers, had a bearing on issues of drought and strategies for more effective water governance. Despite severe drought conditions and an exogenous environment that was not well disposed to the government of the day, there were numerous breakthroughs that enabled the department to pursue a hydraulic mission aimed at serving industry and energy.

931. SAWHAR WLC PAM5547 (1968a).

The energy–industrial hydraulic mission of the state in the 1960s, was gaining momentum that was increasingly representative of deterministic development. However, in the decades to come the system became more vulnerable and the state of collapse, registering in the social sphere (far away from the nucleus of development) posed a major challenge to the longevity of the existing state.

Chapter 6

Dealing with drought in the aftermath of the '1950s syndrome'

Introduction: The 1950s syndrome

In popular memory, the history of drought conditions in South Africa in the first half of the 1960s is often singled out as the best-remembered drought of the 20th century. There are several reasons for its prominence. The drought coincided with the commencement of work on the ORDP – the most comprehensive government investment in water resource infrastructure since Union in 1910. The drought in the 1960s was also responsible for government's appointment of one of the most important commissions of investigation into water matters in the 20th century. Throughout the decade of the 1960s there was a contagious public interest in the state's activities in developing the country's water resources and the comprehensive plans to deal with drought conditions. It was a mix of good and bad news. In some respects water issues diverted the attention of white South Africans from the worrisome news about the pace of Africa's decolonisation. As long as the state responded positively, there was hope for the future.

South African society in the 1960s was firmly wrapped up in what the Swiss environmental historian, Christian Pfister, has described as the

How to cite: Tempelhoff, J.W.N., 2018, 'Dealing with drought in the aftermath of the "1950s syndrome"', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 225–251, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.06

'1950s syndrome'.[932] The trend caught his attention when he became aware of environmental science reports on the rapid increase of atmospheric carbon and greenhouse gas emissions after the Second World War. Pfister argues that the accumulated air pollution – a leading cause of climate change – had its origins in 1950, when the global price of fossil fuel dropped. Working from statistical information on Western Europe he took note of the significant increase in fossil fuel energy consumption. The availability of cheap energy, he reasoned, had a marked effect on the production factors of labour and capital. The syndrome coincided with the growing and wasteful consumption of raw materials. Cheap energy had begun to replace human labour in many fields of human industry. To put it another way, mechanisation contributed to mass production. Energy was a key component of rapid progress.

For Pfister, the period was notable for unsustainable development. Natural resources were over-exploited. The phenomenon was epitomised in the agricultural sector. The Green Revolution was responsible for producing ever-larger supplies of food in many parts of the world; this was only one example of energy production that would have an inevitable effect on sustainable development. The production boom was the result of the mass production of synthetic fertilisers[933] and plant crops whose seeds had been genetically altered in research laboratories.[934] The syndrome of development in the 1950s opened a new phase of global development that saw the emergence of the modern consumer society. Only in 1973, according to Pfister, was there a momentary halt in the process – caused by the first global oil crisis.[935] There are similarities between Europe's 1950s syndrome and South Africa's development, as will become evident in the discussion to follow.

South Africa, as a result of international opposition, was becoming progressively more isolated. Nevertheless, it was able to maintain sufficient international social and economic ties to be part of the groundswell of latest trends, ranging from the hoola hoop to the contagious pop music of the Beatles, Rolling Stones and the Beach Boys. With the exception of television services – considered as 'undesirable' by an influential group in the NP government[936] – South African society was caught up in an upward-spiralling web of modernisation and consumer trends that emanated from Western Europe and the United States.[937] Although the marketing of goods and services in the country was fragmented, in many respects along ethnic lines, by the

932. Pfister (2010:90–118).

933. Smil (2004).

934. Evenson and Gollin (2003:758–762).

935. Pfister (2010:96).

936. Orlik (1970:245–258).

937. Milkman (1977–1978:68–78).

mid-1960s South Africa had a Gross National Product (GNP) of US$11.2 billion, making it the richest country on the continent. The population of roughly 16 million in 1960, was estimated to increase to 20 million by 1970. The standard of living of the country's white minority was said to be on par with most Western European countries, where a consumer-oriented free market system operated in a synchronised system of trade and commerce.[938] Although African opposition to the government was alive and well, and often most articulate beyond the confines of the country, it remained subdued.

The 1960s drought in the public realm

The 1960s drought was a much-publicised event, largely because of improved communications. Apart from the newspapers, radio transmissions also grew more sophisticated in the 1960s. New FM radio wavelengths started operating alongside noisy short- and medium-wave transmissions.[939] As transistors replaced valves in sound equipment, new, cheaper, lightweight, battery-powered portable radios were responsible for a communications revolution, similar to the proliferation of mobile phone technologies and the internet in the 1990s. These innovations were evidence that South Africa had become part of rapid modernisation that globally transcended national boundaries.

In the era of modernity and better communications, officials of the Department of Water Affairs became news celebrities. They communicated on water matters daily with the South African Press Association (Sapa), the editorial staff of several national newspapers as well as the SABC.[940] The heightened public awareness of water stimulated a sense of 'crisis', but it was a discourse that never amounted to predictions of imminent disaster. The drought made the public aware of resource scarcity, but it was a problem that the government was 'working on to resolve in the future'. Although domestic consumers in the larger urban areas were largely safeguarded from the effects of severe drought conditions, there was an acute awareness of its impact on the farming sector – the country's prime source of food supply. Industry and energy determined the new hydraulic mission of the country's water sector, but the disposition of the food-producing farming sector remained prominent, largely as a result of the sector's role as employer and contributor to the local economy in the country's rural areas. Water, energy and food were firmly embedded in a spontaneous WEF nexus consciousness. It made South Africans more than aware of the significance of drought conditions.

938. Thorelli (1968:40–48).

939. Prinsloo (1987:51–52).

940. RP34/1967 (1967:11).

The ORDP remained a hive of activity in the country's water sector, with various phases of the project reaching fruition before the end of the 1960s. South Africans were absorbed with a beguiling fascination for the country's economic growth and development. It was the responsibility of the water governance sector, in terms of the evolving energy–industrial hydraulic mission, to secure sufficient water resources in various parts of the country. It had to cope with circumstances of rapid development that was pushing up the water demand, and the ongoing drought.

South Africa's migration trends and the increasing urbanisation of its rural population remained a prominent feature of the country's demographic profile. Most new city dwellers were Africans, but like all first-generation urbanites their reference framework included recollections of life in drought-stricken farming communities in the country's rural areas. The popular 1960s understanding of drought was outlined by scientists and members serving on commissions of enquiry into drought conditions since the 1920s.[941] Reenen van Reenen, in one of his final popular literary works, published in the 1930s, described drought in the language of the lay person. Drought still resonated as the effect of water shortages – on the stock, and on the farmer – and an absence of moisture for plants in the fields and in the orchards. In addition, the effect registered in 'ever-widening circles to persons with interests [...] distant from agriculture, who at first may be thought to lie beyond its influence'.[942] By 1965, the drought situation was classified by climatologists as a typical 'agricultural drought'. It hit farmers just when large-scale agricultural production started taking off in southern Africa.[943]

The mentality of South African society was consciously focused on sentimental recollections of how the farming sector struggled to continue operations. Harking back to memories of the country's rural past only subsided once the effects of drought became more pronounced in the urban areas of the country; only when residents of the most populous towns and cities on the Witwatersrand were subjected for the first time to water restrictions, did the significance of drought sink in.[944] There had been previous periods of drought in many parts of South Africa, but the intensity and duration was not as intense as it was in the 1960s. South African society and its water governance sector first had to experience drought at close quarters, before the reality of understanding natural disaster conditions settled into the collective consciousness.

Climatologist C.H. Vogel is critical of the fact that, ironically, in the 1960s drought there was more of a public concern over the number of drought-induced livestock fatalities than incidents of human suffering, especially in the

941. Potgieter (1970:16).

942. Van Reenen (1935:19–20).

943. Chikoore (2016:17, 139–141).

944. Tempelhoff (2003:276–282).

rural areas.[945] Even in the planning report of the ORDP in 1962 the reader is struck by the statement that the value of the project would be evident in the lower mortality rates among sheep in the wool-producing areas of the Karoo.[946] Hardly any attention was given to human suffering.

However, Vogel's criticism should be interpreted in the context of the time. In the 1960s the agricultural sector employed large numbers of rural African people. Since the 1950s there had been a significant wool-producing boom,[947] and labour-intensive farming operations contributed positively to the country's economy. In the early 1960s, R2500m was invested in South Africa's sheep and wool farming industry, on which an estimated 750 000 people relied for an income. J.H. van Huyssteen, of the South African Wool Board, articulated the view of sheep farmers in a cavalier tone when he explained:

> We march under the banner of gold but we are, to a large extent, carried on the backs of woolled sheep. Wool is interwoven with almost every segment of our economy. Unlike certain minerals, deposits of which are being exhausted or becoming uneconomical to exploit, the wool industry is a lasting asset.[948]

There was certainly an awareness of the suffering experienced by poor people in the 1960s, but it was part of a more collective suffering – a form of collective depression – which the country's people shared in common, irrespective of race or class. Drought conditions created opportunities for introspection. Drought was discussed on street corners, in the legislative assembly; and it found expression in the government's call for national days of prayer for rain. Societal responses to the prevailing conditions had to cognitively adapt to the mentalities of both the long-established rural communities and new bustling urban regional societies. It was a learning curve for the country as a whole.

Farmers became aware of the need to reduce livestock numbers. Overgrazing, overstocking and diseases were among the reasons for animal deaths.[949] Scientists drew comparisons of vegetation use between domesticated livestock and wildlife; they pointed out that endemic wildlife populations in many of the drought-stricken areas of the country were able to thrive on limited natural grass supplies.[950] Within the next decade there was a shift towards game ranching.[951]

Seen in the context of drought conditions, the traditional historical understanding of the farming landscape was subject to re-interpretation.

945. Vogel (1994a:4); Editorial (1966:5).

946. WP X62 (1962).

947. Van Wyk (2017).

948. Van Huyssteen (1962:28).

949. Vogel (1994b:28).

950. Verbeek (1966:378–393, 387–393).

951. Carruthers (2008:168–169).

For example, the historical geographer A.J. Christopher, critiqued the European conception of the farm against the backdrop of the way South Africans experienced the farm and what it represented. He noted the obvious contrasts in the realm of the hydrosphere. High evaporation rates in South Africa, he argues, makes rain less effective than in Europe. Comparatively speaking, there is a general lack of surface water in South Africa, while this is not the case in Europe, and especially not the United Kingdom.[952] Christopher points out that the size and location of the land in southern Africa – as well as the conception of the pastoral farm – is influenced by the phenomenon of endemic drought conditions, a consideration that is less pronounced in most parts of Europe.[953]

South African researchers examined at close quarters the way indigenous pastoral communities engaged with water in the 1960s drought. Some traditional strategies even informed modern livestock farmers. D.M. Joubert, a researcher at the Department of Agricultural Technical Services in Pretoria and future rector of the University of Pretoria, reported in the *South African Journal of Science* how indigenous communities dealt with drought in the lower Limpopo River area. They kept their livestock under control and only allowed them to access to water supplies periodically in near-dry river pools. Joubert also described the endemic plant life and explained how indigenous botanical knowledge served the farmers as pointers of relative degrees of dryness.[954]

Rural African communities tend to respond intuitively to the earliest signs of drought conditions, often with responses informed by a spontaneous social ecological awareness. For example, there is evidence that since the 19th century, when stricken with drought and famine, African people gave up their livelihood in the rural areas and reported for migrant work on South Africa's mines, the urban areas, or on white-owned farms.[955] In the 1960s the north-western Transvaal region was identified as one of the country's drought hot spots because of the disastrous consequences for local livestock farmers. An estimated 19% of the country's meat was produced in the region.[956] African people in most rural areas, meanwhile, used proven coping strategies of adaptation to drought conditions over extended periods of time. Those who did not migrate to urban job opportunities adapted to foraging strategies to secure food resources for as long as the family unit could remain resilient in the face of food and water scarcity.[957]

952. Allan (2011:Locations 1759–1779).

953. Christopher (1970:93–99).

954. Joubert (1966:349–351).

955. Reader (1964:31).

956. Editorial (1966:5).

957. Kaplan et al. (1971:135, 144, 228).

The CSIR's National Nutritional Institute reported on the plight of African people in the northern Transvaal, indicating that because of limited farming operations, they were unable to provide in advance for the lean years. Under such dire circumstances, the researchers suggested, the government should step in with aid measures. High poverty levels meant that people relied primarily on maize. They no longer had large numbers of livestock. Apart from occasional milk and other dairy supplies, and possibly eggs, protein hardly featured in their diets. Some communities, resident on the country's border areas with neighbouring states, such as Bechuanaland (Botswana), Southern Rhodesia (Zimbabwe), Mozambique, Basutoland (Lesotho) and Swaziland, even resorted to importing food supplies.[958] Medical researchers singled out drought as a prime contributing factor to high mortality rates in rural African communities.[959] Under these circumstances, intellectuals critical of the government found it difficult to swallow the words of the then prime minister, H.F. Verwoerd, at the time of the formation of the Republic of South Africa on 31 May 1961, to the effect that rain was always a blessing and a good sign from God.[960] It was argued that a country divided by race was also divided at a time when natural disaster conditions compromised human safety.

African opposition to the government, and discontent over the new ORDP, was primarily driven by the inadequate supply of water to African farmers, and their exclusion from the supply of water being harnessed in Lesotho; this discontent rumbled on until the end of the drought in 1966.[961] The politicisation of rain and water formed part of a deep-seated consciousness of the resource's intrinsic value.

The water sector's understanding of drought

By 1964 sufficient data had been accumulated on the drought. It was apparent that the first indication of the onset of a drought situation had begun in 1959.[962] For the Department of Water Affairs the first symptom of drought was the large number of irrigation farmers who were asking the department to raise the crest of the existing irrigation water storage facilities. Spurred on by this, the hydrological division analysed water disposal data at existing schemes. It then established more than 500 new gauging stations and prepared a number of synthetic flow records for preliminary water resource assessments.[963]

958. Neser (1965:1160–1161).

959. Ferguson (1960:263).

960. Delius (1963:23).

961. Zonzolo (1966:28–33).

962. Fabricius (1964:267–275).

963. RP25/1964 (1964:6, 9).

Not all areas of the country experienced drought conditions simultaneously. In 1961 various regions reported lower than normal rainfall. In 1962–1963, the Eastern Cape experienced subnormal rainfall. By this time, in the northern OFS and Transvaal severe drought conditions had set in. The department reduced water allocations at most schemes. In the Upper Orange River catchment, the flow of the Vaal River had to be regulated in the second half of 1962 to supplement water supplies to irrigators at settlements along the Lower Orange River. The shortfall in water supply lasted from 01 July to 12 November 1962. However, it was not uniform. In the Eastern Cape the Van Ryneveld Pass Dam, Lake Arthur and Laing Dam had adequate supplies. Neighbouring South West Africa (Namibia) even experienced extraordinary rainfall and floods in 1963, with the Nossob River and Auob Rivers in flood and the Molopo carrying water as far as Abiquas Puts for the first time since 1934. A departmental assessment of the collective water supplies of the country put the state of affairs into perspective. On 31 March 1962, the 84 major dams in South Africa were 60.5% full. The next year they only carried 55.8% of their potential capacity.[964]

The department's hydrologists identified an erratic rainfall pattern. The south-eastern districts of the Cape Province and the Eastern Cape, as well as the Transkei and northern Natal experienced freak weather in mid-year. This was followed by storms in July 1963, causing floods in the Umhlatuzi and Pongola rivers of Zululand. In places, the floods registered the highest levels ever. For the Vaal River the situation was favourable. The Upper Vaal catchment experienced considerable inflow, which was good for the Vaal Dam reservoir. It was abnormal, because most of this water flowed in during the usually dry winter season. However, the next summer was exceedingly dry, with the Vaal Dam carrying only 67% of its capacity at the beginning of the winter.[965] Given the strategic importance of the Vaal River system as the prime provider to water users in the country's most populous and economically important region (the Witwatersrand), there was a constant public awareness on the state of available supplies and the 'countrywide' drought.

In the western and north-eastern Transvaal, drought conditions persisted, with disastrous consequences. By March 1963 the region had experienced drought for 30 months. The water in storage dams had been depleted. Resources had reduced to the extent that quotas had to be introduced on all irrigation schemes in the Transvaal. Even dams that were normally stable, such as the Albasini, Ohrigstad and Loskop were affected. They relied traditionally on the inflow from high rainfall areas, but by the onset of winter in 1964, negligible supplies of water were available. The Department of Water Affairs reported:

> Indications are that the severity of the drought will exceed that of 1932–1933 [...] The fact that this drought, while causing grave water shortages and reduced crop

964. RP25/1964 (1964:6–8).

965. RP18/1965 (1965:9).

> production, has not resulted in a national disaster is mainly due to improved farming and water utilization practices.[966]

In the department's report for 1964–1965 the secretary for water affairs noted:

> Rarely has South Africa been stricken by a drought so widespread and severe as that which made 1964 memorable. Fortunately for the urban, mining and industrial complexes of the southern Transvaal and eastern Orange Free State and for the irrigation settlements along the lower Vaal River, copious spring rains fell over the catchment of Vaal Dam, sufficient to replenish it to overflowing for the first time since February, 1958.[967]

At the time there were two distinct drought patterns. The first was the worst – the drought-stricken conditions in the northern, western and eastern parts of the Transvaal, where it had been ongoing for four years. In no part of the region had the drought been broken effectively. The northern Transvaal, according to the department's report for 1964–1965, was the hardest hit; here it was considered the worst drought of the 20th century. Most dams in the region were, on average, at only one third of capacity. By March 1965 the capacity of the dams had dropped to a mere 26%. For the period 1964 to 1965, the maximum and minimum levels of the larger dams in the Department of Water Affairs' Eastern Transvaal Circle (which included parts of the northern Transvaal) was as follows:

- Albasini (17% and 6%)
- Rust de Winter (42% and 6%)
- Loskop (92% and 12%)
- Rooikraal (100% and 0%)
- Ebenezer (56% and 22%).

Of the 18 dams in the circle only two major and five minor dams had been full in the period 1964 to 1965. Twelve dams, at one stage or another, had less than 10% of their capacity, while five dams did not exceed their capacity at any time during 1964 to 1965. The circle's management had to make drastic reductions of water allocations to government irrigation schemes.[968]

For the fifth year in succession, the rainfall was well below the average in northern and eastern Transvaal, and in the far northern parts of the province government was obliged to grant assistance in various forms. In the western Transvaal the drought was almost as bad as in the northern Transvaal, but in the 1964 to 1965 season, local dams filled up to about 40% of capacity. Nine of the major dams in the area were still 80% full by the end of the rain season in March 1965. The management of the Western Transvaal Circle of the Department of Water Affairs reported:

> The whole area [...] was drought stricken for the fifth successive year, with the result that water had to be rationed on all the schemes. The dams also received

966. RP18/1965 (1965:9).

967. RP30/1966 (1966:8).

968. RP30/1966 (1966:8, 32).

> very little water during the year and the water level in all of them was very low [...] The farmers in the whole of the Northern and Western Transvaal experienced a difficult time.[969]

The second most drought-stricken part of the country was the western half of South Africa, which included the western OFS and the central Karoo, where the local water supply in dams was only one third of the annual average. By the end of March 1965, the combined contents of the storage facilities in the region were less than 25% of the average. In the Northern Cape, especially the eastern portions, the rain stayed away, with only light rains falling in November 1964. By March 1965 most dams were empty and springs had dried up. In the south-eastern Karoo and Eastern Cape, conditions were slightly better, with the average contents of dams standing at 58% of capacity, but by March 1965 these levels had dropped to less than 33%. The department noted that for the first time in many years there were no reports of floods in South Africa. The drought then peaked. The leading experts on the stochastic calculation of the country's water resources estimated that by 1965, South Africa only had access to 40% of the countrywide 28 billion cubic metres of surface water resources at its disposal.[970]

There were also reports of extraordinary weather conditions. Between 18 and 25 June 1964, the most extreme snowfalls in living memory occurred in parts of the country. The highest rates were registered in the OFS, Natal and the southern Transvaal. In Bloemfontein (Mangaung) snow lay 60 cm deep. Snowdrifts obstructed traffic and farmers experienced heavy stock losses. On 25 June, helicopters were used in the north-eastern Cape to bring relief, following reported cases of people who had died as a result of exposure.[971]

For some regional communities, the snowfall was a boon. In the Northern Cape and parts of the OFS the snowfall was thick in June 1964, and this kept the soil damp and made it possible for farmers to plant wheat up to the end of September 1964. However, water resources continued to diminish and by 1965 many farmers in the region had little winter feed for their livestock. By March 1965 there seemed to have been an improvement. The combined capacity of dams in South Africa stood at 63.4%. This was well beyond the expectation of the Department of Water Affairs' experts. It was ascribed to good rains in the spring of 1964. Then, unexpectedly, the Vaal Dam filled up for the first time since 1958, bringing relief with the replenishment of water supplies to the Nooitgedacht, Loskop, Bronkhorstpruit, Allemanskraal and Erfenis dams. In Natal and the Western Cape

969. RP30/1966 (1966:30–31).

970. Venter (1970b:24–34).

971. Snow Report (n.d.).

the rains were also good, but the combined effect of the drought still left scars in the many parts of the country that had been hardest hit.[972]

A 1960s drought research focus

A major concern in the water research sector was that the drought had showed how vulnerable the economy of South Africa was in the face of water scarcity. Researchers at the CSIR's NIWR were of the opinion that the time had come for the reclamation of water. They were confident there was sufficient knowledge to embark on a system of water reclamation.[973]

The drought stimulated interest in hydrological engineering, a field in which Midgley was one of the leaders, and droughts and floods were considered to be stochastic in character. Because of the complex nature of hydrological processes, design decisions on water resource facilities had to rely on extrapolations from relatively sparse data.[974] There was a need for more data and better sampling techniques. It was clear that statistical procedures would, in future, become the backbone of research.

In economic terms, drought conditions in South Africa became synonymous with drought relief. It was the responsibility of the Department of Water Affairs to make financial contributions, in the form of drought relief, to irrigation boards, private individuals and management boards. In 1963 to 1964 the department distributed an impressive R1 452 573; and in 1964 to 1965, a further R1 587 504 was provided in drought relief funds. The main beneficiaries were private individuals.[975]

Groundwater: The department and boreholes

The 1960s drought conditions inevitably pointed to the vital role of underused groundwater resources. As a result of the drought there was an increased demand on the groundwater supplies in many parts of the country. Accordingly, the Department of Water Affairs created new subterranean water control areas at Kroondal, Marikana and the Upper Molopo. It started borehole inventories and sought correlations with the effect of drilling boreholes when surface water supplies were exhausted. As the demand for subterranean resources

972. RP30/1966 (1966:9–29).

973. SAWHAR WLC PAM3294/65 (1965:iv).

974. Midgley (1952:380).

975. RP30/1966 (1966:20).

increased, the department introduced control measures to keep abstraction within a safe yield level for subterranean compartments.[976]

In the north-western Transvaal, research determined that claims of 'trees dying' because of 'drought' were unfounded. What had happened was that many farmers had shifted from ranching to mixed farming and had over-exploited their groundwater resources. These supplies had not refilled by the time the drought set in and the available groundwater was insufficient to sustain the trees.[977] Having made this breakthrough, by March 1965, scientists identified more areas for metering and there were 103 automatic recorders, with a further 520 locations being directly observed and 22 operating with flow metres.[978]

The 1960s rush for groundwater at the time of drought took the department by surprise. Up to 1963, as much as 80% of departmental drilling was done for the Department of Bantu Administration in the homelands.[979] Once the drought-induced demand for groundwater began, the department filled all its vacancies in the borehole division and commissioned 20 new pneumatic drills for doing the work. Old wooden-framed drilling units were replaced. Most of these drilling activities were in the drought-stricken regions of the north-western Cape and Transvaal.

While officials explored the new potential of groundwater sources, management handled the recruitment of apprentices to work on the drilling rigs. The skills shortage diminished when the training programme and the salary scales for officials had been improved.[980] Once the drought had peaked, the demand for drilling services did not decline and in 1966, the department even made significant investments in human resources and new equipment. The trend correlated with the upswing in the country's economy. A negative consequence was that once again the department was unable to attract young men to become drillers. The salaries were simply not competitive.[981] In the face of human resource shortfalls, the department nonetheless had to contend with a constant demand for drilling services.

Apart from services for other government departments,[982] the drilling section was by now active on the sites of at least 35 new dams under construction.[983]

976. RP18/1965 (1965:12).

977. Fabricius (1964:267–275).

978. RP18/1965 (1965:10).

979. RP18/1965 (1965:19); RP25/1964 (1964:15).

980. RP30/1966 (1966:21).

981. RP34/1967 (1967:19).

982. RP30/1966 (1966:21).

983. RP25/1964 (1964:15).

Furthermore, continued growth in demand for drilling was not necessarily for more boreholes. Instead, there was a demand for deeper boreholes, made possible by the new pneumatic technology equipment. The number of boreholes drilled in 1964 had increased by 32%, largely because of advances in drilling technology that made the drilling process quicker.[984] However, boreholes had to be drilled to greater depths, as a result of diminishing underground resources. By 1965, the number of boreholes drilled dropped by 17.4%, but the drop in footage drilled decreased by only 5.3%. In most cases deepening existing boreholes proved to be an onerous task. Cleaning and preparing the hole for drilling was time-consuming. The decline in drilling performance was ascribed to the fact that drilling staff had spent time on helping farmers correct faulty boreholes and had also conducted recovery work on existing boreholes.[985]

In some cases the state subsidised private drilling operations, but in many instances farmers maintained their trust in the work of the department's drilling teams. By 1966 there were still 2477 outstanding applications for drilling.[986] The demand was by far the highest in the Transvaal (1306), with significantly fewer requests from the Cape (991), Natal (109) and the OFS (71).

In 1965, much of the work done was dedicated to drilling for the Department of Water Affairs on 45 dam sites and doing grout holes on the site of three construction projects. At the same time, the drilling division conducted work for the Department of Mines. Most of this work was done in the Transvaal, with as many as 1322 boreholes drilled in 1965. Meanwhile, also in 1965, there were 745 drilling operations in the Cape; 92 in Natal and 66 boreholes were sunk in the OFS. In terms of equipment, by 1965 there was a significant increase.[987] Furthermore, as a result of its experience in borehole drilling, in the 1960s the drilling division of the department collaborated with the Department of Energy on countrywide oil prospecting activities.[988]

Greater awareness of surface water supplies

The drought had created an acute awareness of the country's surface water supplies and experts began working on minimising the country's water run-off into the sea. In times of drought, the flows of the country's

984. RP25/1964 (1964:19).

985. RP30/1966 (1966:19, 21).

986. RP34/1967 (1967:19, 21).

987. RP30/1966 (1966:21, 24).

988. RP34/1967 (1967:19).

rivers could be as low as 35% of the annual outflow into the sea. Moreover, in such years, the run-off could represent as much as 45% of the country's natural water flow.[989]

Debates on South Africa's water and the need to put all available supplies to maximum use in a constructive manner, shaped much of the thinking at the time. Engineers began to focus increasingly on the water supplies of the so-called 'Mountain Kingdom' of the Basotho in the uKhahlamba-Drakensberg. In 1966, A.C. Carter discussed this topic at a meeting of SAICE. The response from water sector experts was interesting. Midgley was of the view that such a project was vital for the future; it could be a source to complement the Vaal system and also had potential as a future component of the Orange River scheme.[990] R.A. (Bob) Pullen, at the time a graduate student under Midgley, stressed the need to take note of the potential of the Tugela and Usutu rivers, and suggested there would be sensitivity to political negotiations at the international level. Any such talks had to be tempered with engineering and economic memoranda. In turn, C.E.R. Langford pointed out the importance of the increasing demand for water in the Vaal system and maintained that the issue of cost to augment existing supplies was of little concern. There was after all a dire need for the water to be brought within the boundaries of South Africa. For the veteran A.D. Lewis, who had been familiar with the potential of Basutoland (Lesotho) water ever since the 1930s, the discussion of the Oxbow project was timely (the prevailing drought conditions) to secure additional supplies of water for the Vaal basin in times of low-flow.[991] A more direct link-up with Lesotho water persisted in the long-term views of the engineers working on South Africa's water supplies.[992]

An end to the drought?

Although the national drought crisis came to an end in 1966, some areas had still not recovered. In April 1965, the drought in the central and north-eastern parts of the country was serious and by the end of the financial year in 1966 it had deteriorated further. In some quarters, expert predictions were questioned.[993] In January 1966 water restrictions were imposed on all sectors of the economy. Later there was even a national Day of Prayer. In January 1966 some rain fell which replenished water in a number of the dams. However, by

989. SAWHAR WLC PAM5547 (1968a:5–6).

990. Carter (1966:155–159).

991. Carter (1966:155–159).

992. Stephenson (1971:461).

993. Van der Merwe (1965:5–7).

TABLE 6.1: Between 1960 and 1966 the number of dams in South Africa increased, but the amount of water they stored remained well below maximum capacity.

Date	Number of dams	Water storage in hectare metres	Percentage (%) of combined full capacity	Combined capacity in hectare metres
31/3/61	73	342 000	65.8	520 000
31/3/62	74	315 000	60.5	521 000
31/3/63	84	308 000	55.8	553 000
31/3/64	87	307 000	53.1	579 000
31/3/65	89	372 000	63.4	587 000
31/3/66	90	295 000	50.0	590 000

Source: RP34/1967 (1967:8).

the close of the financial year there were still stringent water restrictions in place. The reserve in the 48 largest dams in the country was less than 50%. Natal was the only region in South Africa that no longer experienced water problems.[994] Hydrologists agreed that the drought was not the only contributory factor to account for the sparsity of water in South Africa. There had also been a marked increase in water use and land development in the upper reaches of many water catchment areas in the country. Dam statistics recorded on 31 March for the period 1961 to 1966 showed that there was a significant increase in the number of dams and the national surface water storage capacity. However, despite this greater storage capacity, the water supplies had declined, as illustrated in Table 6.1.

The Department of Water Affairs argued that conditions were deteriorating because of the prolonged drought conditions in the interior, and that the situation was only temporarily relieved on the eastern Highveld in 1964 to 1965. In addition to advising and helping to formulate strategies for the introduction of water restrictions, the department's researchers were actively involved in work in the Vaal Dam catchment, where the water level had become critical. They focused on predicting the supply and consumption of water, based on the empirical data at their disposal. The management of the Vaal Dam had to be content with the outcome of these results – that no water would be released from the dam to supply water to the consumers on the Lower Vaal River. However, they did release water from the Erfenis and Allemanskraal dams to the Lower Vaal River.[995]

It was evident that large-scale interventions were required in the use and development of an integrated water transfer system for central South Africa. Transfer would become more comprehensive and complex in the next three decades. In future, the department's experts explained, inter-basin transfer systems would be used before there was a national problem.[996] It was all about

994. RP34/1967 (1967:7).

995. RP34/1967 (1967:8–11).

996. RP34/1970 (1970:17).

water security. In the Department of Water Affairs, the understanding was that the national legislation (the *Water Act* of 1956) was sufficiently robust to enable provide for the department to take charge of managing inter-basin transfers.[997]

The Cape Midlands Circle of the Department of Water Affairs reported that in the year 1965 to 1966, the drought conditions were severe over the greater part of the circle.[998] Some farmers, to the acclaim of engineers,[999] used innovative strategies for securing water supplies, and kept themselves up to date on issues such as siltation of their water supplies.[1000] Although irrigation developments in the era of drought seemed to be of less importance when industrial development and urban growth enjoyed most attention in the water sector, there were voices of reason pointing to the indirect value of irrigation schemes. For E.P. Chunnett, for example, the most important considerations were, namely, improved downstream riverine conditions, food production benefits, and the opportunity for community formation in irrigation settlements.[1001]

However, there was real concern that 80% of the water used in South Africa at the time was already being consumed in irrigation schemes. Moreover, as much as 25% of the water diverted for irrigation purposes was lost in the conveyancing system.[1002] The management of the Upper Orange River Circle reported that the Free State as a whole in the period 1965 to 1966 experienced continuous drought throughout the winter, spring and early summer. Most dams were dry or almost empty and water restrictions had to be introduced in many towns and on irrigation schemes. In Bloemfontein, between 08 November 1965 and 28 January 1966, water restrictions were introduced. The Armenia Dam, serving the Leeuw River scheme was one of the few dams that still had sufficient water supplies. In the latter part of January 1966, there were heavy rains in the catchments of the Modder, Caledon, Riet, Tierpoort and Leeuw River, causing floods. In the process many irrigation systems on farms were breached.[1003]

As late as 1968, the Department of Water Affairs' weather specialists were of the opinion that the drought had not yet quite come to an end. There were many contrasting views. In terms of crop production and rainfall, it was evident that 1967 to 1968 was a bumper year, with farmers producing as much as

997. Van Robbroeck (1979:30).

998. RP34/1967 (1967:24).

999. Schutz (1967:271–272).

1000. Rubidge (1965:223–225).

1001. Chunnett (1965:99–103).

1002. SAWHAR WLC PAM5547 (1968a:6).

1003. RP34/1967 (1967:25).

106 million bags of maize,[1004] so in this context the drought had indeed come to an end. However, subsequent hydro-environmental research suggested that between 1965 and 1970 about 52% of the country's districts in the summer rainfall area experienced only 80% or less of normal rainfall.[1005]

Dealing with pollution

It is evident from the annual reports of the Department of Water Affairs in the 1960s, that within the first decade after the 1956 *Water Act* came into effect, the department embarked on an active strategy to take steps, first randomly and then increasingly in a well-organised manner, to check up on industries that appeared to be responsible for water pollution. At first, culprits were notified of the department's concerns. Then law enforcement began, and polluters were instructed to conform to the stipulations of the legislation.

The strategy of engaging with polluters and guiding them to collaborate with the CSIR's NIWR suggested that a research route was desirable and could lead to proper guidelines for best practice. The role of the NIWR was vital. Ever since the late 1940s, the CSIR's water researchers had focused on pollution. Working under the guidance of Dr G.J. Stander, a leader in the field of water treatment, the NIWR was among the first in the water sector to recommend reuse as a practical means of securing more water for consumption purposes. Measures aimed at curtailing pollution would accentuate the importance of wastewater treatment. Especially in the field of mining, water pollution had become a major concern because acidic mine water drainage (AMD) posed a threat in worked-out mining areas.

There was an urgent need in the 1960s for the Department of Water Affairs to take steps to curb pollution. Although irrigation was responsible for substantial pollution in the form of nitrates, the problem was compounded in the urban areas, where industries and domestic waste posed a major threat to pristine surface and groundwater resources. In 1961, the Department of Water Affairs established formal channels to lodge complaints on matters of water pollution; health officials and whistle-blowers pooled their efforts to improve the enforcement of the 1956 *Water Act*. The first complaints started rolling in from about 1962, by which time many of the river courses in dense urban settlements on the Witwatersrand were showing signs of pollution.[1006] Then, in 1964, the department's enforcement officials investigated 26 complaints about industrial operations and municipalities and made some recommendations. In cases where there were no obvious solutions, certain industries were issued

1004. RP49/1969 (1969:17).

1005. Vogel (1994b:48).

1006. RP25/1964 (1964:6).

with notices in terms of Section 12 of the *Water Act*, 1956.[1007] By 1965 there was a total of 35 complaints of pollution of public water, the sea, and underground water supplies by industrial concerns and local authorities.[1008] In 1966 the number of complaints dropped to 28.[1009]

Operationalising checks on pollution

On 05 April 1962, when regional standards for industrial effluents were issued in line with Section 21(1) (a) of the *Water Act,* No. 54 of 1956, they had a bearing on the whole of the Republic of South Africa.[1010] The standards stipulated the parameters for effluent, such as, for example, a pH measure of 5.5–9.5 and total dissolved solids of a maximum 500 mg/L.[1011] In the department's annual report for 1962–1963 the enforcement division made the first formal disclosures about their investigations. The division had been exceptionally active. A total of 92 industries and 37 municipalities had permission to keep on functioning with the disposal of effluent for a limited period of 6 months. The respite was to give the management of these concerns an opportunity to make the necessary changes to meet the provisions of the law. Alternatively, they would have to submit applications for exemption.[1012] More enforcement steps and constructive sectoral engagements followed in various parts of the country the following year.[1013]

At first the department did not have a systematic method to deal with water pollution. It was almost like using a shotgun in the dark. This haphazard arrangement ceased when the enforcement division's staff did some research on law enforcement measures. It was at this stage that they engaged with the pollution experts at the NIWR.[1014] The institute had been working for some time on municipal wastewater issues and matters of water purification processes in collaboration with local authorities.[1015] The Department of Water Affairs' pollution control officials soon found common grounds for collaboration with the NIWR.[1016]

1007. RP18/1965 (1965:9).

1008. RP30/1966 (1966:8).

1009. RP34/1967 (1967:7).

1010. RP25/1964 (1964:5).

1011. SAWHAR WLC PAM1265i3 (1970:3).

1012. SAWHAR WLC PAM1265i3 (1970:6).

1013. SAWHAR WLC PAM3249/64 (1964c:1–18).

1014. SAWHAR WLC PAM3277/63 (1963a:1).

1015. SAWHAR WLC PAM3290/65 (1965:1–30); SAWHAR WLC PAM3244/62 (1962); SAWHAR WLC PAM3250/65 (1965); SAWHAR WLC PAM3245/64 (1964a).

1016. RP25/1964 (1964:5).

As the sections of the *Water Act* of 1956 that dealt with pollution reached the implementation phase, local authorities and industrial water users were quick to respond to the department's law enforcement measures. By 1964, a number of local authorities and industries had reviewed their wastewater treatment facilities and applied for permanent or partial exclusion from the promulgated standards.[1017] However, from 13 July 1964 the Department of Water Affairs no longer simply granted temporary exemptions in terms of Section 24 from the provisions of Section 21 of the *Water Act*.[1018] Firm action was required. The department's enforcement officials were assertive. At the same time, they were prepared to facilitate an interactive platform for communication between water stakeholders and the experts in wastewater. They were swift and efficient in issuing permits to industries that were compliant with the law;[1019] but they pursued law enforcement activities ruthlessly for those who were tardy in their response. This tactic paid dividends.

As industries and local authorities came under closer scrutiny, the NIWR received more requests for technical advice and research work. Consequently, the NIWR established regional offices at Bellville in the Cape and provided the OFS provincial administration with support to set up a regional laboratory in Bloemfontein.[1020] Apart from granting permits for the consumption of water to industries and local authorities, departmental enforcement officials issued special permits for the purification and disposal of effluents by 1964 to 1965.[1021]

A high standard of compliance was reached in securing collaboration from polluting industries and local authorities. In cases where it was apparent that it would take a reasonable time for local effluent purification operations to come up to standard, there were concessions. In 1965, 12 local authorities and 12 industries were granted either full or partial exemption from compliance with sub-sections 1 and 2 of Section 21 of the *Water Act*. The permits issued by the department spanned a broad spectrum of water consumers and wastewater treatment operations. In 1966, apart from local authorities, user permits had to be prepared for specified stations and operations of the South African Railways, the chemicals and explosives industry; mining operations in the field of asbestos, soft drink manufacturers and paper and pulp factories.[1022]

By 1968, there was evidence of a more systematic approach. The enforcement officials started conducting sectoral investigations. It was in line with work being

1017. RP18/1965 (1965:8).

1018. RP30/1966 (1966:8).

1019. RP18/1965 (1965:8).

1020. SAWHAR WLC PAM3283/63 (1963b:1–2).

1021. SAWHAR WLC PAM3283/63 (1963b:7–8).

1022. RP34/1967 (1967:6–7).

done at the time by researchers at the NIWR.[1023] The first was an investigation into pollution measures in the wine industry, operating in the Western Cape and Johannesburg. Then followed investigations into the water consumption and effluents of diamond and iron mining operations in the north-western Cape, and sugar milling operations in Natal. 1968 also marked the department's first use of a control schedule for the Atomic Energy Nuclear Research installation at Pelindaba. For the first time, there were also no applications for the use of public water to generate hydroelectricity.[1024] This was because of the rapid dissemination of Escom's distribution since the early 1960s, and the cheap rate of electricity supplied by coal-fired thermal power stations in many parts of the country.

The role of the NIWR in pollution control and water reuse

South Africa was not part of the international environmental revolution in green politics in the mid-1960s. The country was isolated politically and the government's prime focus was on industrial development. The state barely provided opportunities for the voice of civil society to be heard. Despite these drawbacks, it was in the field of research and implementation in the water sector that South Africa began making substantial breakthroughs that later set an example for environmental scientists to follow. In the mid-1960s the NIWR had a number of short- and long-term research projects. By 1969, the institute had completed a three-year survey project of the rivers in the OFS, and had submitted a report of a 15-year research project on river surveys for the Natal Town and Regional Planning Commission. The focus of the report was the quality of water and control of pollution in Natal rivers.[1025]

In the same year the NIWR undertook comprehensive research on the conservation and reclamation of industrial water, working in close collaboration with the southern African branch of the Institute for Water Pollution Control. The NIWR stressed the need for industries to take careful note of the water supplies they required. As pointed out by the CSIR's J.W. Funke in his report to departmental enforcement officials on guidelines for checking industrial pollution, industries had to abide by the stipulations of the 1956 *Water Act* in dealing with the disposal of effluents. They had to adhere to the minimum standards required by local authorities. Attention was given to the potential recovery of valuable materials as by-products, with examples provided from a wide range of industrial pursuits from wool-washing to metal finishing plants.[1026]

1023. Murray (1992:76).

1024. RP49/1969 (1969:11).

1025. SAWHAR WLC PAM3289/69 (1968:iv, 1–31).

1026. SAWHAR WLC PAM3263/69 (1969:1–99).

The comprehensive integration of all authorities in the water sector was evident in the research undertaken in the late 1960s. It corresponded with the thinking of experts in the water sector who were investigating plans for the future management of the country's water resources. The strong message that circulated in the water sector was the need to seek the most effective way to control pollution. Essentially it was all about measures to reclaim effluents and make it possible to reuse the water.[1027]

Windhoek water

One of the major breakthroughs in the alternative use of wastewater was the successful establishment, in the late 1960s, of a potable water purification plant in the city of Windhoek in what was South West Africa (now Namibia). This arid city relied for its water supply on the city's wastewater. In the early 1950s, the water authorities in South West Africa (SWA) were aware that they would have to deal with a major water shortage within the next decade. More than 70% of the surface area of SWA had an annual rainfall of less than 400 mm p/a. Furthermore, there were no rivers with perennial flows, other than those on the northern and southern borders of the territory.

In the case of the capital city of Windhoek, the need for water was critical. There were no large storage dams in close proximity to the city, so pipelines could not be laid. In 1954, after deliberations with representatives of the municipality of Windhoek, the NIWR conducted research and recommended the reclamation of sewage water for drinking purposes.[1028] At an early stage it was decided to situate the water treatment works in the catchment area of the Goreangab Dam, close to the existing water purification works. In 1962 the NIWR's researchers, in collaboration with Windhoek's city engineering department, developed purification techniques for the reclamation of water. One problem was the elimination of algae in the maturation ponds in the final phase of the city's sewage works. There were also problems with a conventional wastewater system that was unable to break down effluent waste products from the local abattoir and meatpacking plants. However, by 1965, with guidance from the NIWR, the water authorities in Windhoek managed to address these problems successfully, and started working the pilot plant to produce potable water that measured up to the strict standards of the World Health Organisation (WHO). By the end of 1968, the system was connected to Windhoek's drinking water supply and on 29 January 1969, the South African prime minister, B.J. Vorster, officially opened the plant.[1029]

1027. RP34/1970 (1970:7).

1028. SAWHAR WLC PAM3298/70 (1970:1).

1029. SAWHAR WLC PAM3298/70 (1970:1–2).

Almost a decade later, at a 1978 conference of the Institute of Pollution Control held in Port Elizabeth, Dr Margaretha Isaacson of the independent Institute for Medical Research in Johannesburg, spoke about her participation since 1973 as a member of the research group that worked in Windhoek, investigating the potential health risks of drinking water from the city's purification works. The institute's researchers were confident that the health of the 75 000 residents of the city was not compromised at all by drinking the treated wastewater.[1030] Little wonder that well into the 21st century, the Windhoek water purification system continues to receive international recognition for its contribution to securing sustainable urban water supplies in one of the most arid regions of the world.[1031]

Pollution and industrial water

The need for the Department of Water Affairs to take measures to check on water pollution in the 1960s was concomitant with South Africa's rapid industrial development and the growth of urban areas, with effluent and domestic waste increasingly polluting the existing surface and groundwater supplies. The CSIR's researchers, who became part of the NIWR by 1958, were responsible for ground-breaking work in this regard.

As a result of the 1960s drought conditions, the principle of recycling wastewater, promoted for many years by the CSIR's Institute for Water Research, was taken more seriously. Not only did the department, with government support, implement strict enforcement measures to prevent wasteful water pollution, the country's water scientists proved their point in Windhoek, as discussed above, by devising a method of purifying wastewater for the city's consumer needs.

Lodging pollution complaints

The establishment of formal channels to lodge complaints on matters of water pollution, as well as following up on information from whistle-blowers, was invaluable in the department's drive to enforce the stipulations of the *Water Act* of 1956. In 1962 to 1963 the department received complaints about water pollution in the Loskop Dam; the Groot Olifants River; the Steenkoolspruit at Dundee; the Waterval River, in the Bethal and Standerton districts; the Blesbokspruit in the Heidelberg district; the Jukskei River in the Kempton Park district; and the Klip River in the district of Johannesburg.[1032]

1030. SAWHAR WLC W765 (1978:1–9).

1031. Rose (2016:Location 681, 3292–3300).

1032. RP25/1964 (1964:6).

In collaboration with local authorities, NIWR researchers had for some time been working in the area of municipal wastewater issues and matters of water purification processes.[1033] The industrial water division of the Department of Water Affairs, in turn, was responsible for issuing permits for industrial water use, and had to control the purification and disposal of effluents to prevent pollution.[1034] By this time local authorities and industrial water users were responsive to the measures of the *Water Act*, which had now reached a new phase of implementation. From 13 July 1964, the Department of Water Affairs no longer simply granted temporary exemptions from the provisions of Section 21 of the Act, in terms of Section 24.[1035] It paved the way for an interactive platform for communication between water-consuming stakeholders and the research sector.

The research output was well-focused. As a result of significant growth in the textile industry in South Africa towards the end of the 1960s, the NIWR published a report dealing with effluent management in textile plants. Wastewater had to be treated for the removal of colour, turbidity, suspended solids, heavy metal ions and hardness. Other recommendations included measures to deal with the treatment of boiler feed-water and cooling water. It was emphasised that saving water was important, and the report described measures that could be taken to reduce effluent pollution. There were recommendations that factories should use less chemicals by, for example, recovering saleable or reusable by-products such as wool grease and caustic soda. The report also recommended that final effluents from textile milling plants had to be segregated in terms of organic and inorganic wastewater, which would make it possible to introduce biological treatment processes.[1036] Collaboration between the enforcement officials of the department and the CSIR paved the way for industries and local authorities to be more active in dealing with pollution.

■ 1966 Commission on water supply and provision

The drought of the 1960s, the growth of the economy and rapid urban developments in many parts of the country were reminiscent of the 1940s, when government wanted to take stock of the country's natural resources. Two decades later, a sophisticated and fast-growing economy with substantial potential for growth, especially in the field of energy production, made government aware of the need to rethink its water governance. On 23 June

1033. SAWHAR WLC PAM3247/64 (1964b).

1034. RP25/1964 (1964:5).

1035. RP30/1966 (1966:8).

1036. SAWHAR WLC PAM3265/69 (1969:1–79).

1966, the state president, C.R. Swart, appointed a commission of inquiry into water matters. The commission comprised 15 members, under the chairmanship of Prof. S.P. du Toit and was charged with conducting an investigation into all aspects of water provision and utilisation in the Republic of South Africa.[1037] Other members included D.P. de Villiers, M.T. de Waal, J.F. Enslin, G.P. Jooste, J.P. Kriel, S. le Roux, H.B. Malan, P.S. Rautenbach, N. Shand (who was replaced by G.H. O'Connell), G.J. Stander, E. Thorrington-Smith and A.B. von Maltitz.[1038]

The government wanted guidance on measures for the efficient management of the country's water supply. The recent drought (*c*. 1959 to 1966) had proved just how vulnerable South Africa was. Moreover, in an era of considerable planning it was essential to focus on water security. The commission had to deal with a number of issues. It was necessary to determine the country's potential water supplies and sources (both surface and groundwater) in various regions and the way the water was used. In addition, the commission was asked to advise on strategies for the systematic development and safeguarding of available water supplies throughout the country. The commission had to look ahead and give an indication of what water supplies would be required in future. Government wanted to know the most suitable types of farming for the various regions of the country. In particular, it was necessary to know what parts of the country were suitable for irrigation.

Some of the detail required by the government had a bearing on work already done by other commissions and research groups. For example, it was necessary to determine whether there would be any sense in establishing a nuclear power station using sea water. There was also a need to determine specifically how water could be allocated to various categories of consumers. The water plan had to include guidelines on a strategy for the programmed construction of necessary infrastructure. Importantly, the government also wanted to know how to ensure savings in water consumption and its potential reuse.[1039] The commission submitted its report to the government on 23 October 1969 and the document was accepted by parliament in 1970.[1040] The report was divided into three sections. The first sketched the risks that had to be addressed if South Africa wanted to ensure water security under circumstances of rapid social and economic development. The second part described the steps to be taken to avert a shortfall, by making provision for a balance between the demand and supply of water resources. Finally, in the third section of the report, the commission provided a series of policies to

1037. WP N71 (1971–1972:4).

1038. RP34/1970 (1970:xii).

1039. RP34/1970 (1970:xii–xiii).

1040. Hobbs and Phélines (1987:45).

adopt as far as the water sector's development, allocation, finance and administration were concerned.[1041]

In addressing the challenges in the water sector the commission underlined the finite nature of South Africa's water supplies. There was a high annual run-off, of which large quantities simply flowed into the sea without being put to any productive use. In addition the country's groundwater supplies were not used properly and could make a substantial contribution to the available supply – but only if resource replenishment strategies received more attention. Water consumption in South Africa was bound to increase because of population growth, rising standards of living and the increasing demand for economic development in the spheres of agriculture, industry and urbanisation. The extraordinary acceleration of the demand for water was the price the country had to pay for a compounded economic growth rate.[1042]

It was necessary to maintain a sound balance between the supply and the demand for water. The water supply was unevenly spread over the surface of the country, with 75% of the water supply secured from an area constituting about 33% of the country's total surface area. It was thus necessary to introduce improved methods of developing and using the water resources; to raise the efficiency levels of existing water consumption patterns; to consider the potential reuse of water and rethink the efficient use of irrigation water; and finally, to create new water storage facilities. The potential desalination of sea water was put forward as one such example of finding a feasible solution. Food production was responsible for the largest amount of water consumption in the country. A positive factor was that South Africa was essentially self-sufficient in terms of food production although production lagged behind in some areas. Then, too, there was a need to import certain categories of food. The conclusion reached was that there was no immediate need for the expansion of irrigation activity in the country. It was a low priority, but special measures were required, such as keeping some resources of land and water 'on hold', to ensure future food security.

In its report the commission touched on the future development of urban areas and industrial activity, explaining that in 1960 only four metropolitan areas were responsible for producing 80% of the of the country's goods. These same areas also provided 78.5% of the country's employment opportunities. By the late 1960s, the southern parts of the Transvaal Province were responsible for 45% of the country's industrial production, and the region relied almost entirely on the Vaal Dam. In line with the government's policy of separate development, the commission was of the view that it would be wise to consider reasonable decentralisation of economic activity. At the same time appropriate

1041. RP34/1970 (1970:13).

1042. RP34/1970 (1970:1).

funding had to be made available for the future growth of the major metropolitan areas. The Western Cape, home to the second largest metropolitan area in the country, was experiencing a rapid increase in water consumption and was likely to have a shortfall in the not too distant future. With this in mind the commission recommended that attention should be given to the desalination of salt water.[1043]

The commission reported that the Durban–Pinetown area experienced substantial growth, but there was considerable potential for the development of local water resources because of the advances made in extracting supplies from the Umkomaas River and also the future plans for the extraction of more resources from the Umzimkulu and Lower Tugela. In the Port Elizabeth–Uitenhage metropolitan zone there was sufficient supply for the foreseeable future, but as a last resort local attention could focus on the possibility of desalination. Emergent metropolitan areas, such as Bloemfontein and the Witbank–Middelburg (coal mining) region, were said to have sufficient supplies for the foreseeable future, respectively from the Caledon and the Olifants rivers. South Africa's controversial homeland regions, according to the commission's findings, were situated mainly in the eastern parts of the country where water supplies were abundant. There appeared to be no imminent shortages of water. The indications were that the border regions of the homelands, earmarked for industrial purposes, might experience problems in securing sufficient supplies of water for development.

This view was not shared by those in the country's commercial and financial quarters. Ever since the early 1960s, planners working in collaboration with the Department of Water Affairs and the business sector in the southern Transvaal on the Vaal River system, were of the view that it would not be feasible to develop the homelands until regions with a far greater potential for successful economic development, such as the East Rand, had enjoyed priority.[1044] These views were all highly politicised, potentially to the detriment of future water distribution plans for the country.

■ Conclusion

The 1960s drought can be viewed from the ecological perspective of creative collapse of a system aspiring to resilience. The slow-onset natural disaster of drought conditions posed a major threat to societal resilience. The food and water components of the WEF nexus were compromised. In the long-term, adaptation to prevailing conditions was the only solution if the country's farming sector was to survive serious economic setbacks. In part, the '1950s syndrome' of using natural resources such as energy and water in an

1043. RP34/1970 (1970:2–3).

1044. Midgley (*c.* 1962:125).

unsustainable manner, came up for revision. The water planners refused to think of downsizing. Instead, they were forward-looking and kept an eye on the horizon to provide for capacity.

There was one certainty. By the mid-1960s society was aware of the value of water. It became part of a collective memory that was sensitive to conditions of scarcity. In the water governance sector there was a greater determination than ever before to contend with issues of pollution. The reclamation of wastewater increasingly became an option to consider. At the same time the latest expertise in the field of science and technology was used to deal with water pollution and wastage. Alternative sources of water also had to be considered. In the field of pollution control it was evident that the industrial–energy hydraulic mission had a significant impact on water resources. Therefore enforcement strategies to stem the tide of water pollution in many parts of the country increased, along with additional support from scientists and technologists. In the recycling of wastewater to the extent that its status was equal to potable quality, the seemingly impossible was made not only possible, but practical.

In the mid-1960s government appointed the famous water commission to explore the country's water issues. Ironically, further measures to prevent the collapse of the system against natural disasters in the form of droughts and floods, culminated in a set of recommendations by the commission to put the country's water resources to more efficient use. Not all recommendations were ecologically sound. Neither were they intended to be. Desalination plants and plans to prevent rivers from flowing naturally into the Indian and Atlantic oceans were in defiance of the regional preservation of the global biosphere. But at that time, South Africa was politically isolated, and consequently had a relative degree of freedom to act without consulting the international community for approval. The government was determined to pursue its course of maintaining a racially divided country – a course that hardly reflected the adaptive capacity to accept the evolving social ecological evolution of the country's demographic profile.

The energy–industrial hydraulic mission of the state in the 1960s was in the process of gaining momentum and becoming representative of deterministic development. In future, the system would become vulnerable and the state of collapse, registering in the social sphere (far away from the nucleus of development) would threaten the longevity of the existing state.

Chapter 7

Centralised governance, investigation and research in the 1970s

Apex of the industrial–energy hydraulic mission era in South Africa

At the beginning of the 1970s, South African urban areas, even in the rural backwaters of the country, had all the makings of modernity. Throughout the country there was a well-organised web of postal, telegraphic and telephonic communications. Urban water and electricity supply infrastructure had also become more commonplace.[1045] Despite the country's relative political isolation, there were international ties of friendship, especially with countries in the West, because of the increasing confrontation between free market economies and states supporting the communist economies of the East in the Cold War era. This meant that when the energy crisis started in October 1973, and the Organisation of Petroleum Exporting Countries cut back its output of crude oil, South Africa, like its Western allies, was on the receiving end of skyrocketing

How to cite: Tempelhoff, J.W.N., 2018, 'Centralised governance, investigation and research in the 1970s', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 253–292, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.07

1045. Davies (1972:28–29, 55).

energy prices and diminished supplies.[1046] The 1960s foresight of securing a cheap, reliable supply of coal for Escom's power stations, and Sasol's petroleum from coal production was paying dividends. In addition the hydroelectricity plants of the Orange River Project were proving to be a valuable asset.[1047]

The industrial–energy hydraulic mission was set to reach new heights, largely thanks to the embryonic plans of the early 1940s. The guiding principle in water governance was to provide water to a more diverse array of consumers than ever before. The Department of Water Affairs could rely on highly diversified and complex distribution processes, managed and executed at the local and regional level. At the national level, it was an ongoing process to plan for expanding the central system of bulk water infrastructure. Remnants of the former agricultural–food hydraulic mission still influenced allocation planning.

Despite having to take a back seat to industrial development, the farming sector still had sufficient water supplies, but farmers were now paying more for water and the supply was subject to careful monitoring. In fact, in 1965 the farming community continued to consume 83.5% annually of the country's water, although it was more than a decade since the department, bolstered by the new *Water Act* of 1956, had developed multi-purpose water supply systems. However, there were increasing signs of demographic shifts. Urban and industrial water use increased from 3.4% p/a in 1933, to 7% p/a by 1965. In 1970, long-term estimates, based on data going back to the 1940s, suggested that South Africa's urban and industrial consumption of water had been growing consistently at the rate of 7% p/a.[1048] The department was responsible for expanding and servicing the consumer sectors where the demand for water was at a premium.

The report of the Commission of Enquiry into Water Matters was influential in the department's planning. It provided valuable insight and a well-defined pathway for sectoral development. The commission made a number of recommendations on South Africa's water resources that led to changes in the ORDP, but the main objectives of the original project remained the same – it was necessary to provide water for people, animals, towns, industries, mines and irrigation in parts of the country where water shortages were experienced. As had been the case in the Vaal River catchment since the 1940s, and in the emergent Orange River system too, by the end of the 1960s provision of water supplies for the mining industry played a more pronounced role. There was considerable interest in the mining of the Northern Cape's large reserves of manganese and iron ore near Postmasburg and Sishen, and copper and other ore deposits were

1046. Editor (1974:87–89); Frankopan (2016:435–447).

1047. Van Rensburg (1974:33–39).

1048. RP34/1970 (1970:1).

being mined south of Prieska near the Orange River, between Upington and Keimoes.[1049] It was clear that the realisation of the industrial–energy hydraulic mission now extended to some of the most distant areas of the country.

Water Year 1970

In the history of the Department of Water Affairs, 1970 was a memorable year. The government had already approved a national plan for enlightening the public on the importance of water in South Africa's future. There were concerns that before the end of the century the country's water supplies would be insufficient to meet the demand.[1050]

The stark message conveyed was that there had to be an awareness of the present and future need for adequate supplies of water.[1051] In late 1969 the new Minister of Water Affairs, S.P. (Fanie) Botha was guest speaker at the annual banquet of SAICE. In an atmosphere of collegiality and friendship the institute intimated that it had been 15 years since an engineer from the Department of Water Affairs had been president of SAICE. The country's premier civil engineering organisation hinted it was high time for Dr J.P. Kriel, the new director-general of the Department of Water Affairs, to play a more prominent role in the institution.[1052] For the department it was a great compliment. It was also a gesture of renewed friendship between government and the engineering profession.

In the early 1960s, the department's management tried to steer clear of closer liaisons with the consulting sector. Management was wary of losing specialised and experienced human resources to the private sector. Especially at the time of the ORDP and the first major water transfer systems, the secretary of water affairs, J.M. Jordaan (1960–1968)[1053] was protective of the close-knit collegiality of the department's professionals. He tried to limit external collaboration – even in the field of specialised academic training.[1054] Nevertheless, the department's engineers were easy prey for international engineering companies operating in South Africa. The appointment of Kriel (1968–1980) (Figure 7.1), with the enthusiastic support of the Ministry of Water Affairs, changed the earlier 'closed ranks' attitude.

1049. WP N71 (1971–1972:4).

1050. SAWHAR WLC PAM3299/71 (1971:1–34).

1051. Hobbs and Phélines (1987:46).

1052. Botha (1969:293–297).

1053. SAWHAR DH DWSa/Alumni1 (2017).

1054. Roberts pers. comm., 17 January 2017.

Source: Photograph courtesy Jaap Kroon, Pretoria. SAWHAR, DWAF HOD statistics, 2017.02.23.
FIGURE 7.1: Dr J.P. Kriel, the second longest serving departmental head (12 years).

Water Year 1970 formed part of a marketing strategy targeting the public at large in a year-long celebration of water. It was a great success. Midgley considered it a remarkable accomplishment:

> Hardly a single scientific, technical or cultural society failed to devote some attention to the water theme. The water situation was also freely aired by farmers' associations, regional development organisations, chambers of commerce and of the industry and similar bodies.[1055]

The Water Year programme was launched at Zoo Lake in Johannesburg on 14 February 1970. In the political arena, parliament's approval of the report of the Commission of Enquiry into Water Matters marked one of the first the milestones of success for the Water Year.[1056] For the rest of the year the Minister of Water Affairs, members of the Department of Water Affairs and distinguished persons engaged in water-related discussions, keeping the wider public focused on water. The culmination of the year's events was a conference, the Convention on Water for the Future, held in Pretoria from 16 November to 20 November 1970. It was attended by a large number of local and international celebrities and water sector experts of note.[1057]

1055. Midgley (1971:269).

1056. Midgley (1971:270).

1057. Hobbs and Phélines (1987:47).

Marketing the Water Year was relatively easy. Many departmental officials had become household names at the time of the 1960s drought. The department maintained a presence at agricultural shows and popular public events in urban areas where it was appropriate to market water. The Water Year conveyed the value of water at the grassroots level and was a fanfare of South African skills and expertise. The water researchers also caught the limelight. The CSIR's NIWR participated actively in the campaign. As early as 11 November 1969 the NIWR marketed its research accomplishments at a conference in Pretoria where the Minister of Water Affairs opened its new experimental water reclamation plant at Daspoort. The plant had the capacity to produce an impressive 4.5 ML of water per day.[1058] Subsequently, the NIWR publicised a strategy to reclaim drinking water by setting up a humus tank at the annual Rand Easter Show at Milner Park in Johannesburg.

Economic conditions in 1970s South Africa

A complex set of factors shaped the South African economy in the 1970s. These included:

- the international gold price
- the value of South Africa's currency
- new ore discoveries
- labour productivity
- technological advance.[1059]

Water services, an essential infrastructure component for South Africa's social and economic development, were directly affected by these developments.

Economic historian, C.H. Feinstein identifies three important developmental strands.[1060] Firstly, in the early 1970s the cost and production of gold rapidly increased as the country's gold mining peaked.[1061] At the time there was also an international shift. Gold would no longer be the ultimate reserve asset of the international monetary system. Secondly, a number of adverse economic and political factors asserted a significant influence. The worldwide energy crisis of 1973 pushed up the South African exchange rate. Simultaneously, the local and international commodities market pushed up the country's inflation rate. For local manufacturers, it was more difficult than before to export industrial products. Thirdly, according to Feinstein, the country's industrial sector had a low rate of efficiency. The labour sector had meanwhile become more organised. Despite an official ban on African trade union activity, the first

1058. SAWHAR WLC PAM3299/71 (1971:i).

1059. Kaplan et al. (1971:561).

1060. Feinstein (2005:202).

1061. Hartnady (2009:28–29).

comprehensive strike action in South Africa since 1946 started in Natal in 1973, forcing the government to concede that it was essential for employers to raise salaries at a time of inflation.[1062] As the cost of production escalated – also in the mining sector – the country's industries were unable to bolster the economy. Industry had become non-competitive in comparison with other economies.

Political conditions

Politically and socially, South Africa's rapid phase of modernisation since the 1960s led to a greater division in terms of race and class in the country. In an era when African political opposition to the state was still firmly under the control of the government's authoritarian apartheid framework, there was a reawakening of opposition to the state, led by African intellectuals and backed by a groundswell of new urban communities with sheer numbers in their favour. The government was aware of regional rumblings on the subcontinent and stepped up its security both inside and outside South Africa, with the establishment in 1972 of an all-powerful state security council. In the years to come, this council played a key role in state militarisation through an attempt to shore up state security and dominate regional politics in southern Africa.

On South Africa's borders the neighbouring Portuguese colonies of Angola and Mozambique achieved independence, following the overthrow of the authoritarian regime in Portugal in a coup by left-leaning military in 1974. The subsequent socialist rule in the former colonies led to the onset of an era of regional destabilisation, as the newly independent nations were drawn in as proxies in the Cold War between the communist East and the capitalist West.[1063]

The ramifications of the Portuguese regime change in southern Africa kindled increasing resistance to white rule in South Africa. A countrywide awareness of change was evident in the emergence of identity politics among South Africans of colour. Black consciousness ideology arose in many parts of the country, championed by charismatic leaders such as Steve Biko (1946–1977) and a new generation of youth who still held in high esteem the heroic struggle of Nelson Mandela and his compatriots, incarcerated on Robben Island since 1963.[1064]

Biko, a medical student at the University of Natal, was part of a group of students who formed the Black Consciousness Movement (BCM) and introduced Black Community Projects to teach black people about mobilising against apartheid. The BCM built up close ties with the Christian Institute led by the Afrikaans theologian Dr Beyers Naudé, who had become an outcast in

1062. Lodge (2012:411–412).

1063. Davies and O'Meara (1985:192); Leistner (1975:5–13); McGowan and Johnson (1984:651–652).

1064. Hirschmann (1990:3–4).

the Afrikaans-speaking community and was labelled as an enemy of the apartheid government. Naudé's Study Project on Christianity in an Apartheid Society (SPROCAS), started in late 1969 and collaborated closely with the BCM and specifically Biko.[1065]

From 1969 to 1972 SPROCAS was headed by Peter Randall, a former assistant director of the South African Institute of Race Relations. SPROCAS enabled Naudé's Christian Institute to collaborate closely with the South African Council of Churches. More than 140 commissioners and consultants participated in an extensive project aimed at developing an ethical consciousness in South African churches to join an anti-apartheid initiative. Government reacted by serving many project participants with banning orders.

SPROCAS reports were subjected to oversight by South Africa's Publications Control Board, but the information proved to be valuable and inspirational in a society where racial division had estranged people from one another.[1066] Politically, the reports and the message that circulated among the country's African people, played a role in the political turmoil that followed the 1976 Soweto uprisings. In 1973, SPROCAS issued a seminal report entitled *South Africa's Political Alternatives*.[1067] Participants and authors of the project included academics, influential theologians, political leaders and members of the local community. In the report, they addressed the need for ethics that would speak of brotherhood and respect between all the country's people, and that the rule of law should prevail.

The ideal was for a South Africa in which all people respected civil liberties. There was, the report suggested, a white ruling group who had set themselves up as a ruling caste and had a monopoly of political power. A steady stream of legislation had been created that favoured white interests. The report maintained there was a need for change and a different approach.

Dichotomies were no longer relevant; what was required was an acknowledgement of the need for economic modernisation that extended well beyond notions of 'apartheid' and 'integration'. The report also dealt with theoretical options by leading intellectuals, including pluralism and other alternatives to the Westminster model of political governance – a system that had been in place since Union in 1910.

Although many political opinions expressed in the report were 'controversial' in the early 1970s, the work had considerable legitimacy. Liberal, conservative and radical thinkers all aired their views. In an era when government was not particularly interested in listening to African demands, SPROCAS articulated

1065. Mangcu (2012:284).

1066. JSTOR (n.d.).

1067. SPROCAS (1973).

the views of people who had a sense of social responsibility and were aware of the need for ethical standards that transcended racial issues.[1068] In more ways than one, SPROCAS captured the mentality of a meaningful, but politically marginalised, portion of South African society.

Economic and social relations in South Africa hardened, and government took a merciless stand in the implementation of its apartheid policies. It insisted on decentralisation and the creation of homelands, and the country began to move in the direction of direct racial confrontation – last experienced in 1955, with the Congress of the People, and the Sharpeville massacre of 21 March 1960.

In 1976, school children in Soweto marched in protest against a government notice that stipulated that Afrikaans was to be enforced as the language of instruction in some subjects taught at schools. The student discontent, coming at a time of economic and social disruption, culminated on 16 June 1976 in a protest in which more than 20 000 school children participated. The police opened fire on the unarmed children. In the days of unrest that followed, the turmoil spread countrywide and an estimated 170 people were killed and 2000 wounded. National and international headlines spread the news far and wide and the apartheid government had to contend with critical questions about its policies.[1069]

The Soweto-related protests sparked off a nationalist awareness and sense of solidarity among black South Africans, creating the opportunity for the banned ANC to once again garner significant support from all quarters of society in the country's urban and rural areas, as well as on the international stage. Subsequent intermittent protests made the ruling NP government aware that unless it made concessions, the racial conflict would escalate. Government was in a catch-22 situation; pressure was mounting to relax apartheid rule or, alternatively, to prepare for increasing military confrontation and violence. The mere mention of Soweto became a talisman for the exiled ANC to drum up support for its cause both inside and outside South Africa.[1070]

Despite a comprehensive national and international campaign to market South Africa, the government was unable to restore its image. In fact, the ramifications of the Soweto events derailed the information system, both inside and outside South Africa. The prime minister, B.J. Vorster, was forced to resign in the light of allegations of extortion and attempts at undermining the free dissemination of news in what was known as 'the information scandal', masterminded by the Secretary of Information, Dr Eschel Rhoodie and the

1068. Lever (1973:14–22).

1069. Ndlovu (2004:317–368).

1070. Baines (2007:280–302); Pohlandt-McCormick (2000:23–44).

responsible cabinet minister, Dr Connie Mulder.[1071] Vorster's successor, P.W. Botha, was responsible, in the aftermath of Soweto, for the introduction of a style of government that relied extensively on military-type strategies aimed at combating the 'total onslaught' on South Africa.[1072] The process of political destabilisation both within and outside South Africa and Southern Rhodesia, forced these two subcontinental, white minority-ruled governments, as well as the South African protectorate of SWA (Namibia) into a perpetual state of conflict with freedom fighters. The conflict intensified as political exiles and their well-trained military supporters infiltrated Zimbabwe, Namibia and South Africa, destabilising society with acts of terror while garnering support from marginalised indigenous communities in urban and rural areas.[1073]

By the second half of the 1970s, South Africa's political ecology had a profound effect on the governance of the country's water resources. Amid fluctuations of the gold price and concerted efforts by government to boost the price of gold internationally, there was a trend in the mining sector to rely increasingly on migrant workers from rural South Africa instead of countries like Zambia and Malawi.[1074] The change promoted internal migration of black South Africans from the rural homelands to urban areas. A sagging economy and the intermittent trepidation of unemployment caused hardship in the townships, where households relied on a breadwinner earning a living on the goldfields. Higher rates of water consumption, and initiatives by local authorities in the urban areas to improve services such as water supply, sanitation, and electricity, placed increasing stress on township infrastructure on the Witwatersrand region.[1075]

The department and water governance in the 1970s

Although the Department of Water Affairs' management relied to some extent on the 1966 to 1969 water commission's findings and recommendations, there were essential changes and adjustments. These were the result of unforeseen events on the periphery of the social ecological system of the country's water resources and its supplies. Prominent among these events was Soweto and its immediate aftermath in 1976 to 1980. This was a peripheral factor that changed South African society in a number of ways and evolved into a typical panarchy phase of creative collapse. Over the short term it was possible for government

1071. Haasbroek (2016:74–158).

1072. Haasbroek (2016:47–48).

1073. Giliomee and Mbenga (2007:362–369).

1074. Harington, McGlashan and Chelkowska (2004:67).

1075. Tempelhoff (2003:295, 327, 332–336).

to stabilise the economy, which relied heavily on the mining sector. However, it was an interim period of tranquillity, which later sank to deeper depths of economic decline in the 1980s.

The situation of housing in 1970s Soweto points to the underlying consequences of the politics of the day. Government policy was focused on developing the homelands and diminishing its support for urban areas like Johannesburg. In the process the state underinvested in urban housing for the African population. Between 1970 and 1980, the number of houses provided by the West Rand Administration Board in Soweto totalled 5000 – on average about 500 homes p/a. All houses had water supply and sanitation services.

The main difficulty was that the housing was hopelessly insufficient, and the services provided by the relevant authorities could simply not meet the demand resulting from rapid population growth. The burgeoning number of informal 'backyard shacks' and 'garden huts' on residential properties placed water and sanitation services under severe strain.[1076] Black urbanisation, despite the government's influx control measures, continued apace. After 1976, both the central government and local authorities were more circumspect in respect of relocation initiatives, but nevertheless civil disobedience intensified in the townships and there were rent and rates boycotts.

Restructuring: Regionalisation

The commission of enquiry into the country's water situation (1966–1969) made recommendations on the water sector's contribution to the country's economy and the potential role of the state. It pointed out that South Africa's water resources, in terms of the 1956 *Water Act*, had become very centralised. The government department had full control over the allocation and use of water in public streams, however there were amendments to the legislation that made it possible for the state to apportion the available resources among various sectors of the economy, so that they could contribute to the development of the country. Only by responding to the urban demand for water did local and regional authorities play a role of sorts. It remained a subsidiary role. The commission's view was that government departments should communicate with each other, and deliberations would lead to better decisions on the allocation of water resources to various stakeholder communities.[1077]

The commission pointed out that although the Department of Water Affairs had executed work of technical excellence, there were a number of shortcomings in its planning of the country's water resource development. One area of

1076. Wilson (1984:3–4).

1077. RP34/1970 (1970:12).

concern, in the view of the commission, was that there was no proper apportionment of water among various sectors of the economy. Furthermore, there appeared to be too little financial control exercised over water projects, and the department's policy was on the pricing of water was also called into question. The country's physical resources had been entrusted to the prime minister's planning advisory council, and the commission recommended that in future the Department of Water Affairs should remain in close contact with the commission and be involved in all schemes planned or recommended by the planning advisory council. In other words, there was to be a strong top-down and centralised process of water governance.

In 1975 the government published the National Physical Development Plan (NPDP).[1078] The NPDP focused on the decentralisation and regionalisation of South Africa in terms of population density, development potential, the availability of natural resources and existing infrastructure facilities. The NPDP did not set out to promote decentralisation in favour of the development of homelands.[1079] Instead there was an attempt to identify urban areas for future development. In planning circles, the strategy was said to lack focus because of its spatially unbalanced approach to development planning.[1080] In the 1980s, when economic development became part of a regional discourse, the Department of Water Affairs had a vested interest in participation.

J.P. Kriel's management of the Department of Water Affairs was sound. Senior members of staff who had earlier left the department after experiencing problems with the style of management of his predecessor, J.M. Jordaan, rejoined the department when Kriel took over.[1081] The responsible cabinet minister was the 'energetic' S.P. (Fanie) Botha who appears to have 'pumped' new energy and enthusiasm into the department. Botha entered politics in South Africa in 1958 and was appointed as Minister of Water Affairs in 1968. In the P.W. Botha era, beginning in 1978, he became the minister of mines and labour.[1082]

As Minister of Water Affairs, and later also forestry, Fanie Botha was a resounding success. He was responsible for the effective marketing of the department, and had substantial political muscle as a leading insider in the time of B.J. Vorster's premiership (1966–1978) to drive the interests of the water sector in the political governance of the country. Botha soon became known as 'Fanie Water' in the water sector. He is remembered for offering a number

1078. King and Pienaar (2011:7).

1079. Steyn (1994:8).

1080. Drewes and Van Aswegen (2013:195).

1081. Van Robbroeck (*C*. 2016c).

1082. IMIESA (2006).

of bursaries to students who joined Water Affairs after the completion of their studies – young people known as 'Botha's boys'. Many of these graduates played an important role in the development of South Africa's water sector in later years. Fanie Botha resigned his ministerial post after allegations surfaced that he had refused to hand over diamond leases promised in a secret deal with the South African Police's Brigadier Johann Blaauw.[1083]

Departmental human resources in the 1970s

By 1972, for the first time in many years, the Department of Water Affairs did not experience serious general staff shortages. There was, in fact, an oversupply. In some areas there were more temporary personnel than posts available. It was possible, with the new focus of the department, to accommodate these members of staff. However, there remained a critical shortage of experienced members of staff – especially people with research expertise. J.P. Kriel reported:

> The constant increase in the volume of work entailed in hydrological research and analysis, planning utilisation and development of water resources, design of schemes, water pollution control, the management of new schemes, maintenance of intricate equipment, etc., demands accelerated expansion of the establishment.[1084]

The recruitment of officials paid dividends by 1974,[1085] but the department was unable to retain its professional staff. The private sector offered higher salaries and the country's economy was in a growth phase. Consequently, there was a high staff turnover of professional officials.[1086] By the mid-1970s, when the completion of some of South Africa's major water development infrastructure started peaking, human resources shortfalls became more serious. Qualified people and even administrative officials were hard to come by.[1087]

Apart from an undersupply of qualified engineers, there was also a shortage of hydrologists. Only 46.6% of the senior hydrology posts in the department were filled by 1977.[1088] In the same year only 62.7% of the posts for technical officials had been filled.[1089] The department also experienced a severe shortage of qualified computer programming and administrative staff in 1976. One of the reasons for the IT staff shortages was that the salaries in the private sector were far higher than in state departments.[1090]

1083. Anonymous (n.d.c).

1084. RP48/1973 (1973:1).

1085. RP62/1975 (1975:1–2).

1086. RP62/1975 (1975:2).

1087. RP67/1977 (1977:2–3).

1088. RP51/1978 (1978:3).

1089. RP51/1978 (1978:4).

1090. RP67/1977 (1977:59).

Source: SAWHAR JKC/Dams folder: Illus. 7 (1970–1974).
FIGURE 7.2: Blyderivierspoort Dam under construction. It was a multi-purpose project on the Blyde River to provide water for downstream irrigation, as well as for the Phalaborwa mining industrial complex.

Until the 1970s the department was primarily a man's world. It was therefore with considerable acclaim that the department reported in 1973 that its first female engineer had been appointed to work on construction. Ms A.M. Mouton, an assistant engineer appointed in 1972, was part of the construction team working on the Blyderivierspoort Dam which can be seen in Figure 7.2, under Dr Paul Roberts.[1091]

Up to that time, women in the department served mainly in administrative posts. By 1977, of the 214 clerical administrative and senior administrative assistants, 115 were women. In respect of the department's African members of staff, management was aware of the state's labour regulations of 1965. The department had to ensure that black people were fed adequately so that they were able to perform their work. When making provisions in this respect, the department also provided food to its coloured workers. By 1977, in the aftermath of the Soweto uprisings, there was greater sensitivity towards people of colour. The secretary for water affairs reported that departmental housing for Africans and coloureds was being upgraded. There were also preliminary arrangements for more effective protective clothing for workers. The department also initiated a system of aptitude tests, with a view to

1091. RP61/1974 (1974:53).

selecting South Africans of colour to undergo training for more advanced work. In addition, the wages of Africans and coloured people was revised in line with the guidelines laid down by the Public Service Commission. The department's 1976–1977 report mentioned that all the available posts in this field of employment had been filled.[1092]

Structures of governance

In the early 1970s the Department of Water Affairs was highly centralised. It had to manage, from the top, various institutional structures that provided essential services to consumer communities in all parts of the country.

Irrigation boards and districts

In April 1971, South Africa had 245 irrigation districts operating across a total scheduled area of 300 868 ha. During the year, nine districts were proclaimed and 10 de-proclaimed. By the end of the year, the surface area under irrigation in South Africa had increased to 317 727 ha. In addition, there were also nine settlement management boards and four water boards. In 1971 to 1972 the department delayed approval for six petitions to establish irrigation districts, while eight new ones were submitted. In the case of existing boards the department was privy to statutory inquiries and local officials acted as electoral officers in the elections for irrigation district board members. The Cape Province had the most irrigation boards (147) with 5322 irrigators who were scheduled for farming 171 616 022 ha of irrigated lands. In this province the largest amount of money had been granted in 1971 to 1972, a sum totalling R1 534 406. Transvaal had the second largest community of irrigators (2 642) operating in 86 boards and working on 131 989.04 ha. In the OFS there were five boards with a total of 119 irrigators working on 3392.95 ha of land. By 1972 Natal had 109 irrigators scheduled to work on 10 979 ha in seven boards.[1093]

From 1973 to 1974 there were 243 irrigation districts in South Africa, with a total scheduled surface area of 317 125.89 ha. During the year four districts were proclaimed, two were de-proclaimed and one was taken over by the Department of Water Affairs. In effect, this meant that there were 244 districts with a total surface area of 312 735.90 ha.[1094] By 1978 there were 233 irrigation boards in South Africa serving a scheduled area of 327 523.40 ha. There were also 13 settlement boards and five water boards.[1095] In 1979 there were 235 irrigation

1092. RP51/1978 (1978:4).

1093. RP48/1973 (1973:109).

1094. RP62/1975 (1975:114).

1095. RP30/1979 (1979:145).

boards working on a scheduled surface area of 335 381.82 ha. There were 13 settlement management boards and five water boards.[1096]

Water boards

One of the major water boards to be created in the 1970s was the Umgeni Water Board. Ever since the early years of the 20th century the Rand Water Board, with its head office in Johannesburg, was the best example of the important role water boards could play in South Africa. Although local authorities, the private sector (especially mining companies) and representatives of government were prime stakeholders, it was possible for the Department of Water Affairs to maintain a presence of authority in the activities of water boards.

By the 1960s, water boards made substantial business sense for the Department of Water Affairs. Apart from bringing in large industrial stakeholders and people from the private sector to meet the costs of running the governance system, the department could incorporate water services into homeland areas in the eastern and north-western Transvaal. The pursuit of this strategy meant that the private sector also carried some of the costs of providing proper potable water in the rural and homeland regions of the country.[1097]

In view of the success of the Rand Water Board, which had been serving the greater part of the Witwatersrand since 1903, as well as the industrial development that had made such headway from the late 1940s, government made provision for water boards in the *Water Act* of 1956. Earlier that same year the Midvaal Water Company, to all intents and purposes a water board, was established to supply water to the mining areas of Klerksdorp, Orkney, Stilfontein and vicinity. It supplied water to the municipality of Matlosana (Klerksdorp) and to the mining and industrial undertakings in the region.[1098]

In 1963, as a result of increased operations and a greater demand for water, the Sasol petroleum from coal plant acquired the right to establish the Northern Free State Water Board. Apart from supplying water to the factory, subsidiary industrial and coal mining operations, as well as the village board of Sasolburg, it was part of the stakeholder community. All were reliant on the water board for water supplies.[1099]

In the same year (1963) the Phalaborwa Water Board was established in terms of Section 108 of the *Water Act* 1956, for providing water in the region

1096. RP49/1980 (1980:160).

1097. WP L82 (1982:4–5).

1098. Anonymous (n.d.a).

1099. WP E63 (1963:2–4).

of the mining town of Phalaborwa and other settlements in the Lowveld. The water supply flowed from the Drakensberg into the Lower Olifants River.[1100]

This water board started operations with water storage and purification infrastructure originally developed by the local Foskor mining operation.[1101] Apart from providing water supplies to local residential and commercial communities, the Department of Bantu Administration and Development and the Lowveld mining sector were also major beneficiaries. When the Water Affairs department proposed the development of the board's R4m water scheme in 1964, the intention was to bring all stakeholder communities, including farming operations in the Olifants River catchment, under departmental oversight. The board was primarily responsible for the management, administration and operations of the purification works, reservoir facilities, pipelines and a weir across the Olifants River, in the interest of stakeholder groups.[1102] In 1965 the department requested government to raise its financial support to the project, to R9.5m – more than double the original estimate. It transpired that the project was significantly underpriced.[1103]

As a result of the vast cost involved, the Department of Water Affairs appeared hesitant to establish new boards. That was until 05 September 1969 when the Vaalkop Water Board (later also known as Magalies Water Board) was established to supply water for households and industrial operations at the platinum mines in the Northam area. The board served local communities in the villages of Northam and Saulspoort, the latter a farming community. Within the next decade the board's area of distribution extended as far as Thabazimbi, where Iscor's iron ore mining operations, as well as local residential communities, required reliable water supplies.[1104] The Pelladrift Water Board was established in the circle of the Lower Orange River on 29 November 1974.[1105]

The origin of the Umgeni Water Board, a non-mining-related water board, was the result of an awareness in the planning division of the Department of Water Affairs in the early 1970s that the Durban Corporation, the city's water utility, extracted its water supply with a pipeline from high up in the Umgeni catchment. The management of the Durban utility wanted to develop a site for a storage facility at Inanda because an increased water supply was needed at the Department of Water Affairs' purification works at Umlaas Road. This plant was used to provide water to the border industries of the neighbouring KwaZulu homeland area.

1100. WP Q64 (1964:4).

1101. SAWHAR DH11/D2090 J.G. du Plessis Collection (1985:2025).

1102. WP Q64 (1964:5–6).

1103. WP T65 (1965).

1104. WP L82 (1982:3–5); Anonymous (n.d.b).

1105. RP30/1979 (1979:126).

There were large areas between Pietermaritzburg and Durban where there was no regular free access to water supplies. Potential water customers shopped around in the rural areas trying to secure supplies from either Pietermaritzburg, the Department of Water Affairs' Umlaas Road, Pinetown Water Services Corporation, or from the Durban Corporation. Some had access to the Midmar Dam. The top main in the system passed on to the Ferncliff water purification works of Pietermaritzburg.[1106] Potential benchmarks for a water board included the Rand Water Board and the Phalaborwa Water Board. According to Van Robbroeck, the water board concept was 'revived' as a convenient tool for service delivery, following investigations on water matters in Natal in the 1970s. He and local water management experts, as well as key stakeholders in government and politics, started working together on the creation of the Umgeni Water Board. Umgeni Water was established in terms of Proclamation 114 of 1974 (*Government Gazette*, 4300, 14 June 1974) and made provision for a water board to provide water for urban, industrial and agricultural purposes and to local authorities in its area of supply.[1107]

It is perhaps more precise to argue that in the case of Umgeni, it was evident that the Department of Water Affairs' management saw water boards as appropriate providers for multi-purpose water consumers, and not only for mining interests. Moreover, in the planning of water transfer schemes, the water board as an institutional water governance entity, proved itself to be a useful tool.

In 1976, Midgley was confident that the newly established Umgeni Water Board was in a good position to transfer purified water in the demarcated 2500 km^2 area that was earmarked for industrial development. The government dams of Midmar and Albert Falls, were used at the time to augment the Pietermaritzburg water supply from Henley Dam (Msunduze) and to Durban from Shongweni Dam (Mlazi) and the Nagle Dam (Mgeni). On the cards at the time was a fourth dam in the lower Mgeni. The Umgeni Water Board was anticipating the exhaustion of the Mgeni supplies, and the potential of diversions such as the Illovo River into the Mlazi and the Mkomas into the Mgeni. Midgley was confident that Umgeni would have sufficient water to meet future demands.[1108]

There were also a number of regional water supply corporations along the north coast of Natal. There were also government dams at Hazelmere (Mdloti) and Goedertrouw (Mhlatuzi) that were under construction at the time, in an effort to meet the demands for new growth points at Verulam–Tongaat and Empangeni–Richards Bay. In the case of KwaZulu, the Pongola–Makatini Flats were said to have great potential; they were watered from the Pongolapoort Dam.

1106. Van Robbroeck (*c.* 2016a).

1107. Anonymous (n.d.d).

1108. SAWHAR WLC W11 (1976:4–5).

By the end of the 1970s, in addition to Umgeni, there were a number of water boards in South Africa:

1. Pelladrift
2. Phalaborwa
3. Rand Water Board
4. Vaalkop (Magalies) Water Board.[1109]

There were also plans in the Department of Water Affairs' Natal Circle to establish a water board at Mhlatuze, which would serve the area around Richards Bay and Empangeni.[1110]

The circle system of governance

The circle system, a pragmatic form of regional governance exercised by the Department of Water Affairs since 1912, began to change in the 1970s. This was the direct result of the department's shift to centralisation in many of its management and planning activities. The circles were not summarily scrapped. Instead, the department, through its circle officials, maintained a strong presence in specific regions and catchments of the country. Historically, these institutions were slow to change. They tended to become more focused on specialised services required by the regions and communities served. Circle offices had a wealth of local knowledge. However, in the 1950s, Justice C.G. Hall pointed to one of the major shortcomings of the circle system – an absence of sufficient administrative human resources and an often over-reliance on a single circle engineer with a narrow focus.[1111] He was clearly a proponent of a more deterministically structured governance system to give substance to the emergent industrial–energy hydraulic mission.

As location-specific institutions, the department's circles were in a position to provide head office with valuable information on matters such as the management and reorganisation of irrigation boards and districts;[1112] the local status of the water resources;[1113] oversight of governmental water schemes and the management of departmental dams;[1114] water allocations from new storage facilities to water boards;[1115] extended services, when transboundary agreements on water use between South Africa and Swaziland came into effect (especially

1109. SAWHAR WLC W11 (1976:15).

1110. RP49/1980 (1980:157).

1111. Water Law Commission (1952:29).

1112. RP48/1973 (1973:97, 105); RP49/1980 (1980:138).

1113. RP61/1974 (1974:102); RP62/1975 (1975:118).

1114. RP48/1973 (1973:107).

1115. RP62/1975 (1975:111–112).

in the eastern Transvaal);[1116] how local infrastructure and user communities coped with drought and flood disasters, as well as the support provided by the circle officials;[1117] and how the circle officials could be of greater service to stakeholder communities. In addition, circle officials played an important role in local dam construction projects funded by the department.[1118] With the benefit of hindsight it becomes evident that the role of the circles, as they evolved since the start of the century, can hardly be overestimated. The question to be answered is: why then did the department decide the shelve these institutions?

An interpretation of the information provided in the department's annual reports for the 1970s, suggests that the circles serviced the water-related needs of local and regional communities with commendable commitment. Coloured communities in various parts of the country were prime beneficiaries.[1119] Other government departments also had access to the specialised services of circle officials, such as active participation in:

- experimental projects
- activities at research stations of the Department of Agriculture[1120]
- agricultural education institutions[1121]
- activities of local farmers' associations and societies[1122]
- irrigation gardening projects at prisons[1123]
- dam construction projects for the Department of Coloured Affairs.[1124]

Circle officials played a commendable role in what is today categorised as disaster management operations. The best examples were when the Orange River caused flooding at Upington and at other irrigation farming locations in the Lower Orange River catchment in 1971 to 1973. In addition they dealt with technical problems related to hydropower turbines at the Gariep and Vanderkloof dams in the Upper Orange River in 1977 to 1978, and gave active support to the departmental head office division responsible for the Vaal River system with the management of water allocations[1125] and the incorporation of the Bloemhof Dam

1116. RP61/1974 (1974:103–104).

1117. RP48/1973 (1973:142–143); RP67/1977 (1977:109); RP49/1980 (1980:117).

1118. RP65/1977 (1977:114).

1119. RP48/1973 (1973:105); RP62/1975 (1975:102).

1120. RP48/1973 (1973:106); RP67/1977 (1977:107, 109).

1121. RP67/1977 (1977:109).

1122. RP30/1979 (1979:136).

1123. RP62/1975 (1975:102).

1124. RP48/1973 (1973:105).

1125. RP61/1974 (1974:101).

into the system.[1126] The circle officials once again rendered valuable service in the 1974 to 1975 floods – a one in a hundred year flood in the Upper Vaal.[1127]

In the circles of Natal and the Eastern Cape there was a notable early interest in matters related to water and environmental issues. Since the 1960s, the Natal Circle's officials had showed keen interest in an environmental approach towards the conservation and management of the water resources under the department's jurisdiction. In many projects they collaborated with the University of Natal, the provincial nature conservation authorities, and civil society organisations. These institutional ties made for sound environmental principles that informed the circle's water resource governance strategies.

From 1971 to 1972 the Natal Circle was responsible for the establishment of a Mountain Catchment Committee. Stakeholders in the project were the Department of Water Affairs and the Department of Forestry and Agricultural Technical Services. This measure made it possible for the forestry department to convert various catchment control areas into mountain catchment areas under the forestry department.[1128]

The Department of Water Affairs was interested in pursuing an environmental approach in the field of dam construction. In 1975, when planning the construction of dams on the Umfolozi River in northern Zululand, it engaged with the Natal Parks' Board, a major role player on the Umfolozi and one that was keenly aware of the role that any dam developments could play in the ecosystem they were caring for in the nature reserve. R.N. Porter, a parks' board official, participated in the department's dealings with the board on the planning for dams on the Umfolozi.[1129]

In January 1976, the Minister of Water Affairs appointed a 10-member committee to look into the ecological aspects involved in the construction of a dam in the Umfolozi River. In August there was a workshop attended by stakeholders with an interest in the proposed dam construction. Interested groups that attended included the University of Natal, Natal Museums, Natal Town and Regional Planning, as well as the South African Association for Marine Biological Research and the KwaZulu Department of Agriculture and Forestry. Under the guidance of Porter they developed a matrix approach for

1126. RP48/1973 (1973:94).

1127. RP65/1977 (1977:111).

1128. RP48/1973 (1973:108).

1129. Other articles by R.N. Porter on the theme included R.N. Porter, 1975, Preliminary notes relevant to the environmental impact of dams constructed in the Umfolozi River catchment. In Mimeo, Natal Parks Board files pp. 7; R.N. Porter, Preliminary notes relevant to the environmental impact of dams constructed in the Umfolozi River catchment Mimeo, National Parks Board Files, 1977, pp. 10; Porter, R.N., a description of the natural resources of the Umfolozi Game Reserve, Mimeo Natal Parks Board files, 1977, pp. 19. Porter, R.N., Damming the Umfolozi: Environmental impact assessment, South African Journal of Science, 73(112): 323.

an environmental impact assessment of the dam project. From the workshop, 30 different engineering actions and 36 environmental concern variables were extracted, making for 1080 interactions. Porter pointed out the need to be very careful in taking decisions on how and where the dam(s) would be built. He singled out the examples of Mana Pools, a wetland area of Zimbabwe, which lost its character and became a depleted landscape after the construction of the Kariba Dam. He went on to show that dam construction, like the Aswan High Dam in Egypt, had created a major threat from forms of bilharzia that proliferated in the dam after its construction.[1130] The positive outcome for the Natal Circle's officials was that key water sector managers in the national department were privy to the most recent ideas about water and its interaction with the environment. Environmental science rose in the estimation of the department's management. It was the circle officials that kept head office well informed on issues of substantial importance to the environment.

Dam developments on the Pongola River attracted considerable environmental attention in the 1970s, largely as a result of the exceptional biodiversity and vast wetland region the river fed on. In 1973, Roger Phélines, the resident engineer of the Jozini Dam, was the lead author of an ICOLD conference paper on the consequences of damming the Pongola River.[1131] Researchers of the University of Natal were also active on river catchments and their ecological systems. In 1978, three zoologists explained the negative impact the construction of what was then the J.G. Strijdom Dam on the Pongola River might have on the fish life in the river.[1132] The department's water resource storage planners had considerable food for thought.

By 1978, departmental officials of the Eastern Cape circle were actively engaged in interdepartmental committees. They served as representatives in discussions with the Department of Forestry, attending to agricultural technical services on mountain catchment grazing and drift sand control. They were also involved in the mountain catchment of the Elliot area and worked on grazing control in the Cathcart, Stockenström and Victoria East division. Furthermore, they participated in deliberations and activities on drift sand reclamation in the coastal area of the Port Elizabeth and Humansdorp division.[1133]

The 1970s advent of comprehensive water transfer systems jeopardised the clear lines of distinction between water catchment areas and the activities of the circles. As a result of engineering and related technological interventions, circle offices and their functions became a subsidiary of water transfer schemes responsible for providing water artificially to areas where the demand for

1130. SAWHAR WLC W678 (1978:15–16).

1131. Phélines, Coke and Nicol (1973:173–189).

1132. SAWHAR WLC W679 (1978:140–142).

1133. RP30/1979 (1979:134–135).

supplies was at a premium. The planning division of the department, to all intents and purposes, gradually replaced the operations of the circles. The move was largely because of technological developments in the water sector, the result of information and telecommunications systems – primarily computer-aided data generation and processing. Technology, it appears, changed the nature of work done on the ground by officials of the Department of Water Affairs, as well as the government's homelands development programme.

Dealings with the homelands and the 1966 Helsinki rules

In the 1960s, regardless of the rejection by Britain and the governments of Bechuanaland, Basutoland and Swaziland to the suggestion that they be incorporated into South Africa, the South African government persisted with its focus on developing the so-called Bantustans (homelands) into 'sovereign independent' African states. In the government's political planning jargon, independent Botswana, Lesotho and Swaziland remained part of a future dispensation in which they would 'blend in' with the homeland system for a more comprehensive southern African constellation of states.[1134] In 1973, an interdepartmental committee was appointed to compile a report on how a select group of states in southern Africa could collaborate on the use and protection of their commonly shared water resources for current and future requirements.[1135]

The committee's main aim was future planning for water resources from neighbouring states. Swaziland came in as an early partner, as a result of the development of the eastern Transvaal water transfer systems for generating electricity. The Komati/Inkomati River, as discussed earlier, was a prime river shared by South Africa and Swaziland. In the longer term, engineers had already worked out plans for using Lesotho's water supplies, but relations between South Africa and Lesotho had not yet been normalised. That would follow in the 1980s. In the interim the South African government, on the advice of its committee, put to the test the implementation of the 1966 Helsinki rules – a set of international rules for dealing with transboundary water sharing strategies. Following extensive deliberations, the committee's report was submitted to the government at the end of 1978 and was shared with all stakeholders in 1979. The committee recommended a flexible approach to planning water use. All states had to be privy to the way available water resources were being used and how these would be used in future. There had

1134. Bowman (1968:231–260); Snellen (1967:305).

1135. RP109/1979 (1979:1).

to be a thorough assessment of the water requirements of each of the partner states, as well as a collective estimate.[1136]

Specific recommendations were made for irrigation in the developing states, and for water to be shared in terms of an average consumption of 1000 m^3/c/a in all the partner states. The plan acknowledged the principle of beneficial use of water, and a reserve of water that could be used in future. Water scarcity in the subcontinental region was underlined, as was the need for a reasonable access to surface water supplies in the river catchment areas. Attention had to be given to groundwater and the way it would be shared between states. There was also an understanding that plans for the future use of water would be shared between the member states participating in the system.[1137]

In 1979 the secretary for water affairs reported that there had been ongoing talks with Swaziland on common water resources. There were also deliberations with Lesotho on the supply of water from the Highlands Water Project. By the end of 1979, a joint technical committee had almost completed a report on the potential alternatives for the development scheme. In the case of the Transkei, a proposed hydropower project had reached the stage where it was necessary to consider, in collaboration with the homeland government, the matter of relocating people so that the development of the dam basins for the construction of the hydropower scheme could go ahead. South Africa and the governments of Transkei and Bophuthatswana also established permanent water commissions that met from time to time to discuss water supply problems, find solutions and make recommendations to their respective water authorities.[1138]

Structures of investigation

It is difficult to draw a distinction between research-oriented functions and other investigations conducted in the Department of Water Affairs in the 1970s. Working from information in the department's annual reports for the period, it appears that some divisions had instructions to conduct investigations at grassroots level and report back to management at the head office.[1139]

Although the committee's planning had a strong ideological inclination towards developing a holistic philosophy for interstate water resource relations between South Africa and the independent homelands, it was at the same time, a useful tool for deciding how the government would deal with non-homeland governments to secure its future water supplies. The 1975 NPDP,

1136. RP109/1979 (1979:7–8).

1137. RP109/1979 (1979:9, 16–18).

1138. RP49/1980 (1980:2).

1139. RP109/1979 (1979:19–21).

discussed above, should also be considered against the backdrop of South Africa's plans to introduce the Helsinki rules.

Planning division and the survey section

By 1979 the planning division of the department was responsible for comprehensive investigations relative to the country as a whole. The Pretoria head office planners relied on a team of survey officials in its offices in Pretoria, Worcester, Orania, Ermelo, Pietermaritzburg, Upington, Cradock and Kroonstad. Officials working from these offices were responsible locally for carrying out work concerning contours:

- construction
- flooding
- dam deflection
- purchase and servitude surveys
- aerial survey checks
- general surveys.

In many respects the officials were an extension of planning at the head office – their 'eyes and ears'. They had substantial local knowledge and were familiar with conditions. Much of the department's planning, based on data collection, was the responsibility of these officials. The results of their investigations were fed directly into the data and planning outcomes that were consolidated in Pretoria. At the head office there were four stereo plotters and a drawing office for the production and fair drawing of plans.[1140]

In the 1960s the department started making use of a rich supply of aerial surveys. They were effective and provided accurate information from which planners could work. By 1978 the photographs were provided by the director-general of surveys, the Department of Transport and private firms working under contract. The department had limited photogrammetric capability at the Pretoria head office, so it usually contracted out the work that needed to be done. In 1977 management introduced an incentive scheme to speed up the mapping process. By 1978 there was an 81% improvement in this regard. The ability to meet deadlines for producing the maps on time was the result of field checks and contracting some surveys to the ground survey section. Apart from surveys and mapping work, the survey officials were active in sediment surveys in dam basins and highly accurate measuring of dam deflections, a process carefully managed from Pretoria. In 1978 there were 23 planning investigations that included water source analyses, systems analyses, the provision design of alternatives, the systematic estimation of costs, economic

1140. RP30/1979 (1979:50).

comparisons and feasibility studies in a variety of catchment areas and towns, or for very specific projects.[1141]

The planning section was also responsible for foundation investigations where engineering geology was required to determine the suitability of foundations for the construction of storage dams, diversion weirs and tunnels. These investigations were usually conducted in close collaboration with the Geological Survey division and the Department of Mines. The department's planning division had the capacity to serve as a communications platform with the public. It was responsible for the White Papers and supplementary documentation that informed parliament on the proposed work to be done by the department. In addition, the staff wrote memoranda or draft letters to the office of the Minister of Water Affairs. They also responded to public enquiries and prepared speeches and lectures to be used by the minister and the secretary for water affairs.[1142]

Officials of the division served in SANCOLD and by 1978 had represented the department on 59 interdepartmental and other committees. The planning division was also responsible for the establishment of new water boards. For example, they were instrumental in providing support in the planning of the Umhlatuzi Water Board. They were active in the interdepartmental committee responsible for the division of water resources between South Africa and the various 'black states'. In the 1970s there are frequent references of work done in respect of the homelands and how time-absorbing many of these activities were. Another important function of the planning division was to make assessments on whether permits for the planting of forests could be allowed in some catchments. Officials served on an interdepartmental committee that made recommendations on the issuing of permits. They worked from estimates prepared to determine the run-off reduction that would coincide with afforestation.[1143] The report of the interdepartmental committee on the division of water between South Africa and the 'homelands', under the chairpersonship of Dr J.P. Kriel, took up much of the department's management time. However, the report was completed in 1979, and submitted to the office of the Minister of Water Affairs.[1144]

1141. RP30/1979 (1979:50–56).

1142. RP30/1979 (1979:56–60).

1143. RP30/1979 (1979:60).

1144. RP49/1980 (1980:2).

Division of special tasks

A division of special tasks was created in 1976 to make sure that these important tasks were in good hands. Dr C.P.R. (Paul) Roberts was appointed as chief engineer (special tasks). Roberts, the son of an engineer, was born in Basutoland (Lesotho) and went to school in the Cape before studying civil engineering at the University of Pretoria. He joined the Department of Water Affairs after completing his studies with distinction in 1960. As a young engineer he worked on the Craigie Burn Dam and was responsible for the survey of eastern Transvaal dam sites (Jericho, Westoe and Welgemoed) for Escom,[1145] before being granted leave to complete his PhD studies at the Massachusetts Institute of Technology (MIT) in 1967.

The division was not intended to become large. Its main function was to see that special investigations were carried out efficiently. Roberts distinguished himself as a diligent engineer with innovative ideas. Early in the 1970s he cottoned on to environmental engineering. His primary influence was exposure to engineering research in the US, where some of the early ideas of environmental engineering had been doing the rounds when he was a student. His interest was later sparked when, at the Water Year 1970 conference, he listened to a paper on environmental aspects of civil engineering in the water sector presented by Floyd Dominy of the US Bureau of Reclamation. Dominy alerted engineers to the fact that, 'Ecological balance – environmental change – will necessarily receive ever greater consideration in the planning, construction and operation of water projects.'[1146]

One of the special tasks the division undertook was a detailed reassessment of the existing and future projected water needs for South Africa over the next 25 years. The group of investigators had to make amendments to the report of the 1970 commission into water matters, specifically on the future water use for South Africa. By 1978 the special tasks division was working on four main themes. These included the present and projected use of water in South Africa, specialised hydraulic and river mechanics studies, environmental studies, and miscellaneous tasks. Meanwhile the scope of these special tasks had increased to the extent that they included looking into the phenomenon of urban water use, and an investigation into Vaal River abstractions. In the field of specialised hydraulics and river mechanics, the special tasks division studied the Orange River at Agtereiland to determine what work needed to be done in the aftermath of serious floods. They also investigated the effects of sudden turbine releases at the P.K. Le Roux (Vanderkloof) Dam for generating power.[1147]

1145. Roberts pers. comm., 17 January 2017; PRC/Report(a) (1962).

1146. Dominy (1970:1–7).

1147. RP30/1979 (1979:82).

The chief engineer remained abreast of new developments and on one occasion attended a river mechanics course at the University of Colorado, Fort Collins, in the US. The division participated internationally by filling in questionnaires (sent by other countries) on the hydraulics of dams, and provided information on SANCOLD. In the field of environmental studies the division studied the Drakensberg pumped storage facility and coordinated the activities of landscape architects working on improving the site.[1148] In addition, officials investigated the flooding of wetlands on the Vet River, in the upper reaches of the Bloemhof Dam. There were reports that the local ecology had been changing and the division conducted its investigation in collaboration with the Department of Agricultural Technical Services.

The division of special tasks took the responsibility for compiling brochures on the South African dams. In the process, a set of 35 brochures were prepared in English and French for the executive meeting of the ICOLD held in Cape Town in October 1978. The division also took responsibility for the eastern Transvaal's water planning, after the retirement of the departmental adviser on water affairs in the area. They made significant progress with the water balance and drafting of a report by the end of the financial year 1977–1978. In 1979 members of the task team concentrated on the analysis of urban water use of towns with a total population greater than 5000. They completed 34 comprehensive reports, which accounted for a total water consumption of 54 MCM. The total estimated water consumption in the urban areas, industries and the mining sector was 2025 MCM and this accounted for 42% of the country's water.[1149] The group investigated a number of *ad hoc* analyses of water consumption records for different towns on behalf of other divisions in the department. Furthermore, they worked closely with the water pollution control division on building a database on industrial and urban water usage and quality.

Specialised studies in the fields of hydraulic and river mechanics included:

- the capacity of the Driel to Jagersrust canal and certain remedial measures to minimise sediment deposits in the system
- developing a strategy to use certain parts of the Mfolozi swamps for sugar cane production
- a state-of-the-art report on the hydraulic aspects of river diversion for the SANCOLD.

The group completed 13 detailed case studies for ICOLD on the topic and prepared lecture material for a hydrology course.[1150] In terms of environmental studies, by 1979, members of the special tasks division had investigated

1148. Roberts pers. comm., 17 January 2017.

1149. RP49/1980 (1980:87).

1150. RP49/1980 (1980:87–88).

environmental considerations in the planning stages of projects and the subsequent implementation of remedial actions and landscaping work. They worked from an environmental assessment matrix of ICOLD and focused on the Kilburn Dam.[1151]

The team looked at irrigation systems for dams where there were permanent irrigation installations at earthen dams, and assessed the value of grassed faces downstream of these resources. Other environmental assessments included:

- work on rivers, such as the Palmiet, Kromme and Mvoti
- the issue of drift sand in the Breede River Government Water Scheme, as well as the Riviersonderend–Berg river project
- a floodplain study of the Vet River
- landscaping and reclamation on the site of the Drakensberg pumped storage project.[1152]

In 1978, W.J.R. Alexander, one of the senior research engineers in the Department of Water Affairs, focused on the Vaal Dam as one of his many forays into long range projections of droughts, floods and climate issues in southern Africa. His focus on the Vaal Dam was in a drought period when water supplies in South Africa's water storage dams dropped to low levels, similar to those experienced in the 1960s. The only difference was that in the 1970s the drought cycle was not of such long duration. The report is also notable for the fact that it forms part of Alexander's early writings on the potential impact of sun spots on surface water flows on the subcontinent.[1153] It formed part of his early explorations on the phenomenon of climate change.

Research structures in a learning institution

The 1970s marked the onset of a dedicated departmental focus on research. The Water Research Commission (WRC) and the Hydrological Research Institute (HRI) were the lighthouses of dedicated research activities within the department. Non-departmental research institutions, such as universities and the CSIR's NIWR remained important partners. However, the work done inside the department, sometimes in collaboration with consultants and outside institutions, proved to be of substantial value to the department. Apart from being an active governance institution, there were indications of a learning organisation. Given the fact that the department was cutting its teeth in the field of using computing in many divisions, it is evident that the intellectual space officials and researchers occupied was one of comprehensive learning.

1151. TOA/20170117/Interview (a) Paul Roberts.

1152. RP49/1980 (1980:88–89).

1153. Department of Water Affairs and Forestry (1978).

The Water Research Commission

The WRC was established in 1971, as a direct result of a recommendation by the Commission of Enquiry into Water Matters (1966–1969). When the report reached parliament, the responsible minister, S.P. Botha, stressed the need for generating knowledge to address the needs of the country. He emphasised that a statutory organisation should take responsibility for this important task. Subsequently, the *Water Research Act,* 34 of 1971, was approved by parliament on 01 September 1971.

The first secretary of the WRC was the secretary of water affairs, J.P. Kriel, and the *ex officio* chairperson was Dr G.J. Stander, the leader of the NIWR at the CSIR, who soon became the WRC's CEO.[1154] From the outset the objective was to establish a system of coordinating research and development. This implied that all relevant institutions had to be involved so that there could be mutual consultation, exchange of views and vibrant debate.[1155]

In its second year of operations, the WRC reported on an investigation in progress to develop a National Water Information Centre where new water knowledge was showcased and ideas could be disseminated. This proposal was suggested in the report of the 1966 water commission enquiry. In 1973, the management of the WRC had in mind a centre that would be open to interested parties who wanted to gain access to the latest international information on water.[1156] The next year, the CSIR library in Pretoria started with what was to become known as the Waterlit Collection, one of the most comprehensive collections of scientific water literature in the world. Between 1974 and 1997 the project was sponsored by the WRC.[1157]

In a 1976 article, Stander, the CEO of the WRC, explained that of the 35 projects under investigation by the WRC's contracted researchers, most had a direct application for local authorities. Within the space of a few years the WRC became a highly effective instrument in helping the Department of Water Affairs to find solutions to water problems. Individuals were taken from various sectors and given an opportunity to have an open discussion on exploring common problems. The WRC then followed up on whatever recommendations were made. If need be, the WRC consulted overseas experts. WRC members also created new subdivisions in existing research projects, or even went so far as to start up new research programmes. The WRC, Stander stressed, was an independent organisation that did not do research itself, but worked in the direction of coordinating research at grassroots level. Typically it began with a small steering committee and from there

1154. Water Wheel (2011:7).

1155. OBF1536 (1982:4).

1156. WRC (1974:9–10).

1157. Tempelhoff and Stopforth (2014).

sought expertise across a broad spectrum of water experts. In the years to come the WRC played an increasingly important role in advanced South African water research work. The knowledge base was seated at South Africa's premier research institutes, such as the CSIR, and at universities in various parts of the country.[1158]

Hydrological Research Institute

The Department of Water Affairs maintained, and even expanded, its own internal research sector. In 1970 it created the post of Chief of Scientific Services, and work began on the construction of a building complex for the HRI overlooking Roodeplaat Dam on the Pienaars River on the northern outskirts of Pretoria.[1159] The building project was completed in 1971 and the institute was formally opened on 20 October 1972.[1160] One of the reasons for its establishment at this specific location was the unique sub-humid conditions there, and the fact that three rivers flowed into the Roodeplaat Dam. Local conditions made it hydrologically feasible to study both standing and moving water.[1161] Many years later, explaining why the Department of Water Affairs started the HRI, its first director and agrohydrologist,[1162] Dr J.S. Whitmore, explained:

> [*It is*] because South Africa' s water supplies are at best undependable, and at worst grossly inadequate, that they are infinitely more precious than our much vaunted gold – for they are vital not only to all sectors of our economy but to our very survival and that of every plant and creature. Small wonder therefore that South Africa has a long and creditable history of water research and development.[1163]

Initially, seven sections covered the scope of the institute's research. These included hydrometeorology, surface water hydrology, groundwater hydrology, water quality, catchment management, hydrological techniques and multidisciplinary research. The first research projects identified by the HRI team dealt with:

- precipitation
- interception
- evaporation
- run-off
- the hydrological aspects of salination and soil[1164]
- groundwater studies.

1158. W673 SAWHAR WLC (1976:21).

1159. Hobbs and Phélines (1987:45).

1160. Hydrological Research Institute (1972).

1161. RP48/1973 (1973:17).

1162. Department of Water Affairs and Forestry (1961).

1163. Whitmore (n.d.).

1164. Water Research Commission (1974:16).

In the field of precipitation, the HRI's researchers collaborated with the weather bureau and a private project 'Project Waterhael' – a combined rainfall stimulation and hail prevention project that operated in Bethlehem in the OFS. Researchers marked a set of gauging stations built on the periphery of the seeded area. They monitored and developed a system to register very low concentrations of silver iodide, in an effort to determine how large the area was that was affected by the seeding process. The researchers were of the opinion that they would be able to determine the material benefit of augmenting rainfall, and even introduce certain precautionary measures to modify the weather to the extent that it would not aggravate natural hazards.[1165]

The Department of Water Affairs' primary interest was to determine what impact precipitation had on streamflow and groundwater recharge. By 1972 they were working on mathematical and statistical physical methods of evaluation in the field.[1166] In the eastern Transvaal, at Mariepskop, they erected two large screens to investigate the feasibility of extracting water from the mist and low cloud (water harvesting) on the mountain that was frequently shrouded in mist.[1167] In August 1972, HRI researchers staged a presentation at a World Meteorological Organisation conference on precipitation in mountainous areas. Their experiments on 28m×2.6m screens proved that the water intercepted could outperform rainfall quantities several times over.

The researchers experimented on evaporation reduction on a small scale by using chemicals. In some cases it was possible to secure water savings of as much as 50% of evaporation. One of the most effective chemicals used had to be imported. It was extremely expensive and too costly for local use. The research determined that the most effective evaporation retardants were long chain fatty alcohols, specifically cetyl and stearyl. These tended to form a thick layer on the water surface.[1168] The jury was out on the viability of this type of treatment on a large scale. Another strategy to reduce evaporation was by increasing the reflection of incident radiation off the water's surface.[1169] The research of the day was aimed at future water storage and planning. At the time of conducting the research it was estimated that by the end of the 20th century, water storage facilities in South Africa would span a surface area of 725 000 ha. Therefore it made sense to investigate potential anthropogenic evaporation management strategies.[1170]

1165. RP48/1973 (1973:18–20).

1166. RP61/1974 (1974:24).

1167. RP48/1973 (1973:18); De Villiers (1973:1).

1168. RP48/1973 (1973:18–19); SAWHAR WLC PAM2333 (1971:1–38).

1169. Department of Water Affairs and Forestry (1977).

1170. RP48/1973 (1973:19).

At the HRI, since its inception, computer technology had played an important role. By 1973 there were monthly modelling reports on the operation of a dam under various operational conditions. As a result of the good rains that had been falling since the severe drought of earlier years, dams started filling up in many parts of the country and researchers found they had access to more potential sites for doing limnological surveys in large dams and lakes.[1171]

There was a clear-cut difference between dams which stratified each summer, and those that did not. Individual dams tended to adhere to a very specific behavioural pattern. The stratification phenomenon had an effect not only on the water quality and temperature, but also on the distribution of silt and pollutants and the propagation of density currents.[1172]

A preliminary research project of the HRI investigated the basic causes of salination on the Pongola Government Water Scheme. Researchers started working on a more detailed water balance study in two experimental catchments, where they measured groundwater run-off and water quality. In an effort to ensure that timely measures were introduced to prevent unnecessary salination or waterlogging in the J.G. Strijdom Dam, once the area had been cleared of bush, the preliminary survey included an examination of the stratigraphy of the underlying strata. Researchers used penetrometer probing, pump tests, physical and mechanical analyses of material recovered from boreholes, and chemical analyses of groundwater until 1975.[1173]

In their groundwater studies, the HRI's researchers used various isotope techniques to good advantage. Their analysis of the stable isotope Carbon-14 studies, mentioned by J.C. Vogel in a 1970 conference paper,[1174] enabled them to gauge the age of the water, its movement and origin. Many experiments followed when the Orange–Fish Tunnel was drilled. In addition, the HRI team collected profiles of other samples of the stable isotope, tritium, at six points in the Bo-Molopo, as a guideline to determine the recharge of the local dolomite.[1175]

On the Nyl River in the Northern Transvaal, the researchers continued their research on the water storage potential of the decomposed basalt underlying the impervious superficial deposits in the river. When in flood, the river spread across a vast area to form a gigantic lake and wetland. The researchers worked on strategies to drill boreholes in an effort to store water below the surface to recharge the underlying alluvium artificially, to maintain the groundwater yield when abstraction increased. Soon after its establishment the WRC began a

1171. Department of Water Affairs and Forestry (1973); Buckley (1980:20).

1172. RP48/1973 (1973:19).

1173. RP61/1974 (1974:26–27); Department of Water Affairs and Forestry (1975).

1174. SAWHAR WLC PAM1265g4 (1970:1–5).

1175. RP48/1973 (1973:19–20).

comprehensive investigation into formulating a more consolidated strategy to conduct groundwater research.[1176] It became a significant role player in the bigger research plan. By 1975, the government's subterranean water control areas were under the supervision of the division of hydrology of the Department of Water Affairs. The main systems were:

- Kroondal-Marikana (dolomite 535 km^2)
- Bo-Molopo (dolomite 3745 km^2)
- Uitenhage (artesian 1146 km^2)
- Nyl River Valley (alluvium 829 km^2)
- Baden-Baden (spring 4.7 km^2) in the Montague district
- Mogol River (river bed 141 km^2).[1177]

In 1976, the geohydrological functions of South Africa's Geological Survey were transferred to the Department of Water Affairs.[1178] Technical assistants in the Geological Survey's water catchment areas provided valuable support in the collection of data. They observed water levels from boreholes and the flow of stations. Samples were collected weekly. Then followed a trend of private observers replacing departmental officials. At the same time the WRC was responsible for funding investigations into groundwater in all parts of the country.[1179]

In terms of water quality, in 1972, HRI researchers gained valuable experience in the use of automatic equipment for the analysis of water, and used many intricate measuring techniques. They secured an electronic chart scanner to translate data from a recorder that relied on a punch-card computer process,[1180] and also honed their multidisciplinary skills by working on the water economy of plants. When modern irrigation systems began to proliferate rapidly, the research focused on how these systems could function optimally to provide water for crops.[1181]

By 1975, the nature of reporting in the department had adjusted to storing digital data on computer and publishing in hard copy. The HRI started consolidating river flow data from October 1960 to September 1970. Data for the period from October 1970 was to be published in hard copy.[1182] By 1977, the WRC was giving its full support to an electronic strategy to store the chemical data collected for the visualisation of groundwater resources. The use of

1176. Water Research Commission (1977:17–22, 39).

1177. RP48/1973 (1973:28).

1178. SAWHAR EBC/SA Groundwater (1998:1).

1179. Olivier (1976:135).

1180. RP48/1973 (1973:20).

1181. RP65/1977 (1977:26).

1182. RP48/1973 (1973:29).

computer technology became pervasive in drawing diagrams, tables and graphic illustrations.[1183] Collected data that appeared in print were sometimes first used in reports before being published.[1184]

In 1976, it was reported that within less than four years of its establishment, the HRI's premises had become too small to accommodate all its staff.[1185] The HRI had meanwhile become an independent division of the Department of Water Affairs, and had built up a sound reputation for high quality research.[1186] Processing large amounts of data remained problematic and so the HRI began using minicomputer facilities for a number of data checks and operations, as well as modelling. At the same time the CSIR researchers at the NIWR were working on effluents and wastewater, and were developing mathematical models of the hydrology of mineralisation in two river catchments in South Africa.[1187] These models were considered to be a synthesis of catchment systems subject to what would today be described as anthropogenic interventions. This project began in 1974 and started producing significant findings by 1976.[1188] Within the next decade international recognition followed.[1189]

The HRI produced a prolific amount of research in the decade of the 1970s. A comprehensive list of technical reports and research notes appear on the Department of Water and Sanitation's web archive. Regrettably, the digital list is incomplete, and some reports are not available on the website.[1190]

The restructuring of the hydrological branch of the Department of Water Affairs had the effect of refocusing the activities of the HRI. By 1978 its primary objectives were:

- to gain the necessary expertise to control the country's water resources better
- to establish a water quality bank and surveillance programme to provide early warnings of the presence of harmful materials in water by focusing on the deterioration of water quality
- to render a service to other sections within the department to solve any problems that might arise.

In respect of the latter focus, the HRI made a valuable contribution towards strategies for effective water purification at the Ebenezer, Doorndraai,

1183. Water Research Commission (1978:31).

1184. SAWHAR WLC PAM7779 (1974); SAWHAR WLC PAM7781 (1975).

1185. RP67/1977 (1977:25).

1186. SA Water Bulletin (1979:12–21).

1187. The Theewaterskloof Dam–Berg River system in the south-western Cape and the Orange–Fish–Sundays River in the Eastern Cape.

1188. SAWHAR WLC W252 (1976:13–19).

1189. SAWHAR ZKC (1986: Section 7.9).

1190. Department of Water and Sanitation (n.d.a).

Donkerpoort, Roodeplaat and Welbedacht dams. The investigations conducted by the HRI researchers give an indication of the problems caused by iron and manganese, often because the abstraction points of water were in zones where iron and manganese were released as a result of bacteriological actions.[1191]

In addition, the HRI assisted the Geological Survey section of the Department of Mines in the analysis of water samples drawn for prospecting purposes. In the Eastern Cape, researchers investigated the issue of salination in local rivers. In particular they worked on the Orange–Fish–Sundays River system and helped the planning division of the department to install and calibrate metres in the rivers. As far as water pollution was concerned, the HRI's researchers did not conduct specific investigations, but provided assistance in surveillance programmes in areas where there were indications of potential groundwater pollution. The results were used in modelling, to gain experience for useful interventions elsewhere. By 1978 the work conducted at the HRI included:

- investigations into precipitation
- turn-off
- the hydrological aspects of salination of soil
- groundwater studies.[1192]

Computer technology

In many of its fields of operation the Department of Water Affairs was an exemplary learning institution. Much of the progress can be traced back directly to the staff's exposure to computer technology. The Kat River Dam near Fort Beaufort in the Eastern Cape was the first project in which the department's engineers used the computer for design calculations.[1193] There was good progress, with an increasing demand for more memory storage capacity for the department's IBM computer. Subsequently it was upgraded from 8 L to 32 L words, along with two disc drives, two tape drives and a multiplex control unit. The existing card reader and line printer were replaced with faster units. The machine was then capable of performing more comprehensive programmes, with a reduction in running time of as much as 80 hours. Still, the department's staff tended to exceed the amount of time they were allocated.[1194] By 1973 a night shift programme was started so that the computer system could deal with all the work.[1195]

To meet the needs of the design office staff, the software was upgraded to work on the department's IBM1130 and the CSIR's IBM360 computer systems.

1191. RP30/1979 (1979:39, 45).

1192. Hobbs and Phélines (1987:45).

1193. Van Vuuren (2012:181).

1194. RP48/1973 (1973:43).

1195. RP61/1974 (1974:47–48).

The updated software, secured from overseas, included Advanced Diagnostic Signal Analysis System for the analysis of arch dams; PLNST for two-dimensional plane stress; PLNPT for the stability analysis of three-dimensional blocks in rock formations; and HEAT, software to measure the effects of heat on concrete. In 1974 a computer was used for the first time for purposes other than scientific activities, when the department entered staff records and details of equipment used on construction sites.[1196] By 1976 a comprehensive personnel system with all information on officials appointed under Section 3 of the 1956 *Water Act* was stored and maintained on the B6700. The database included leave and salary information.[1197]

Interdepartmental IT communications was the next frontier. Because of the growing need for computation in a great variety of fields there was an agreement with the Department of Agricultural Technical Services to purchase a larger computer that could be used interdepartmentally, including those in SWA (Namibia).

The system stored and processed data for the department at one central location while offering retrieval facilities at various terminals in different parts of the country.[1198] The trend of linking systems was not confined to government departments. The division for hydrological research also had access to data held at the Hydrological Engineering Centre at the University of the Witwatersrand.

The Department of Water Affairs' researchers managed to get the punch cards with the coded coordinates of many flood hydrographs; these were intended for use in the development of an arid-zone rainfall run-off model. The problem was that the departmental computing system was unable to deal with the data. The streamflow generating programme could only be accessed on the Escom computer (CDC6600) in Johannesburg. In an effort to put the material to good use, the department made a point of securing more modern equipment for its existing computing system.[1199]

By the end of 1974, the data processing division of the Department of Water Affairs had expanded rapidly. Apart from the department's own IBM1130 computer working two full shifts per day, there was a link-up to a large Univas 1108 computer at a commercial bureau in Johannesburg. It served as a temporary measure and an intermediate arrangement for coupling the existing system to a powerful Burroughs B6700 computer that had been installed by the Department of Agricultural Technical Services.

1196. RP48/1973 (1973:43).

1197. RP67/1977 (1977:59).

1198. RP61/1974 (1974:48).

1199. RP62/1975 (1975:25).

The data system was set for countrywide use. At the same time tenders were out for terminals at all the circle offices and the additional installation of a high-speed self-service card reader and print terminal to enable engineers and hydrologists more rapid turnaround time for programming than was available previously. Management encouraged engineers, hydrologists and technologists of the department to make use of FORTRAN programmes, and 44 officers of the department in the period 1973 to 1974 attended training courses. In the computer section the team of computer specialists had increased to nine, and they received training in COBOL software, with a view to developing a staff control system. The computing facilities were used increasingly for administrative tasks in the department. In 1974 to 1975 the operational hydrology division of the department acquired a minicomputer for flood management research. At the same time it secured a variety of software for use on the Hewlett Packard computer to facilitate flood operations. Subsequently, the computer was used on a flow system for flood warning in the Vaal–Wilge catchment area. Minicomputers were also scheduled to be linked up with a local radio network to send data to the head office of the department in Pretoria.[1200]

By the mid-1970s there was a move to engage more members of staff in the use of the computer. The computer section serviced all divisions of the department in the commercial, scientific and telemetric use of computer systems. There was a management and advisory committee on computer services, under the chairpersonship of the managing engineer (planning). This measure was to ensure that there was coordination in the way computer services were used in the department. The computer facility of the department's staff, at the time, was a TC3500 that was later replaced by a B771 remote job entry terminal. The system was open to any official to load software on the B6700 computer and wait for results. The facility ensured that the engineer's time could be utilised in the most effective way.

There was a development project on a departmental message network, reminiscent of an early email system. It formed part of a national installation system of message switching for nationwide government use. The programmable system was loaded with switching computers in Pretoria, Bloemfontein and Cape Town. This kept the department's head office in contact with key sites. There were terminal cluster installations at P.K. le Roux Dam, the Vanderkloof canals, Vaal Gamagara, the central construction workshop, Jonkershoek tunnel system, the greater Brandvlei and Swartland. A further 11 clusters were scheduled for installation in 1976. At that time the department's B6700 had been linked to the system network and a new terminal messaging service was phased in. The eventual objective of the system was to link all government departments. Other equipment of the Department of Water

1200. RP62/1975 (1975:24, 56, 59).

Affairs included a software development to link the IBM 1130 as a remote job entry terminal to the B6700. That project was completed in 1976. In the same year the department acquired a NOVA3 computer system with digitisers and graphic display screens. The system was used by the hydrological division for the interactive digitisation of river flow charts and flood routing calculations.[1201]

By 1978, within the space of less than two decades, the computing services section of the department had gone through a remarkable evolutionary process. Two electrical engineers had joined the section, and there was a comprehensive service provided over a large spectrum of computer use activities. There were data processing projects for private and scientific purposes, as well as data communication and process control measures in place. Despite more appointments, the problem of staff shortages persisted, especially of senior officials. The secretary for water affairs stressed that the employment conditions of the programming staff were no longer realistic. One consequence was that the available computer equipment could not be used properly.[1202]

The overall coordination of work in the computing section was still done by the managerial advisory committee for computer services, under the control of the managing engineer for water resources. The computing capacity of the department was varied. The general processing facility for departmental staff was a B771 remote job entry terminal, which was used primarily by head office on the B7700 at the agricultural water affairs computer centre. The department's own IBM1130, linked to the B7700 as a remote job entry terminal for larger projects, was used in 1978 for the B771 and vice versa. There were terminal communications with the outside construction sites and circle offices. A private company was responsible for the maintenance of these systems. The department's management and staff were satisfied with the development of the message switching network that had been introduced. They had an estimated 98% availability to access on a continuous time basis. The line protocol responsible for switching exchanges changed to High-Level Data Link Control in 1977 to 1978. There were problems at first, but by the end of the financial year the system ran smoothly.

Smaller computers had already started taking over many tasks by the late 1970s. The Department of Water Affairs collaborated with the Department of Agricultural Technical Services in the evaluation of tenders for the purchase of its minicomputers. The use of computers clearly became more generic and comprehensive in the operations of the Department of Water Affairs by 1978. At the time these machines were powerful tools for:

- digitising flow records
- the partial automation of laboratory work at the HRI

1201. RP67/1977 (1977:58–59).

1202. RP30/1979 (1979:67–68).

- telemetric control systems at the Vaal Dam. In the case of the latter, it is evident that the department looked into developing a microcomputer system interface to monitor the radio network's reaction and pass correct information to a VARIAN 72 system.

Although the computing equipment had been set up, the programming still had to be developed for using the system.[1203]

By 1979, computer services extended over a broad spectrum in the department. It had diversified to the extent that staff had access to a range of microcomputers, minicomputers, data communication and data processing services for commercial and scientific purposes. The single problem was still a shortage of the necessary staff with appropriate skills. One positive development was the extensive work done to ensure optimal use of the department's computing equipment. The facilities of the department's computer included:

- a B7700 mainframe computer at the bureau of the agriculture–water affairs computer bureau where most of the important computing of the department was done
- one IBM1330 processor at head office which was also used as a remote job entry terminal to the B7700
- two B771 remote entry terminals at head office and the HRI at Roodeplaat respectively
- four direct interactive terminals to the B7700 for programme development and problem solving
- one graphic programmable terminal for structure analysis
- one minicomputer system with four digitisers, five graphic display screens and two plotters to process river flow and flood data
- a multi-programmable process control computer coupled to the department's stereo plotters to increase the production of useful aerial photogrammetry.[1204]

The message switching network development process had reached a point where the system was linked to a financial system and there was programming for a link up with an ICL2970 system at the statistics computer bureau. That system was almost complete by 1979. Some of the minicomputers in the Department of Agricultural Technical Services had also been prepared for connection to the system. There was ongoing work to link up the B7700 to the system. In respect of minicomputers, there were initially problems with their absorption into the system, but the issue was soon resolved. The machines were used for recording the outside offices' financial data. There were problems with data feed-through to the B7700. Despite some delays the computer was used for the first year's accounting of the department's financial systems in 1979. Additional computer work in the department by 1979 included the digitisation of

1203. RP30/1979 (1979).

1204. RP49/1980 (1980:70–72).

flow records. Many of the problems in the system had been sorted out, but existing digitisers were unable to stand the test of time and required constant attention. Other tasks were the partial automation of the laboratory at the HRI, and the development of the central telemetric system, of which the centrepiece was a telemetric control system for the Vaal River basin. Staff losses caused delays on further progress with the extension of new computer systems.[1205]

Conclusion

The 1970s was a memorable decade in the history of water governance in South Africa. It started with the Water Year. Although the decade was off to a good start, with sound plans on work that needed to be done on the advice of the 1966 to 1969 commission on water matters, governance in the Department of Water Affairs was influenced by the emergence of serious political and economic crises.

In the aftermath of the Soweto protests of 1976, the country's economy sagged, despite futile attempts by government to keep the system functional. The Department of Water Affairs, despite the exogenous influences of social, economic and political disruption, continued with its operations. A dedicated staff adjusted to structural changes aimed at integrating departmental operations with the introduction of the homelands system and decentralisation. The value of water boards became apparent. However, the circles system, dating back to 1912, proved its worth at the coalface of departmental operations in many of the isolated rural areas of the country. Nevertheless, in time to come the circles would be disestablished.

An outstanding feature of the 1970s is the intensity of ongoing research activities. Apart from the department's own research, the HRI, as well as the newly established WRC, added to the substance of important research work in the country's water sector. Many of the technological breakthroughs in the department were the result of increased computing capacity. There were traces of early online interdepartmental communications and engagements, but these would have to wait another decade before communications would be running smoothly.

1205. RP49/1980 (1980:71–72).

Chapter 8

Dealing with pollution and unconventional water security strategies

Introduction

In the 1960s, the realisation of South Africa's industrial–energy hydraulic mission meant that there was no sense in allowing as much as 25% of South Africa's surface water to flow into the Atlantic Ocean without being put to the best possible use.[1206] By the 1970s the hydraulic mission incorporated three distinct responsibilities:

1. dealing with pollution problems of effluents contaminating the country's river systems as a result of urbanisation, industrialisation and mining
2. developing appropriate systems to transfer water wherever the demand for the resource was at a premium
3. finding a positive response to securing more energy.

To accomplish these water-related development objectives it was necessary to scupper the natural water endowment by investigating the environmental implications and affordances of the resource in an unconventional way. In the 1970s, water governance authorities increasingly resorted to mechanical

How to cite: Tempelhoff, J.W.N., 2018, 'Dealing with pollution and unconventional water security strategies', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 293-323, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.08

1206. Midgley (1963:461).

technologies and unconventional strategies to maintain the industrial–energy hydraulic mission.

Gupta and Van der Zaag, working from Allan's assessment of IWRM and the hydraulic mission, suggest that when the demand for water exceeds the supply,[1207] the conventional hydraulic mission of dam construction starts moving in the direction of a more holistic, IWRM phase. This means that more attention is focused on environmental, social and economic considerations in the process of decision-making.[1208] True to Allan's analysis, the 21st century vision of a shift away from a conventional hydraulic mission was not on the agenda in developing countries.[1209]

However, this was not the case in 1970s South Africa. As will become evident in the discussion to follow, South Africa's strategies for procuring water supplies were far from social-ecologically resilient. Nor were they environmentally friendly. Procuring more water and transferring supplies to the places where they were needed was unconventional, to say the least. The management and senior officials in the Department of Water Affairs resorted to some extraordinary strategies to realise their objectives.

In 2005 Swatuk underlined the need for exceptionalism when he called for 'unconventional ideas' in the water sector.[1210] The 1970s was an era when such ideas were responsible for significant breakthroughs in dealing with issues of pollution (water for reuse) and inter-basin transfer systems.

The peak of wastewater expertise and the case for reclamation

In the 1970s South African scientists and engineers enjoyed international recognition for the work done in water treatment, purification and reuse.[1211] The NIWR at the CSIR had become one of the major knowledge distributors to local authorities and government departments. Its former head, Dr G.J. Stander, by now CEO of the WRC, played an active role in promoting water reclamation research.[1212]

There was substantial collaboration between local authorities and the water governance sector, and a lively exchange of ideals and views in industry

1207. Allan (2006:38–63).

1208. Gupta and Van der Zaag (2008:28).

1209. Allan (2004:135–149).

1210. Swatuk (2005:174).

1211. SA Water Bulletin (1977c:1–2).

1212. SA Water Bulletin (1979).

journals and newsletters on emerging trends in the sector.[1213] From the 1960s, wastewater treatment works developed at an exceptional rate to accommodate the sewage of the new apartheid era township of Soweto, increasing by as much as 6.5% annually. With the onset of the 1970s, Johannesburg municipality resorted to using the farm Goudkoppies to augment its effluent treatment processes.[1214] The Klip Phase 1 of the Johannesburg City Council's new Bushkoppie outfall sewer, completed in 1978, accommodated the sewage system in the entire Soweto, Roodepoort, Maraisburg and surrounding areas.[1215] Wastewater treatment works of significant size became a standard feature of all large conurbations.

Some smaller municipalities took note of the trends in wastewater treatment. Despite a downswing in the economy, there were reports of new and more efficient wastewater treatment works. For example, in 1964, Middelburg in the eastern Transvaal (Mpumalanga) boasted one of the first Huisman activated sludge wastewater treatment works, which the CSIR's NIWR had developed as a suitable model for small local authorities.[1216] The next phase in the town's wastewater treatment system started with the construction of a 9 ML/d activated sludge plant in 1976. At the time of its completion in 1987 the final cost was R987 000.[1217]

South African water sector researchers, despite relative political isolation, kept abreast of international trends. In 1977 G.G. Cillie, director of the NIWR, pointed out that as a result of ongoing socio-economic development in many parts of the world and the concomitant industrialisation process, the availability of water was bound to keep on decreasing. Growing demand meant that in many parts of the world, societies were running out of clean water. He was a strong proponent of innovative technologies to purify effluents to the standard of potable water. The threefold argument in favour of this approach was that it provided a positive answer to the demand for the prevention of pollution, particularly in the case of secondary purified sewage effluents; that it was a valuable augmentation system for producing water that conformed to the quality requirements for a wide range of uses; and, finally, that it presented reclamation as an economically attractive method of securing new sources of water.[1218]

1213. SAWHAR WLC W785 (1978:11–17).

1214. SAWHAR WLC W788 (1978:24).

1215. Public Works Construction and Transport (1978a:10–11).

1216. SAWHAR WLC PAM3290/65 (1965:53–58).

1217. SAWHAR WLC W786 (1978:25, 27).

1218. SAWHAR WLC W654 (1977:10).

Pollution control and environmental awareness

The Department of Water Affairs was firm in its resolve to control pollution, especially in the mining sector. In the early 1970s there was evidence of preliminary forays into what would later become a pronounced environmental awareness. The department, based on the advice of its top research experts, participated in strategies of resource reclamation aimed at securing resources in a country with finite access to copious water supplies.[1219] When, in the mid-1970s, the department began a restructuring process, its new division responsible for dealing with pollution focused specifically on mining, industrial and municipal pollution, with a view to finding solutions to the escalating wastewater problem.

Because of its outstanding performance in wastewater research, South Africa was an important member of the International Association on Water Pollution Research. The WRC's Dr G.J. Stander served as chairman of the association in 1975,[1220] and South African researchers were in demand overseas. In 1975 the University of Cape Town's Prof. G. van R. Marais, a specialist in water resources and public health research, was appointed as a water pollution consultant on the Pan American Health Organisation.[1221]

Meanwhile, the Department of Water Affairs kept a keen eye on what the European Economic Community and the United Kingdom were doing in terms of enforcement strategies to address pollution problems.[1222] Information and communications with overseas colleagues in the water sector made it possible for South Africa's water affairs department to keep abreast of trends and introduce appropriate local enforcement measures.

Pollution control

In its report, the Commission of Enquiry into Water Matters (1970) was critical of the Department of Water Affairs' existing measures to combat water pollution caused by the industries and mines on the Witwatersrand. Water was used with abandon as a 'cheap resource', and no one bothered to take the necessary measures. The commission warned that there had to be planning and a concerted effort to combat pollution.[1223] On 20 April 1970, the South African cabinet passed a resolution for the establishment of a subsidiary

1219. SAWHAR WLC W99 (1974:33–37).

1220. SA Water Bulletin (1976a:1, 1976c).

1221. SA Water Bulletin (1975:3).

1222. SA Water Bulletin (1976b:4).

1223. RP34/1970 (1970:111–119).

committee under the planning advisory council of the prime minister, to investigate the issue of pollution. The committee's membership totalled 20 people, representative of all bodies and disciplines that had expertise in the field of environmental pollution.

The committee had a comprehensive brief, with leverage to consult with a range of experts. It had to identify and define the state of pollution in South Africa and how it could be stopped, or, at the very least, curtailed. The committee had to advise on the existing legislation and whether it could be applied to address the pollution problem. Failing this, the committee was asked to make recommendations on amendments or report on the need for new legislation. Government wanted to know what had to be done and how much it would cost to address pollution. The committee was also tasked with making suggestions on research, and sharing its views on what other countries were doing to deal with pollution. Furthermore it had to compile a report for submission to the planning and advisory council of the prime minister. Any technical issues encountered were to be the responsibility of the CSIR.[1224]

The committee's original report was not accepted outright. It was adjudged to contain too much information that was widely known. A crisper version soon appeared that had been edited by the prime minister's planning advisory council. According to the council, the new document summarised the essential details. It singled out the prime water polluters as the mines, industries, sewerage systems and the agricultural sector. Pollution in the aquatic realm involved mineralisation, undesirable suspensions, turbidity, foam and silt, pit-water and refuse, as well as biological pollutants such as pathogens, viruses and bacteria.[1225]

The South African government was not keen to embark on an all-out modern environmental awareness strategy to nip pollution in the bud. Instead, pollution was explored as a highly specialised field; it called for the government departments to perform their responsibilities effectively. The reason for this approach was that in the early 1970s the state had started shifting towards a higher security mode. Government did not want civil society to contest controversial industrial activities that could potentially be harmful to the economy. The private sector, in turn, actively supported government's initiatives of a conservative environmental agenda.[1226] Certain sectors of industry, notably in the fields of mining, agriculture, and energy, enjoyed high security.

1224. SAWHAR WLC PAM3813/72 (1972:1–2).

1225. SAWHAR WLC PAM3813/72 (1972:7).

1226. See, for example, Robertson (1970).

In some – indeed, in many – international quarters the country was not very welcome. The UN was one. In June 1972 a delegation of the Department of Planning attended the UN Conference on the Human Environment. Although the South African delegation only had observer status, because of its tenuous international standing, the leaders of the delegation expressed their support for opposing the proposed international ban on whaling – because it was considered to be harmful to South Africa's industries.[1227] The delegation did not appear to have a great interest in matters related to water and the environment.

In some circles of the country's water sector, such as wastewater researchers and staff at the Rand Water Board, there was a keen awareness of environmental matters. The utility made a point of combating water pollution, in line with international standards of the time. In the 1970s it even received accolades from the UN for its outstanding work on pollution control.[1228]

The government in the 1970s was committed to addressing pollution, and as far as environmental matters were concerned, state institutions were integrated for optimal results. The Department of Water Affairs, for one, collaborated with the South African Bureau of Standards (SABS) and the Department of Health, as well as provincial and local authorities, to take responsibility for controlling water pollution. From the outset, the authorities were aware it was virtually impossible to bring all water pollution under control, but they expressed the aspiration to do so. The water sector committee's report to the prime minister's planning council acknowledged the legacy of pollution by stressing that:

> Today we are paying dearly for past malpractices. Acidification due to the run-off from old coal-mines and mine dumps gives rise to problems.[1229]

For Midgley, who studied South Africa's water resources against the backdrop of numerous potential hurdles, there was good reason to be confident that the country could make do with its available water resources. An important proviso was the careful consideration of the cost of securing these resources. As part of these considerations, Midgley identified:

- the rising costs of energy
- the fact that the cheapest dam sites for suitable water resources had already been exploited
- that population increase was responsible for the escalating levels of pollution of surface and groundwater resources.

1227. Steyn (2001:27–29).

1228. Tempelhoff (2003:304–306, 328).

1229. SAWHAR WLC PAM3813/72 (1972:7).

He predicted that levies would have to be increased along the line of service delivery.[1230] In the case of dealing with water pollution his message was clear:

> Enough clean water can be made available if we are prepared to pay for it. The rate of price increases will be slowed if we are prepared to take a holistic view of the water cycle, and if we are prepared to modify our demands – i.e. if we adapt lower quality water to appropriate purposes.[1231]

In the media, Johannesburg's *The Star* newspaper carried some of the first popular environmental awareness reports in the country's history. Much of this press coverage was under the banner of the CARE campaign (Cleaner Air, Rivers and Environment) in which James Clarke, the leading South African environmental journalist of the day,[1232] urged civil society to let its voice be heard on matters related to pollution and the destruction of the environment.[1233] Water pollution was among the most contentious issues under public scrutiny[1234] because of the ubiquitous nature of polluted surface waters in many parts of the country's developing areas.

It was clear that water reuse was a key factor in securing sufficient future water supplies for the country – especially in the highly developed, industrial region of the Witwatersrand. Polluted water, half-treated, and then reused was the desired outcome, and this was considered an appropriate way to ensure that the future water supply was not compromised by the growing demand for more and more.

The mining water conundrum

From 1971 to 1972 the Department of Water Affairs worked within the framework Section 26 (c) and (d) of the *Water Act* to draft water regulations. The SABS, the Department of Health, the Department of Industries, the government's mining engineer, the Chamber of Mines of South Africa, as well as the Natal Coal Owners' Society, along with a number of other interested bodies responsible for mining operations, were brought in as stakeholders. The objective was to introduce a 'minimum code of practice' with a view to implementing pollution control measures over an extended period of time. The DWA report of 1971–1972 was optimistic:

> There are indications that the mining companies will cooperate in this respect. The regulations will be used as a means of collaboration with the operators. Similar regulations for secondary industry and local authorities will be considered.[1235]

1230. SAWHAR WLC W11 (1976: 10).

1231. SAWHAR WLC W11 (1976:14).

1232. Clarke and Wheeler (1976).

1233. Steyn and Wessels (1999:79–80).

1234. Singer (2011:91).

1235. RP48/1973 (1973:109).

The main centre of control for the gold mining sector was scheduled to be at Germiston while the coal mining sector had its centres at Dundee (Natal) and Witbank (eastern Transvaal). When necessary, further offices could be opened at Bloemfontein and Windhoek.[1236]

The department, as was the case with the CSIR's NIWR, worked actively with the mining industry.[1237] Indeed, since 1965 officials of the department had worked in collaboration with the Department of Mines on sealing structures in mines, as well as seeking ideal strategies for the construction of slimes dams.[1238] By 1975 the WRC took the lead role in a coordinating research and development committee for investigating water pollution in the mining industry, with a special focus on the Pretoria–Witwatersrand–Vereeniging (PWV) region.[1239]

Environmental awareness?

From 1971 to 1972 the department, in conjunction with the departments of forestry and agricultural technical services, distributed information on combating pollution in South Africa. The exhibition was popular at agricultural shows throughout the country.[1240] In some respects the campaign was a soft option on promoting public interest in forests and also (indirectly) plantations. From its side the Department of Water Affairs' commitment to environmental awareness was to secure clean water resources.[1241]

Hardcore issues requiring a pronounced environmental consciousness were not registering on the environmental radar of the department. Instead, 'the environment' was promoted in the sector in terms of a reclamation centre at Witbank and the work of the department on a similar project at Dundee. It was the Chamber of Mines' vegetation unit that helped in trimming, stabilising and planting grass and digging canals on the Witwatersrand.[1242]

Given the fact that South Africa was privy to the UN's famous 1972 Stockholm conference on the environment, there were people who were well informed on the environment. However, in governance contexts, the environment did not proactively incorporate civil society.

1236. RP48/1973 (1973:109).

1237. SAWHAR WLC PAM1265i5 (1970:1–13).

1238. Rudd (1973:184–192); RP34/1967 (1967:4).

1239. Water Research Commission (1976:17).

1240. RP48/1973 (1973:112).

1241. Department of Information (1971:47).

1242. RP48/1973 (1973:109).

Reclamation work 1971 to 1972

The reclamation of coal mining sites in what was then the eastern Transvaal and northern Natal, focused on preventing stormwater from becoming contaminated. Instead of merely treating larger amounts of mine water after rainstorms, mining companies and local authorities, in conjunction with the department, worked towards reducing the amount of contaminated water. Mine water was even used to extinguish coal fires. By 1973, in the coal mining region of Witbank there was surface work on drains to lead off as much stormwater as possible to prevent the water from entering old workings at the defunct Douglas No. 2 Colliery. At the time, workers were busy moving into the lowest part of the old excavations to drain the mine. The water extracted was scheduled to be pumped into evaporation ponds. Stormwater entering the mine was discharged into streams before it could become polluted.[1243]

At the No. 1 Douglasdale Colliery in Witbank the workings had been extended to the town itself. There were fears that some of the coal would catch fire and create a smoke nuisance. The plan was to keep the workings flooded. The overspill of the colliery passed through to evaporation ponds. The defunct Delagoa Bay Colliery had to grapple with seven known fires, so the mine had to be kept flooded. Two pumps transferred the overspill to evaporation ponds. At the defunct Coronation Collieries of Kromdraai, near Witbank, the owners of the mine had started working on trimming the dumps and building barrier dams in an effort to lead spoil and stormwater away from the streams. The coal dumps of collieries were also systematically trimmed with barrier dams to collect spoil and prevent stormwater from gathering in the proximity of dumps.[1244]

Singer notes that in the 1970s most government departments, as was the case with local scientists and policy makers, were well informed on global environmental control measures.[1245] The Witbank region was the prime supplier of coal to the increasing number of thermal power stations on the Highveld that had to provide energy to Escom's countrywide electricity grid. This meant that the Department of Water Affairs, in partnership with the energy and coal mining sector, had to enforce measures to control pollution, with the support of a scientific research community that was familiar with international standards.

In the northern Natal coalfields, the DWA report of 1971–1972 states:

> Water pollution in this field has often been in the public eye and a detailed survey of the conditions prevailing at suitable points has been made. The results of the survey show that the conditions have been grossly exaggerated, with the exception

1243. RP48/1973 (1973:109).

1244. RP48/1973 (1973:110).

1245. Singer (2011:90).

> of polluted water from the defunct Burnside Colliery entering the Wasbank River and the seepage from the hilly country round Hlobane.[1246]

At the time there were ongoing activities to prevent the overspill from the Burnside Colliery from entering the Wasbank River by means of mine seepage. There were also plans to build a dam on the Nkonglwana River to dilute the mine seepage and ultimately make the water usable again.[1247]

In the gold mining sector, work began in the East Rand's mining areas, where the Modderfontein slimes dam and sand dump was trimmed and planted by the Chamber of Mines Vegetation Unit. The objective of the exercise was to limit pollution in the Blesbokspruit, a tributary of the Vaal River. As a result of heavy rains towards the end of 1971, two mines of the South African Land and Exploration Co. Ltd and the Brakfontein Gold Mining Company were partly flooded. The stormwater entered old surface workings as a result of a blocked canal between dams in Benoni and the Geduld Dam near Springs. In 1971–1972, the DWA reported:

> The canal was blasted clear and is now being trimmed and the banks planted with grass. The Benoni dams are regulated and water flow measuring devices are being installed at various points to determine whether or not the water from the canal is flowing underground in the faulted areas. Should such points be located they will be concrete lined.[1248]

At the Clydesdale (Tvl. Collieries Ltd) Coalbrook Collieries near Sasolburg, an amount of 2628 m^3 of fluoride-bearing water flowed from underground water supplies, and the Rand Water Board lodged a strong objection to the state of affairs. It was prepared to take in water with a fluoride content of 1 mg/L, but at the time the fluoride content of the mining water was 24 mg/L.

Non-mining industrial pollution

In the non-mining industrial sector the Department of Water Affairs was active in a number of generic fields. In the pulp and paper industry, by 1972 there were extensions to the water treatment plants at large paper mills in Mandini, Springs and Klip River. In some cases operators responsible for dealing with the problem, used part of the settling capacity for upgrading effluent received from a nearby local authority to make more effective use of the available water. At Port Elizabeth, planning started on the reuse of municipal effluent, and the mill's management took note of the future requirements it had to meet. At Durban one paper mill started using effluent water in its milling processes.[1249]

1246. RP48/1973 (1973:110).

1247. RP48/1973 (1973:110).

1248. RP48/1973 (1973:110–111).

1249. RP48/1973 (1973:111).

Meanwhile, significant progress was made in the establishment of acid recovery. This entailed recovering acid from chrome plating works using hydrochloric acid. By 1972 it was possible to recover acid and then resell it to consumers at the ruling price of new acid. Up to 1971 the waste acid had merely been discharged into sewer systems of local authorities. The dissolved solids then reappeared as effluent discharged into rivers. According to the Department of Water Affairs, the introduction of the acid recovery process within two years was a significant breakthrough, in that mineral discharges in watercourses had been reduced.[1250]

Departmental restructuring of pollution control

In July 1975, the Department of Water Affairs Division of Water Utilisation was renamed the Division of Pollution Control. The staff of this new division came mainly from the former industrial water section, but it retained the old section's functions and basic organisation. The division's officials served on 24 committees of the WRC as well as national and interdepartmental committees. They also attended conferences overseas,[1251] and were active in global institutions such as the International Association of Water Pollution Research.[1252] Another change at the time saw the agricultural water pollution section taken over by the Division of Planning.[1253]

The department was aware that there was a growing demand internationally for more effective water pollution prevention, and officials monitored new trends discussed at a UN Water conference in Argentina in March 1977. It was evident that there was a shift towards more authority for local, regional and national authorities in dealing with pollution, as the availability of water resources diminished.[1254]

From 1976 to 1977 officials investigated about 50 cases of pollution or suspected pollution. Most pollution hotspots became areas of investigation for resolving existing problems.[1255] New strategies were investigated to locate pollution. In 1975 the NIWR conducted experiments on whether fish could detect early traces of toxic pollution in water.[1256] By 1978 there were indications of a move in the direction of the total reuse of effluents to potable standards.

1250. RP48/1973 (1973:111).

1251. RP67/1977 (1977).

1252. RP51/1978 (1978).

1253. RP56/1977 (1977:121).

1254. SA Water Bulletin (1976d:23).

1255. RP51/1978 (1978:135).

1256. Morgan (1976:2).

The economic climate of the day was said to have boosted this innovative trend. According to the WRC's Dr G.J. Stander, cleaner wastewater at a slightly higher cost, began to make practical sense.[1257] The department's annual report noted, in support of this notion:

> [*A*] few additional units for advanced purification at a sewage works are likely to have decided cost advantages over the construction and maintenance of the dual reticulation system that would be required for 'second grade' water.[1258]

The secretary for water affairs pointed out that reclaimed water could be put back to work in the existing distribution network. He went on to explain that not all environmental disasters were directly linked to industrial pollution problems. In one event of a fish-kill in the Pongola canal system, the officials determined it had been caused by a pesticide spill. In another event, on a pan near a Witwatersrand town where a number of birds had been killed, the cause was traced back to botulinum poisoning emanating from an ox carcass in the water.[1259]

Dealing with water pollution in a mining boom period

Growth in South Africa's mining industry in the 1970s was a direct result of the global energy crisis that began in 1973. A fragile sense of uncertainty in the international economy created a significant demand for South African minerals, especially gold – a hedge against potential financial collapse. At the same time the coal mining industry and uranium-rich gold mines provided alternative energy resources. While the mining sector enjoyed the windfall, the Department of Water Affairs was keen to introduce international trends in water pollution control measures. A cat and mouse game ensued, with the department following a diplomatic line.

On 02 February 1976, new regulations were published for addressing mine pollution.[1260] At the time there were about 1000 operational mines in South Africa. Collectively they produced about 50 different types of minerals, with a total value of R4500m p/a. In addition, there were about 3000 defunct mines that needed to be investigated by the mine pollution group of the department. The mining sector was sensitive to trends in the global financial markets. In 1977 the gold price once again increased, and many marginal mines resumed operations. There were also new mines going into operation, working in both opencast and underground modes. The department's pollution control officials

1257. SA Water Bulletin (1977b:8).

1258. RP30/1979 (1979:148).

1259. RP30/1979 (1979:148).

1260. RP67/1977 (1977:123).

did regular checks for systematic restoration activities. At some defunct coal mines there was a rush for waste heaps where it was possible to recover usable coal.[1261] It was at these sites that pollution posed a major threat to the riverine water catchments.

Officials of the department kept a watchful eye on the Witbank coalfields, focusing on the Douglas No. 1 and No. 2 sites, where drainage trenches were under construction while the slopes of local mine dumps were rehabilitated. On the Natal coalfields, officials worked at the Burnside Colliery where they made good progress in diverting mine water with a canal to divert the flow of the Wasbank River.[1262] By 1978, there were once again serious concerns about the northern Natal coalfields because of the expansion of mining operations. The department's officials were keeping a close eye on pollution.[1263]

The next year the division reported that two mines in northern Natal had held several meetings with officials to resolve the problem of long-term pollution of water resources. The researchers of the NIWR were aware that there were defunct mines in the region and that they had been decanting AMD for many years.[1264] Some mines installed flow-gauges to take water samples at points where serious pollution had posed problems previously. They even provided the department with copies of their strategies for dealing with pollution in future. Of particular importance to the division was the task of 'report back' on the status of the water supplies. By 1979 there were a number of new mining operations. There were also indications of more effective control of effluents. It appeared that the rate of pollution was diminishing.[1265] However, defunct coal mines in the Witbank area and northern Natal remained a problem.

Coal mining operations in Witbank in years gone by had been of the board and pillar type – an underground operation where pillars of coal were left standing to prevent the surface areas from collapsing.[1266] In 1975, in view of the increasing demand for energy from coal, the department's pollution division took note of plans to resort to opencast coal mining near some old pit mines at Witbank. It was partly as a result of Escom's capacity to produce more energy. For the mining companies it was possible to use large energy-intensive draglines for effectively taking coal from the pit.

1261. RP51/1978 (1978:132).

1262. RP67/1977 (1977:122).

1263. RP30/1979 (1979:146).

1264. Stander, Henzen and Funke (1970:97).

1265. RP49/1980 (1980:160).

1266. McCarthy and Pretorius (2009:57–58).

It appeared at first that the department's pollution experts were negative about opencast operations, but the mines gained government approval to go ahead. This type of coal mining was easier on a grand scale and created more employment opportunities, at a time of declining gold mining jobs.[1267] The department was satisfied that all measures aimed at dealing with pollution in the pit mines were merely of a temporary nature. The thinking, therefore, veered in the direction of removing all coal from defunct mines by means of opencast mining. In restoration terms, it meant that topsoil would be replaced once mining operations came to an end. It was costly, but the argument in the coal mining sector, supported by the pollution control division, was that the price of coal had increased, so it was possible to carry the expenses. The mindset in the mining industry and the department by 1980 was:

> If the price for the export of coal would make it economical to mine the rest of the coal in these mines by opencast methods, it would be in the interest of the state to give preference for the export of coal from these old mines.[1268]

The Department of Water Affairs acknowledged that the energy crisis was a bonanza for the coal miners. The value of large dumps of duff (fine) and subgrade coal increased in value to the extent that they were removed and sold off for use. Dumps that in former times would have required rehabilitation, were now used and disposed of in energy production processes.[1269]

The department's pollution division was even active in feasibility studies for pumping coal slurry from the country's coalfields to the new industrial and resource harbour at Richards Bay. This town had developed as industrial hub in 1965,[1270] by using saline effluents as a carrier for coal. There was an international trend to transfer mineral resources in pipelines over long distances.[1271] Studies indicated that sufficient saline water supplies were available. These could be pumped directly into the sea. The division's officials reported:

> This imaginative scheme would be beneficial not only because of the low cost of transporting the coal, but in that some sources of fairly severe mineral pollution could be eliminated.[1272]

In 1983, when the pipeline conveying the coal was completed, the capacity of the coal exporting cargo berth of Richard's Bay was reached. The single transfer

1267. Bromberger (1978:90–98).

1268. RP49/1980 (1980:161).

1269. RP67/1977 (1977:122).

1270. Minnaar (1984).

1271. Dick (1972:961–962).

1272. RP67/1977 (1977:122).

measure, and some other modifications, made it possible to increase the annual quantity from 24.3 to 44.7 million tonnes.[1273]

The Department of Water Affairs kept a close eye on developments at Richards Bay. Water Affairs officials were involved in a number of investigations as watchdogs for possible pollution, and served on the committee for the rehabilitation of coastal dunes to the north of Richards Bay after mining operations for rutile, illuminite and zircon had been completed. Other watchdog activities included the rehabilitation works on the platinum mining activities in the Bafokeng platinum mining area in the western Transvaal; storm water drainage activities in the OFS's Welkom mining areas; the development of a large open cast mine to extract zinc, copper, silver, lead and iron in the north-western Cape, and the potential siting of refineries. From Sasolburg there was information on the disposal of certain oily and tarry wastes from the Sasol I plant, in a confined section of an underground mining operation.[1274]

The gold price and its fluctuations created uncertainty on the viability of a number of mining operations on the Witwatersrand, the West Rand and the OFS in the 1970s. There were considerable concerns over labour unrest on the mines.[1275] This had grave consequences for the rehabilitation of mine dumps. The Department of Water Affairs had clearly taken a lenient stance on the mine dumps of gold mining operations.[1276] On the East Rand of the Witwatersrand, there was an ongoing project to recover gold, pyrite, and uranium from old slimes dams. The life expectancy of such projects was set at 25 years. Reworking the slimes dams meant that the process would remove them, and that this would address the issue of pollution.[1277] However, disasters were inevitable. Not all of them were disclosed.

In 1979, the department reported on an accident at an operational site run by a company called ERGO, a commercial gold extracting operation, where a tanker caused a serious cyanide spill. Although the accident did not have serious consequences, the division's officials convened a symposium to discuss road transport and how spillage of dangerous and polluting substances could harm the environment. In the same year, the division's mining investigation team reported on new mining operations on the West Rand and pointed out that the gold price was rising, so the mining sector was booming once again.

1273. Minnaar (1985:20).

1274. RP67/1977 (1977:122).

1275. Leys (1975:205–207).

1276. RP67/1977 (1977:122).

1277. RP51/1978 (1978:132).

Overnight the mines were again in a position to deal with their pollution problems.[1278]

In an era when petroleum prices reached record highs and the oil-from-coal process of Sasol only provided 7% of the country's fuel, there was an urgent need for a higher production rate.[1279] At the site of Sasol II, in the eastern Transvaal, a new oil-from-coal plant was under construction, while mining operations had reached an advanced stage.[1280] In 1978, the department's mining pollution officials reported that the Bosjespruit colliery at Secunda had started operations. There was also a new mine at Ermelo that had reached production stage. At the same time Iscor's Grootegeluk coal mine, near Ellisras, started up in the north-western Transvaal without posing a threat to local water resources.[1281] Most of the mine's water supply was piped from the Hans Strijdom Dam (currently the Mokolo Dam).[1282]

Apart from keeping track of all the new developments in coal mining, the department's officials still monitored the situation in Witbank's worked-out collieries, to prevent the further contamination of the Olifants River. Monitoring activities were also enforced on the Natal coalfields.[1283] In 1979 the department's officials appeared to be satisfied with measures taken to prevent excessive pollution in that area.[1284] In the north-western Cape, at Aggeneis, there were mining operations to extract lead, zinc, copper, silver and magnetite. Here too it seemed that the mining company and local officials were aware of measures necessary to avoid pollution. In the same year, the secretary for water affairs reported that there were serious problems with water and de-watering processes on the Far West Rand dolomitic areas, at Zuurbekom and Welverdiend, to the west of Johannesburg. As a result of good rains over a few years, the dolomitic compartments had filled up again. This meant that additional pumping processes had to be started up. However, in the long-term this strategy proved to be a somewhat futile exercise. As mining operations gradually ground to a halt, it was inevitable that the dolomitic cavities would once again start filling up with rainwater, as had been the case before the advent of local mining operations.

1278. RP49/1980 (1980:160–161).

1279. Malan (1975:47–65).

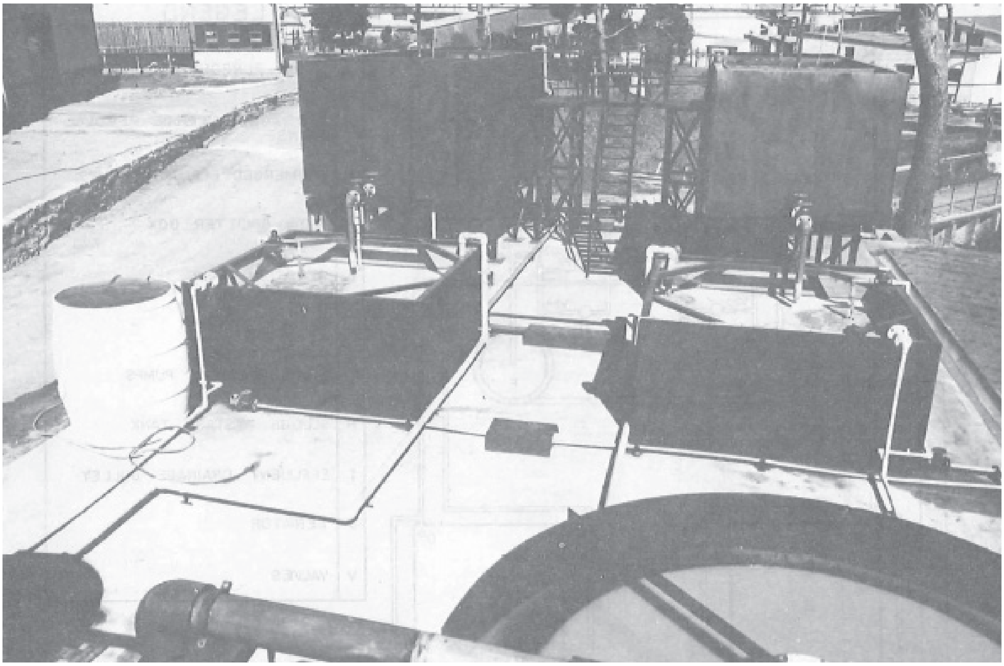
1280. RP51/1978 (1978:132).

1281. RP30/1979 (1978:146).

1282. Kotze (1982:366).

1283. RP51/1978 (1978:132).

1284. RP30/1979 (1979:146).



Source: SA Water Bulletin (1977a).

FIGURE 8.1: In 1977 the South African Tanner's Association, in collaboration with the WRC, as well as a leading British pollution research organisation, was instrumental in starting a pilot plant to deal with toxic effluents from a leather tanning company in King William's Town.

Industrial pollution

Once the department had appointed suitable officials, it was possible to develop cordial relations with municipal authorities on issues of industrial pollution. Companies could engage collaboratively with officials on solving pollution problems (Figure 8.1). In the industrial sector it was important to focus on the disposal of toxic substances, and in 1975 to 1976 there were cheap systems in place to render arsenic-based cattle dips harmless in water catchments that were previously in danger of becoming polluted. By 1976 there had only been two prosecutions for contravention of the legislative measures against pollution, and this commendable outcome was ascribed to the collaboration that the section's officials had from the industrial sector. In total, 36 permits were granted to industries for water use in terms of Section 12(5) of the *Water Act*; and 48 permits were granted in terms of the legislation to dispose of effluents.[1285]

1285. RP67/1977 (1977:133).

The Department of Water Affairs' industrial pollution control division worked from the understanding that industrial expansion in South Africa was confined to a few large enterprises. The main projects were Sasol II's plant at Secunda; the Coalplex plant of AE&CI at Sasolburg; the Reeds Paper factory at Stanger; and the Triomf phosphoric acid plant at Richards Bay. These new industrial operations worked closely with the department on strategies to minimise their water consumption and learn how to reuse their water.[1286]

One example of collaboration between the department and industry, dating back to the 1960s, was Sappi's Ngodwana plant. The Ngodwana Pulp Mill was started by the paper and pulp manufacturer in the eastern Transvaal (Mpumalanga) area in September 1966. Prior to commencing operations, the plant's management had to conform to the requirements of the department. No effluents could be released into the nearby the Elands River. Once the plant began its operations, it became evident that much of its wastewater was highly mineralised and had a marked effect on the environment. The company consulted with the NIWR to do research on several types of grass, among others a variety called kikuyu (*Pennisetum clandestinum*), a robust East African grass. By 1978 the mill had a site of 53 ha under kikuyu grass, on which cattle grazed. The wastewater from the mill was used for irrigating the grass. By the time the water reached the river, it no longer posed a pollution threat to the Elands.[1287]

By 1977, the Triomf phosphoric acid plant at Richards Bay began production and all its processes of disposing effluents were duly approved by the department. There was also a new paper mill in the area, but the teething problems it experienced were addressed to the satisfaction of the department's officials. In 1976–1977 few new industrial operations started in South Africa. This gave the pollution officials an opportunity to follow-up and re-check existing plants.[1288]

At Chamdor, on the West Rand, a new oil refinery began its operations – and before long there were complaints of pollution. The officials reported that a sensible, economical strategy had to be developed to dispose of acid oil sludge, and it was a matter that required swift attention. Officials of the pollution control division, in collaboration with researchers in the industrial sector, set to work on finding solutions. In 1976 to 1977 the industrial pollution section of the department initiated three prosecutions, of which one resulted in a conviction.[1289] In 1978, the industrial section of the division for pollution control reported there were serious problems at an undisclosed paper mill and

1286. SA Water Bulletin (1977a:123).

1287. SAWHAR WLC W680 (1978:1–2).

1288. RP51/1978 (1978:133).

1289. RP51/1978 (1978:133–134).

a wool-washing facility. An amount of R600 000 was set aside to address these matters.[1290] The department was satisfied that the measures it was taking to combat industrial water pollution were meeting its objectives.

Municipal section

The municipal section of the department's pollution control team had to contend with the national problem of local authorities being hard hit by inflation and a chronic scarcity of funds. Many important infrastructure works simply had to stand over. In some cases, local authorities switched to smaller and cheaper options than those they initially planned.[1291] At the time Val Bolitho, the assistant engineer of health services of the Johannesburg City Council, published influential findings on the economic cost of wastewater treatment in South Africa.

As a result of rapid urbanisation, Bolitho explained, local authorities had to start preparing for the construction of wastewater treatment facilities with a capacity of processing 10 000–12 000 ML/d. The cost of these facilities, at the time, was estimated at R4.25m. In view of the comprehensive nature of municipal wastewater and the industrial effluents that also needed to be accommodated, Bolitho pointed to the advantages of regional wastewater treatment plants.[1292] In a follow-up article Bolitho explained there was a serious shortage of sufficient data to work from, but it was evident that it was viable to combine biological phosphorous removal plants with physical chemical plants, ultimately contributing towards the production of potable water resources in a region such as the PWV.[1293] Multi-purpose wastewater treatment systems appeared to hold the promise of a bright future.

Although the 1970s were a time of financial constraints, one positive result that the department's municipal inspection section could report on was that officials had issued 31 permits to municipalities for operating wastewater treatment works and the disposal of effluents. There were concerns about the eutrophication of dams and impoundments, and local authorities were urged to maintain higher standards in certain areas. Municipalities were warned that departmental steps would follow to check up on high phosphate and nitrogen levels in impoundments. At a number of municipalities, new plants were designed specifically with the objective of abstracting phosphates and nitrates.[1294]

1290. RP51/1978 (1978:147).

1291. RP67/1977 (1977:123).

1292. Bolitho (1975:118–120).

1293. Bolitho (1976:145–149).

1294. RP67/1977 (1977:123–124).

Local authorities had to bear the brunt of the country's financial crisis. Yet there were positive pointers from the water sector's researchers. In 1975, L.R.J. Van Vuuren at the CSIR's NIWR, reported that the full-scale reclamation of water for the secondary use of industrial and unrestricted use could be made compliant with the WHO standards for as little as 20 cents/kL.[1295] The country's economy only needed a small boost to become part of a veritable sea change in wastewater treatment activities.

However, the required economic respite did not materialise. Instead, the outcome was that the department had to condone certain less effective types of purification plants, such as oxidation ponds, which could easily be incorporated into more advanced types of works in future when funds were available.[1296] In 1978 the economy had still not improved and there were increasing talks about the construction of regional wastewater treatment works – some were even described as innovative and well ahead of the latest trends.[1297]

In the larger urban areas of South Africa, such as Johannesburg, the municipality went ahead and developed new wastewater schemes with sophisticated designs and biological means to remove phosphates and nitrates. As a result of the work done in the field a collaborative initiative was put in place between the CSIR and the city's engineers. In addition, the secretary for water affairs reported, a number of South African universities and the WRC had made praiseworthy contributions, so much so, he added, that 'South Africa now leads the world in this field'.[1298] Despite the economic conditions, by 1979 there were signs that local authorities had begun to invest in new wastewater treatment works. The department warned the local authorities that it intended making use of the SABS for laying down new standards for water purification. This had a positive effect. By 1979 some authorities had already started with plants that complied with all the regulations and proved to be showpieces of high standards.[1299]

Assessing the 1970s pollution control measures

It is clear that the Department of Water Affairs endeavoured to maintain a close check on water pollution in a number of strategic areas. South Africa's economy relied on mining and its secondary and tertiary industrial production processes, so the department was responsive to times of 'boom and bust' in

1295. Van Vuuren (1975:133–143).

1296. RP51/1978 (1978:134).

1297. Bolitho (1976:145–149).

1298. RP30/1979 (1979:148).

1299. RP49/1980 (1980:162).

the mining sector. If the energy crisis pushed up the demand for coal, the department provided proactive support. When mines closed down, the department helped to contain the spread of water pollution. When defunct mines were reopened, the department kept an eye on old water spills and took appropriate measures.

In line with the government, the department took a moderate stand on matters of pollution at a time when the international community started moving towards responsible environmental awareness and the promotion of sustainable development. It was a typical South African response to unconventional environmentalism. Although there may have been some lapses, especially in strict enforcement relating to industrial water, government went to great pains to emphasise that the country's anti-pollution measures as far as water was concerned, were making a significant contribution towards maintaining sound health standards.[1300]

Inter-basin water transfer systems: Grootdraai and Sasol's water supply

As the demand increased for electricity and Sasol's petroleum from coal, there was a greater demand for reliable water supplies. In the 1970s both Escom and Sasol were major water consumers and had become important components of industrial development in South Africa. To keep their operations running smoothly the Department of Water Affairs had to develop and maintain complex water transfer systems. These processes were based on the key recommendation made by the commission of enquiry into the water resources of South Africa (1966–1969), namely to ensure that sufficient and reliable water supplies were made available for industrial purposes, especially where water resources were not readily available.

Comprehensive water transfer systems, per se, marked the full realisation of the industrial–energy hydraulic mission, and the water governance authorities resorted to their typical unconventional strategies to meet the ever-increasing demand for water. As discussed earlier, some of the first inter-basin transfer systems date as far back as the 1940s. In the next three decades the ORDP was completed and by the 1970s, the Vaal River system became an even more important driver of the country's industrial–energy hydraulic mission.

Water transfer systems: Komati–Usutu

In the mid-1970s the Department of Water Affairs proposed a R24m pipeline system to link the Komati and Usutu rivers in eastern Transvaal (now Mpumalanga).

1300. SA Water Bulletin (1978b:10–12).

The objective of the scheme was to ensure that shortages in one system would be alleviated by transferring water from another. Escom's thermal power stations in the eastern Transvaal became the prime consumers of water from the Upper Komati River and the Usutu River schemes. The managers of these schemes were well aware of the need to ensure that sufficient water remained available for the operations of Escom's power plants in the region. The power stations of Komati, Hendrina and Arnot were the main users. Collectively these stations had the capacity of generating 5100 MW. In 1976 they still relied entirely on the Komati River. Since the 1950s, three dams had been constructed to meet the demands of the power stations. By 1976, the Komati power station, with a generation capacity of 1000 MW, drew water from the Nooitgedacht Dam. The water pumped from the dam was transferred to a reservoir at Klipfontein towers by means of twin 710 mm pipelines with a combined capacity of 100 000 m^3 p/d. The Hendrina and Arnot power stations, with a capacity of 2000 MW and 2100 MW respectively, secured their water supplies from the Wintershoek pump station downstream of the Nooitgedacht Dam. Water came from the Vygeboom Dam, near Badplaas, and the Gemsbok weir; it then flowed to the Wintershoek pump station by means of twin 1092 mm pipelines, with a capacity of delivering 290 000 m^3/d.[1301]

The plan proposed in the mid-1970s was to look at the future use of the Usutu River, which had previously been used to provide the needs of the Camden and Kriel power stations that had power generating capacities of 1600 MW and 3000 MW respectively. The planners had in mind the growing need for power supplies for the towns of Ermelo, Witbank and Middelburg. The existing system was developed in a number of phases by means of interconnecting pipelines and pump stations. Dams linked in the process included the Jericho, Westoe and Morgenstond. In phases 1 to 3 the Jericho and Westoe dams were interconnected by means of an aqueduct between the two reservoirs and a pump station at the Jericho Dam, with rising mains to Camden. Phase 3 of the project was still under construction in mid-1976, but it was scheduled to feature a pipeline from Camden to Kriel, the Morgenstond Dam and pipelines via Camden to the Jericho Dam.[1302]

Apart from securing water for power supply, an additional feature of the proposed linking of the Komati and Usutu rivers was to provide for the growing industrial and domestic urban water demands, as well as the needs of the farming industry. The strategy of multi-purpose water transfer schemes was highly unconventional. For one, apartheid South Africa did not have many African friends. The fact that Swaziland was prepared to share water resources meant that there was a trend towards normalising interstate relations. In 1976, it was pointed out that the area between the Witwatersrand and Swaziland

1301. SAWHAR WLC W177 (1976:49).

1302. SAWHAR WLC W177 (1976:49).

had significant potential for development. The vast local supplies of coal were attractive to both the mining and energy industry. Experts were of the opinion that the future demand for water in the region might change significantly in time to come.

In 1975, the announcement by Sasol that its new oil-from-coal plant would be established near Trichardt in the eastern Transvaal (Mpumalanga) meant that more water had to be provided for the generation of electricity at the at the new Tutuka power station, which was still in the planning phase. In addition, the new water supply had to contribute water to the Matla and Duvha power stations.[1303] In response to the anticipated demand for more water, especially for increased supplies to Sasol, construction work began on the Grootdraai Dam in the Vaal River.[1304] The Grootdraai (completed in 1978) was key to providing water to the Sasol plant. However, the Grootdraai's water was based on a 26% MAR run-off to the Vaal River.[1305] From the Grootdraai, a number of pump stations, pipelines and canals were used to transfer water over a distance of 65 km to the Sasol plant and then further to the watershed between the rivers of the Vaal and the Olifants. From there it was scheduled to flow down the Steenkoolspruit, a tributary of the Olifants River, to the power stations of Matla and Duvha.[1306]

Heyshope Dam was constructed in the Assegaai River, and used the Geelthoutboom pumping station to transfer the water of the Assegaai to the Vaal River. The project was completed in 1985. The scheme made it possible to transfer as much as 100 MCM p/a into the Vaal River system and significantly supplement the Grootdraai.[1307] The highly sophisticated system of pipes, pumps and storage facilities was an unconventional way of securing water for industrial–energy purposes. The fact that the Usutu River, in effect, provided water to the Witwatersrand that would ultimately flow down the Orange River, came in for severe criticism from aquatic ecosystem experts in the next two decades.[1308]

However, security of energy supply was of prime importance in terms of the department's hydraulic mission. This was also evident when drought conditions started in 1978, and there were concerns in eastern Transvaal about assured supplies of water to the energy sector. Emergency plans had to be made. The way this problem was resolved is discussed in the next chapter.

1303. Department of Water Affairs and Forestry (1986b:9); SAWHAR WLC W177 (1976:49).

1304. SAWHAR ZKC (1986:Section 4.10, 15.25).

1305. SAWHAR ZKC (1986:Section 6.13).

1306. Department of Water Affairs and Forestry (1986b:9).

1307. Department of Water Affairs and Forestry (1986b:9).

1308. Snaddon, Wishart and Davies (1998:169).

Tugela–Vaal system

For the greater part of the 20th century, engineers were more than aware that the Tugela River was an important transporter of fresh water resources into the Indian Ocean. It flows in the KwaZulu-Natal section of the 1000 km-long Drakensberg/uKhahlamba mountain range, which extends from the southern Cape to the Limpopo province in the northern areas of South Africa. In the late 1960s, as a result of the growing demand for freshwater resources in the interior of the country, engineers worked on a number of strategies to tap the water of the Tugela River. One of the early ideas was to transfer water from the Tugela to the Vaal, where the Pretoria–Witwatersrand–Vaal Triangle region, the economic heartland of South Africa, needed vast amounts of water.[1309] In 1969, a construction project was completed that provided a reasonable supply from the Tugela River to the Highveld plateau region of the country's Vaal River catchment.[1310] The Vaal River system had been developed to the extent that in 1970, after the completion of the Bloemhof Dam, there were 16 major storage facilities in the Vaal catchment.[1311] The Vaal system's capacity was almost over-extended in even providing water supplies to consumers along the Orange River. The demand for water and energy increased at a blistering pace. Escom's power supply system was growing rapidly – especially after the completion of the national grid in 1973.

At peak times, the power utility had access to the hydroelectrical power generation facility on the Hendrik Verwoerd/Gariep Dam, but that was considered insufficient and there was a demand for more hydropower. In response to this demand, engineers of the Department of Water Affairs worked on the anticipated need for more water from the Vaal Dam and came up with a figure of 630 MCM p/a, which could add up to more than 50% of the existing supply of the dam. It was estimated that the addition of this supply would provide sufficient water for the Pretoria–Witwatersrand–Vereeniging (PWV) region until 1992.[1312]

The provisional design of the Tugela–Vaal scheme required the construction of the Java Dam on the Elands River. The Department of Water Affairs planners wanted to lay a pipeline with pumping stations from Spioenkop Dam, over the Drakensberg and ending in the Java Dam. The water was to be stored there until it was needed for transfer to the Vaal Dam.[1313] When the White Paper on this plan saw the light of day there were political rumbles. The Department of

1309. Conradie, Messerschmidt and Morgan (2000:155)

1310. Conradie, Messerschmidt and Morgan (2000:14).

1311. WP F70 (1970:3).

1312. Conradie, Messerschmidt and Morgan (2000:155).

1313. WP F70 (1970:1).

Bantu Administration had concerns that such a large proportion of what was to become the QuaQua homeland, was incorporated into the proposed Tugela–Vaal scheme.[1314] For the residents of the homeland it was all about securing their own land. It did not make sense for them to share their land for the purposes of central South Africa's emergency back-up water supply.

Reacting to these concerns, a senior engineer in the Department of Water Affairs, Theo van Robbroeck, started working on an alternative plan. He came up with the idea of the Sterkfontein Dam on the Nuwejaarspruit.[1315] The dam site was close to the watershed between the Vaal and the Tugela. Initially there was disbelief. On paper the new dam site could potentially hold even more water than the Vaal Dam. The proof for Van Robbroeck's assessment had its origin in a paper delivered by Dr Peter Matthews at a symposium of the division of hydraulic engineering of SAICE, held at the University of Natal in July 1969.[1316] Soon the survey maps showed that the plan was indeed on the mark. Van Robbroeck then studied the White Paper on the proposed scheme and found that his new plan would even be a cost saver. His strategy formed the nucleus of what would later become known as the Tugela–Vaal project.[1317]

Instead of pumping water from Spioenkop, Van Robbroeck proposed a new storage dam at Woodstock, higher up the river, with a weir and pumping station at Driel, which received water from the Mjambona tributary further down. The new plan was that the Spioenkop Dam would be used to regulate the flow of the Tugela in the downstream part of the river. Instead of a pipeline, there was to be a canal, which could be increased in capacity. The canal was scheduled to end at a pumping station on the forebay at Jagersrust, from where it would be pumped over the Drakensberg. A further canal and short tunnel would then transfer the water to the Sterkfontein Dam. The ingenious new proposal also made provision for a long tunnel between the valley of the Nuwejaarspruit and the Elands River. Van Robbroeck, in collaboration with Bruno Graber of Escom's hydropower division, Bob Pullen, and Monty van Schalkwyk, presented a paper at the 1970 Water Year symposium entitled, 'Hydro-electricity, the key to the multi-purpose development of the Tugela River' in which they outlined the basics of the concept of a pumped storage power scheme in the Tugela.[1318]

The idea was too late to be incorporated into the first phase of the Tugela–Vaal scheme, but it was indeed incorporated into the second phase, thanks to

1314. Van Robbroeck (*c.*2016b).

1315. WP W70 (1970).

1316. Matthews (1969a:44–46; 1969b:1–30).

1317. Van Robbroeck (*c.* 2016b).

1318. Van Robbroeck (*c.* 2016b); SAWHAR PAM1265b2 (1970:1–13).

the insight and efforts of Flodec Pyzikowki, an experienced Czech engineer, who was impressed by the proposal. Subsequently, at a meeting of representatives of the Department of Water Affairs and Escom, it was decided that the project would be undertaken as a joint venture. The government embraced the project and sold the idea successfully to the public, so much so that it brought substantial publicity for the originators, planners, the department and Escom. Although there were some managers in the Department of Water Affairs who were not enthusiastic about the plan, its innovative recommendations could not be ignored, and before long it was presented to parliament in a new White Paper and was duly accepted.[1319] The official opening of the first phase of the Tugela–Vaal Project took place on 08 November 1974.[1320]

Hydropower developments

Drakensberg hydropower project

In the process of developing what was to become known as the Drakensberg hydropower scheme, four reservoirs were built. The first was the Woodstock Dam on the Tugela, which regulated the flow in the case of potential flash floods (please see Figure 8.2).[1321] The water was then discharged into the Driel Barrage a little further downstream, from where it was pumped via canal into the Kilburn Dam as part of a pumped storage power scheme, with a capacity of generating as much as 1000 MW. During times of lower power demand, water was pumped up the steep mountainside to the Driekloof reservoir, which was a relatively small reservoir that could flood easily. The surplus water from Driekloof flowed into the Sterkfontein Dam – a large, deep storage facility, about the size of the Vaal Dam. Because it covered a relatively small surface area, the Sterkfontein Dam had a low evaporation rate.[1322] Water from the Sterkfontein Dam could then be fed into the Vaal Dam system, if and when it was required.

The significant potential of the Drakensberg hydropower system was that it could generate and pump water at a theoretical maximum load factor of 42%. The station was used on a permanent basis to transfer water to the Sterkfontein Dam, and from there it would be able to flow into the Vaal in times of water scarcity, where the water would be used at a weekly rate of basically 30% of its load factor (Figure 8.3 and Figure 8.4).[1323]

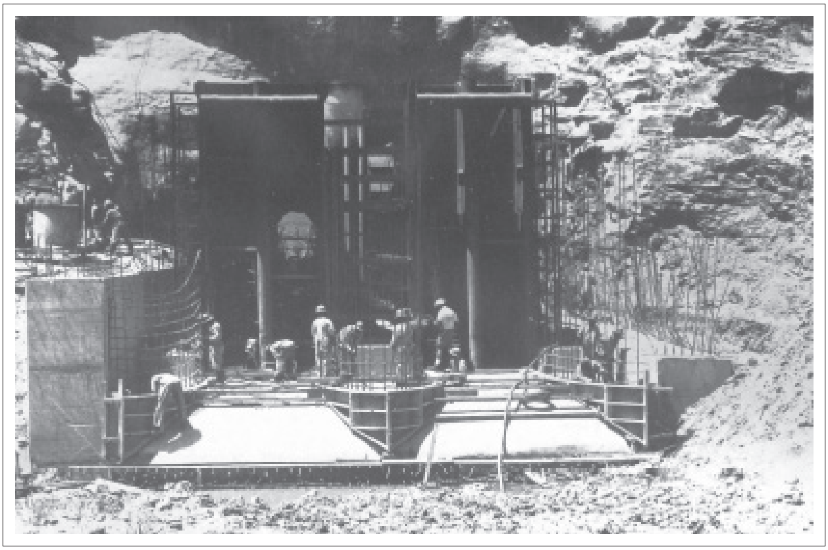
1319. WP W70 (1970).

1320. RP67/1977 (1977:17).

1321. SAWHAR ITC/DWS(c) (1978:22)

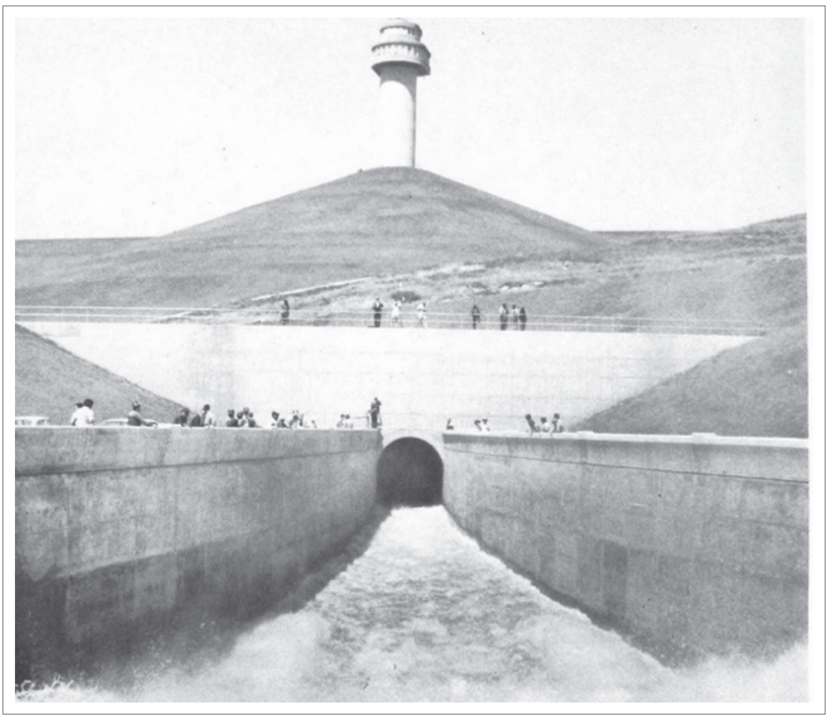
1322. Conradie, Messerschmidt and Morgan (2000:155, 157).

1323. RP49/1980 (1980:157).



Source: RP49/1980 (1980:n.p.).

FIGURE 8.2: A scene at the construction site of the Tugela–Vaal government water scheme in 1978–1979, showing the tunnel intake at the Woodstock Dam for diverting water.

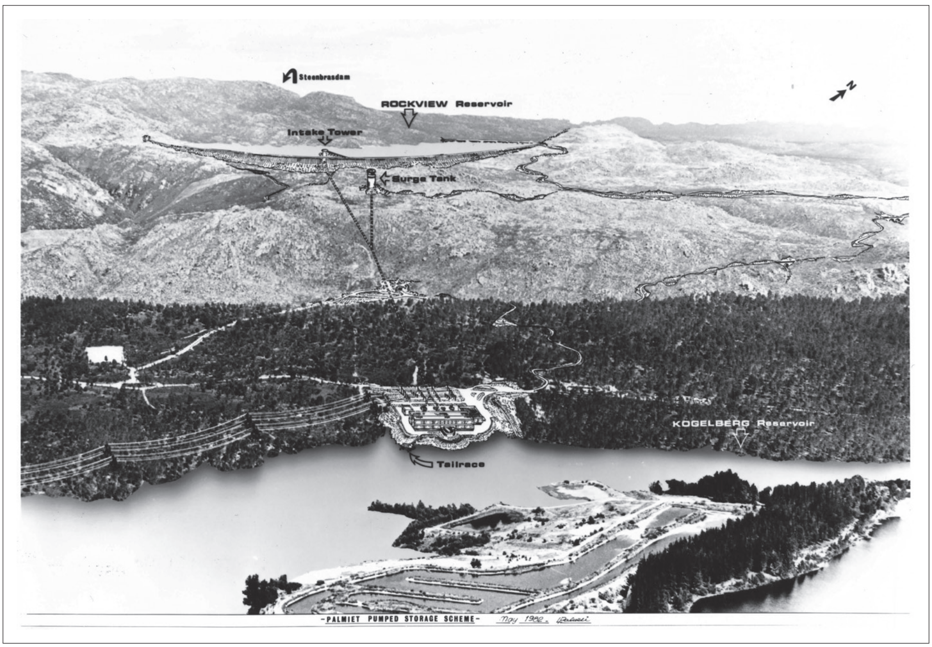


Source: RP49/1980 (1980:n.p.).

FIGURE 8.3: A 1978 test release of water from the Sterkfontein Dam to check the operation of the outlet valves.

Source: RP30/1979 (1979).

FIGURE 8.4: The Drakensberg pumped storage development project under construction at the Driekloof Dam in 1978.



Source: SAWHAR AHCA3(9) (1980).

FIGURE 8.5: A schematic representation of the Palmiet pumped storage scheme in May 1980.

The lessons learnt from the Drakensberg pumped storage facility were subsequently transferred to the development of the Palmiet pumping facility in the Hottentots-Holland mountains, about 70 km southeast of Cape Town (please refer to Figure 8.5).[1324]

Steenbras hydroelectricity 1978

In June 1978, in the Western Cape, the Steenbras hydroelectric scheme of 180 MW reached completion. At the time it was said to be the first installation of its kind in Africa. The system operated as a hydropower generating system, situated between two reservoirs. One was below the power station, and the other 300 m above the power station. During the day, water was stored in the upper reservoir and at night it was released into the underground system of tunnels to drive four turbines in the power station. At the time of its construction the power station was intended to be of service to Cape Town. The city was running short of electricity supply at peak times each day. During off-peak hours, at night when there was relatively cheap surplus electricity available, the water could be pumped back into the upper reservoir for use the following day.[1325]

One of the advantages of the system was that Cape Town was less dependent on power supply from Escom. At the time, Escom, a costly service provider in a region without sufficient coal deposits for power generation, was responsible for 75% of Cape Town's power supply. The Steenbras project was a measure aimed at protecting Cape Town's power consumers against potential interruptions, breakdowns and expensive power. Unlike the case with a thermal power station, the hydroelectricity plant could start operations within the space of two minutes. The lower reservoir of the system was designed to hold a reserve capacity of water sufficient to provide water for 16 hours of power supply. The reversible system sets were developed in conjunction with the contracting firm of Siemens, in association with Escher Wyss of Switzerland. Siemens was also responsible for the 132 kV SF6 lower voltage switchgear.[1326]

Hydropower: Ruacana

A number of South Africa's leading hydroelectric civil engineers cut their teeth in the 1960s, in the field of hydropower in SWA (Namibia). The potential of the Ruacana hydropower scheme on the border of Namibia and Angola was actually first identified in 1926, but it only materialised in the mid-1970s. The delay was because the authorities on the Namibian and the Angolan side of the

1324. Conradie, Messerschmidt and Morgan (2000:157, 159).

1325. SAWHAR WLC W711 (1978:39).

1326. SAWHAR WLC W711 (1978:39, 43).

river could not reach a compromise on the boundary between the two countries. The project then resurfaced in the mid-1960s as part of the deliberations of the Odendaal Commission, which was tasked with drawing up a development plan for Namibia. Ruacana was again suggested as a potential site for developing power for the territory.[1327]

It was estimated that the system would go into service in 1977, initially to the tune of 80 MW, but shortly afterwards it was planned that another 80 MW power system would come into operation. It was predicted that the system would provide substantial electricity for the South West Africa Water and Electricity Corporation power utility, under the guidance of the IDC until 1985, by which time Namibia would be linked to the Escom grid. Engineers working on the project predicted that within eight years of the completion of Ruacana, the supply of power would be insufficient. In this case, the Namibian authorities could then turn their attention to the Cunene River, where they would be able to secure more hydropower.[1328]

The developments made in electricity in this decade, notably in hydropower, were exceptional. Previously, South Africa was hardly a serious role player in the field of hydropower; it simply could not compete with the iconic Kariba hydropower scheme on the Zambezi River. It is also true to say that hydropower was not foremost in the minds of South African engineers and researchers. The country's coal supplies were abundant and too cheap to bother with water power. However, the success with hydropower at the Gariep reservoir, along the Orange–Fish Tunnel and also the Vanderkloof Dam, provided the necessary incentive for engineers to explore opportunities elsewhere in the country. It was then merely a matter of alerting the political powers that be to these fascinating, but unconventional, plans to use water to generate electricity.

■ Conclusion

The ability to transfer water to and from various places with such consummate skill was a major technical accomplishment for South Africa in the 1970s. It was unconventional, but remarkable, in that the system was ultimately instrumental in providing electricity to the country as a whole. In time to come, South Africa's complex but highly effective water transfer system was internationally recognised as one of the major water transfer systems in the world.

The commitment of the authorities in supporting the water resource development proved well founded. The plans served the national interest and

1327. SAWHAR WLC W688 (1976:12).

1328. SAWHAR WLC W688 (1976:12, 15).

provided a form of technological and socio-economic solace at a time when the country began to prepare for significant political change.

On the environmental front, as outlined above, the measures by the government to combat pollution were timely. The battle against polluted river systems was ongoing. Pollution was the price the country had to pay for rapid development and growth. The government may have lacked the urgency and aspiration to buy into sustainable environmental development, but its Department of Water Affairs remained true to a principled approach to maintain sound water quality in the country's catchments.

Chapter 9

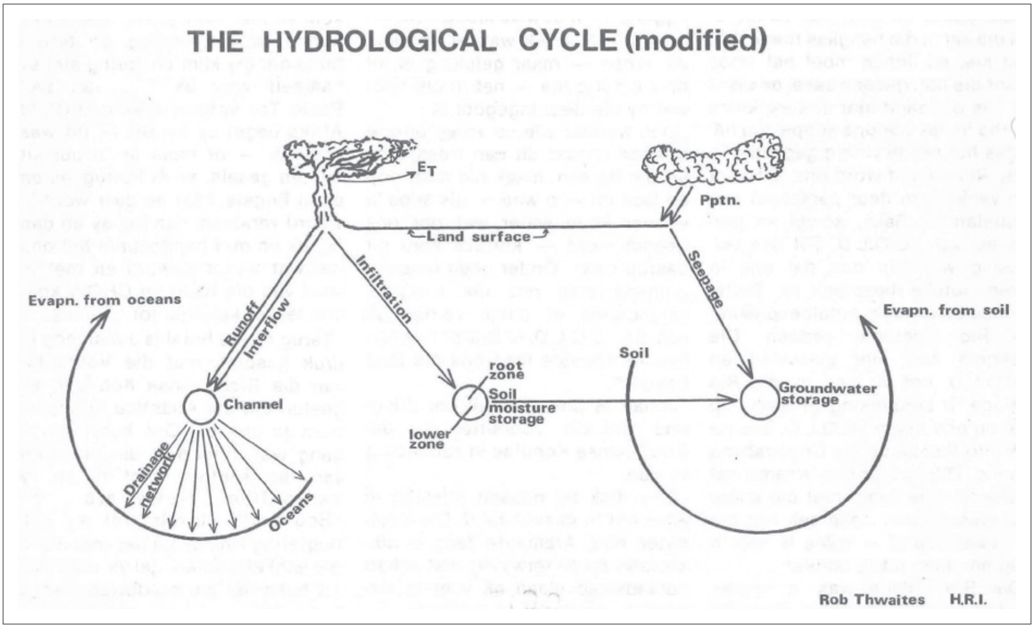
The peak of the energy–industrial hydraulic mission (1980–1990)

Introduction: Economic factors shaping the 1980s

In the 1970s the South African economy grew at an annual rate of 4%. The growth was faster in the first half of the decade than the second. Then, towards the end of the 1970s, there was a spike in the gold price when South Africa's real per capita income achieved its highest level ever. From that time onwards, until 1994, income dropped consistently by 18% over a period of 13 years.[1329] On the surface, it seemed that the performance of the South African economy could simply be ascribed to the normal fluctuations in response to international economic trends. But the deeper-layered shifts in the social, economic and political ecology of South Africa pointed towards far deeper structural changes. Society was preparing for a transformation process that led to significant changes in the way politics were conducted in the country.

How to cite: Tempelhoff, J.W.N., 2018, 'The peak of the energy–industrial hydraulic mission (1980–1990)', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 325-379, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.09

1329. Fedderke and Simkins (2012:181).



Source: Thwaites (1982:19).

FIGURE 9.1: The deterministic mindset in the water sector was humorously expressed by Rob Thwaites in the department's in-house publication. Thwaites used the mechanical workings of a bicycle to provide a metaphorical understanding of the hydrological cycle.

Developments in the country's water sector reflected society's mentality at the time. While maintaining a sophisticated and complex hydraulic mission, the system had to be maintained with a less expansive organisational structure, partly as a result of slow economic growth. The emergent deterministic mindset embraced by the state meant that more had to be done with less. Technology – in the form of more advanced computer systems – were expected to compensate for the decline in human resources.[1330] In some respects this approach was somewhat premature. The country's pariah status and intensified isolation from international relations jeopardised the hopes of introducing advanced technologies.

The stresses of the social ecological system that South African society had to absorb in order to remain resilient, proved too intense. The water sector's energy–industrial hydraulic mission, largely shaped by a strong deterministic drive to take charge of an artificial ecological system, carried significant signs of natural resource exhaustion and environmental stress.

In a Department of Water Affairs in-house publication, Rob Thwaites, a researcher working in the HRI, published an illustration of the hydrological cycle (please refer to Figure 9.1). Using the term 'cycle' in a metaphorical context as a bicycle, Rob Thwaites explained how the natural cycle worked.

1330. SAWHAR DH11/JD1624 J.G. du Plessis Collection (1980:1218).

The fact that it was a mechanical process, suggests the extent to which deterministic thinking shaped the mindset of the country's leading water scientists. From a cultural capital perspective, unwittingly the illustration provides a curiously apt statement of the prevailing mentality at the time.

Maintaining the existing South African industrial–energy hydraulic mission in the 1980s was a concerted attempt at manipulating a contingent state of equilibrium by pleasing a set of exogenous role players, such as Western investors. However, at the time, many Western states who supported free market economics were no longer favourably disposed to supporting the apartheid system in South Africa. Consequently economic, cultural and sporting sanctions were applied in an attempt to force the South African government to change its discriminatory policies.

Restructuring the state's governance system

In the course of the 1980s in the political arena, the South African government prepared itself for a typical panarchy phase of creative collapse. By reorganising the structures of the legislative and executive operations of governance in 1983, it hoped to maintain white minority rule while transferring limited power to South African coloured and Asian minority groups. However, it made the crucial mistake of excluding Africans from these feeble attempts at power sharing. The strategy of holding on to power was essentially a front loop retraction in the infinity framework of panarchy. By conserving real power, it hoped the creative collapse would be limited and a white-controlled state could survive the crisis. However, these plans did not materialise. Exogenous political developments later in the decade prevented their realisation.

In the early 1980s, before launching its new constitutional plans, the government held consultations with senior officials to determine how far it could go ahead on a transformational route. Many years later, Dr Paul Roberts, a senior member of the Department of Water Affairs management at the time, recollected how, across the country's civil service, there were meetings between the political leadership and officials to 'test' their views on various governance proposals and models. Roberts formed part of a group of officials who met at a venue not far from the Union Buildings in Pretoria between 02 November and 06 November 1981 for a course on national security. They were shown 'forbidden' photographs of, among others, the struggle icons Nelson Mandela and Ronnie Kasrils. The officials listened to excerpts of statements made by the leadership of the liberation movement, before being divided into select groups to discuss the concept of the government's proposed tricameral governance system. The proposed new system made no concessions to the black majority. The officials were told that the government intended to 'cater for' Africans in the independent homelands. There was no talk of a single unitary state. About 40 officials of the Department of Water Affairs, from the level of an assistant chief engineer to the deputy director, attended these deliberations.[1331]

By 1982, the new constitutional proposals caused a serious rift in the ruling NP, with the minority group following A.P.Treurnicht to form the Conservative Party. The conservatives openly declared they were not prepared to be told by people of colour how the country would be ruled in future.[1332] In November 1983, white South Africans participated in a referendum on a new constitution for South Africa, which had been approved by parliament earlier in the year.

The new arrangement, billed as 'constitutional reform' made provision for a tricameral legislative system (representative of the country's white, coloured and Indian population groups) and a system of government departments that dealt with 'general' and 'own affairs'. At the helm of the government was the state president, no longer merely ceremonial, but instead with extensive executive powers, similar to those of the former prime minister. The president ruled in consultation with the cabinet.[1333]

An important component of this new tricameral system was the President's Council, an advisory body of well-informed individuals in many fields. The council was first formed in 1981 and in the new dispensation replaced the Westminster-styled upper house, the senate, which had done sterling work since 1910 in keeping a check on parliament's legislative and executive processes. The legislative authority in the new dispensation was seated in a House of Representatives for the coloured population, the House of Delegates for the Indian population, and the House of Assembly for the white population.

In the 1980s the President's Council became a formidable structure of influence in the governance system. It was an *agora* that brought whites, coloureds and Indians together to deliberate openly on critical issues in South African society. The council was proportionally representative of all three participating parliamentary population groups (formula: four white and two coloured representatives, and one Indian representative). Ultimately, the council turned out to be an expert think tank and advisory body with legislative capacities for exploring many issues of critical importance for the country's future development. Importantly, it had to make recommendations on the best potential governance system for the country.[1334] For example, the 1985 council report, *An urbanisation strategy for the Republic of South Africa,* suggested a way forward that dispensed with territorial ethnic segregation and instead focused on an interconnected South Africa, in which eight development regions

1331. SAWHAR WLC W3798 (1982).

1332. Welsh (1984:147–151).

1333. Welsh (1984:153–156).

1334. Welsh (1984:151–153).

paved the way for integrated functional economic, social and political governance units.[1335] Although the report was far from perfect, it did address a number of latent and historical issues that obstructed the structural normalisation of an emergent non-racial society in many of the country's urban areas.[1336]

As will be explained below, the regional management system recommended in the report had a direct impact on the way the Department of Water Affairs was structured in the 1980s. The severe drought (1978–1987), an ecological disaster that lasted for the greater part of the decade, was hardly conducive to creating a suitable climate for constructive deliberations on the transformation of the future South African society.[1337]

At the departmental management level, J.G. du Plessis, the director-general (DG) of water affairs, a civil servant with almost 40 years of service and firmly rooted support for the government of the day,[1338] expressed grave reservations about the proposed splitting-up of the water management functions in the country between the homelands and the 'Republic of South Africa'. According to Roberts, the DG even wrote a memorandum for the attention of cabinet and the civil service commission, advising government against this artificial division of the water sector. Needless to say, government did not respond to the advice and the situation led to the fragmentation of catchment areas in the territories of various homeland areas.[1339]

The adoption of the tricameral system in 1983, and its rejection by the ANC, led to the formation of the United Democratic Front (UDF) in 1984, with comprehensive support from trade unions and black South Africans in the country's townships, all of whom were highly dissatisfied with the new dispensation that excluded direct African participation and representation in the country's politics.[1340]

The next year, the P.W. Botha government declined to negotiate with all South Africans on the new constitutional arrangements, and this led to international condemnation and the imposition of severe economic (and other) sanctions on South Africa in 1985.[1341] The isolation of the 'notorious apartheid state' grew more pervasive. One consequence was that well into the 1990s, the

1335. Morris and Padayachee (1988:9).

1336. Hindson (1985:401–432).

1337. Daniels (1987:1–16).

1338. SAWHAR DH11/JD1713 J.G. du Plessis Collection (1983).

1339. SAWHAR WLC W3798 (1982).

1340. Swilling (1987:1–23).

1341. SAWHAR DH11/JD1634 J.G. du Plessis Collection (1985:1–2).

economy had to withstand turbulent times. South Africa's money literally began to run out, as Fedderke and Simkins point out:

> The excess of government revenue over government expenditure remained positive until the mid-1980s. Thereafter it turned negative, and sharply so by 1993, contemporaneously with growing political crisis. The ratio of government debt to GNP rose from 34.9% in 1985 to 51.4% in 1995, falling back thereafter.[1342]

They argue that in the 1970s, the aggregate South African economic growth was largely a result of significant labour and capital investment. Technology was not one of the drivers in the significant economic growth taking place in the country. By the 1980s technology started featuring more prominently. It compensated for the weaker labour and capital components of the country's economic nexus. Government departments' budgets were cut and some departments were consolidated, in an effort to reduce government expenditure in 1979 to 1980.

The declining economy naturally had a marked effect on the DWA. The new DG, J.F. Otto, warned that the situation made the position of Water Affairs precarious. There would not be sufficient water if an extended period of drought should hit South Africa. He explained:

> If the present trend in the provision of funds continues, attention will also have to be given to the curtailment or suspension of betterment works on existing irrigation schemes or the construction of new schemes. Many of the irrigation schemes [...] constructed 40 or more years ago will, in due course, have to be rebuilt in part or entirely and with a real reduction in expenditure it is going to become more and more difficult to undertake this work, since the supply of domestic and industrial water enjoys preference.[1343]

He also made the point that the increasing number of water transfer systems meant that costly energy was required to pump the water to specific destinations. The cost of water was bound to increase significantly.[1344]

Departmental restructuring 1978–1984

The consolidation of the departments of water affairs and forestry formed part of the government's rationalisation policy in the second half of the 1970s.[1345] The new consolidated department came into existence on 01 April 1980. The former Department of Forestry, as well as the conservation branch of the former Department of Environmental Conservation and Energy, were incorporated into the new department. The official name of this new configuration became

1342. Fedderke and Simkins (2012:181).

1343. RP51/1981 (1981).

1344. RP51/1981 (1981).

1345. RP39/1989 (1989:1).

the Department of Water Affairs, Forestry and Environmental Conservation. The integration included a number of rather odd additions. For example, the National Parks Board, the Lake Districts Board and the National Botanical Gardens were all placed under the new department. The DG of the new-look department was J.F. Otto, with J.G. du Plessis as the deputy DG. A.E. Sonntag was the chief director of administration.

J.G. du Plessis, in his first communication with the staff of Water Affairs, emphasised the austerity measures the state had introduced and called on officials to be supportive. Economically the country was suffering, but the new department was in the process of developing a sound administrative system. He also called on the officials who formed part of the former Department of Water Affairs to refrain from considering themselves inferior in status to the positions they previously held.[1346]

Collectively the department was responsible for the country's governance systems of water, forestry and environmental affairs. The former secretary of water affairs, Dr J.P. Kriel, retired, and his deputy, L.D. (Dale) Hobbs was secretary for a short while before his appointment as chairperson of the Rand Water Board on 01 December 1980.[1347]

The directorate of administration was a unique innovation in the government's reconfiguration of the departmental system. The Department of Environmental Affairs was the only state department that had its own directorate of administration. J.G. du Plessis was strongly in favour of the system. It was, he argued, possible to set up an effective administrative system in the confines of a highly diverse department.[1348]

In the financial year 1981–1982 the name of the department was changed once more. The Department of Water Affairs, Forestry and Environmental Conservation became the Department of Environmental Affairs.[1349] Officials in the former Department of Water Affairs made a concerted effort to integrate with their counterparts in forestry and environmental conservation. The ominous state of affairs, for a government department with a distinct identity and a long tradition of service to the state, was a hard blow to all the water affairs officials. Government's integration of departments in an 'ongoing' manner was a matter of grave concern for many officials in the civil service.[1350] However, government persisted in its strategy. The compatibility between the departments of water, forestry and the environment, was reportedly seated in

1346. SAWHAR DH11/JD1624 J.G. du Plessis Collection (1980:1215–1216).

1347. RP96/1981 (1981:1).

1348. SAWHAR DH11/JD1624 J.G. du Plessis Collection (1980:1216).

1349. RP105/1982 (1982:1).

1350. RP96/1981 (1981:1).

the growing awareness since the 1970s, that there was a need for pollution control measures. The new Department of Environmental Affairs was a working environment for the water sector officials to develop new ideas about the environment.

Officials in the department were certainly aware of environmental issues. In his autobiographical writings J.G. du Plessis noted that in the mid-1970s he was appointed to serve on a departmental committee working on the proposed Tugela government water scheme. There were meetings with the Natal provincial nature conservation chief, John Geddes Page, on matters of environmental awareness and dam construction. Furthermore, departmental officials of the Natal Circle of Water Affairs had been working with nature conservationists for some time. Du Plessis wrote of his visit to the Umfolozi Nature Reserve where he was taken on a guided tour, and how he became even more profoundly aware of the environment.[1351]

At the coalface of operations, the directorate of water affairs maintained its focus on addressing pollution, to ensure that effluents of municipal water users, industries and even the agricultural sector, were less harmful to the aquatic ecosystems of rivers into which they flowed. There was also an awareness of the growth in forestry activities in the country and the impact these had on the water supplies in the river catchments of South Africa.[1352]

In 1980, on the instructions of the government, the department's forestry division was responsible for rethinking the functions of state sawmills. Decisions made on these activities were informed by a report of the Board of Trade and Industry. However, after due consideration, the state's ownership of sawmills was considered unnecessary, and in 1981 the state relinquished its Tweefontein sawmill in favour of a company in which the government and the Merensky Foundation had equal shares. In the same year the Elandshoek government sawmill was sold to SAPPI.[1353]

In 1981 to 1982 the rationalisation of the department, now under the name of environmental affairs, saw the transfer, from the Department of Health and Welfare, those functions that had a direct bearing on water pollution. From the CSIR, the new department then acquired responsibility for timber technology research. However, research related to wood anatomy and tree improvements remained at the CSIR. The legislation related to the new Department of Environmental Affairs was also subject to rationalisation.[1354]

1351. SAWHAR DH11JD770 (n.d.).

1352. Van Vuuren (2013:51–80).

1353. RP96/1981 (1981:1).

1354. RP105/1982 (1982:1).

The department now had a directorate of administration; a directorate of water affairs; and a directorate of forestry and environmental affairs.[1355] In August 1982, the marine development branch of the Department of Agriculture and Sea Fisheries was also transferred to the Department of Environmental Affairs. The step followed in the wake of the commission of enquiry into the fishing industry, also known as the Treurnicht Commission, which made provision, *inter alia*, for a reduction in the quota of pelagic fishing off South Africa's coastline. In its annual report the department noted that there were indications that the country's population was becoming 'more environmentally conscious'. The department expressed the hope that there would be widespread support from government and the population at large for a proposed new strategy to 'keep South Africa beautiful' in 1983, and that more people would help in maintaining and improving the habitat.[1356]

In the medium term the integration of the departments of forestry, environment and water affairs did pay dividends. Officials with varied backgrounds collaborated in a single department and made a collective contribution towards better understanding two major water security risks – droughts and floods. The union between the departments came to an end on 01 September 1984 when the Department of Water Affairs was reinstated as an independent department. J.G. du Plessis then formally became the DG.[1357] One of the major changes in the structure of Water Affairs was the creation of the tricameral parliamentary system in 1984 and the reclassification of functions of the state in terms of 'general affairs' and 'own affairs'.

In the new dispensation the responsibility for irrigation activities (irrigation boards and certain government water schemes) and subsidised borehole drilling activities, as stipulated in Schedule 1 of Section 14 in the new *Republic of South Africa Constitution Amendment Act*, 105 of 1984, was transferred to the respective administrative entities in the House of Assembly, and the newly created House of Representatives and House of Delegates.[1358] In the case of Water Affairs, 26 government water schemes, or portions of schemes, were transferred to 'own affairs' and relegated to either the House of Assembly, the House of Representatives or the House of Delegates. The national department continued to provide engineering and administrative services. The Department of Water Affairs remained responsible for financial aid schemes for farmers, and irrigation boards for the construction of water works, as well as matters of flood relief. Many of these services were officially transferred on 01 September 1984, but the department still stood at the helm of government water schemes

1355. RP105/1982 (1982:4).

1356. RP58/1984 (1984:1).

1357. SAWHAR DH11JD J.G. du Plessis Collection (1987:244).

1358. RP46/1986 (1986:1).

on an agency basis for the transitional period from 01 September 1984 to 31 March 1985.[1359]

In the cabinet there were a number of changes. The directorate of water affairs, previously under the Department of Environmental Affairs, once again became independent. The restored Department of Water Affairs' in-house journal, *Waboom,* did not hide its delight with the arrangement, in an editorial titled 'Dit was amper!' (*That was a narrow escape!)* in December 1984.[1360] In terms of ministerial and cabinet oversight, the department was grouped within the portfolio of the Ministry of Agricultural Economics and Water Affairs. In the new dispensation, J.G. du Plessis' deputy was G.C.D. Claassens. The annual report for 1984–1985 notes that there was a concerted effort to create a sense of 'team spirit amongst the staff and to promote involvement in the new department'.[1361] On 01 September 1987 Claassens succeeded Du Plessis as director- general.

Under this new arrangement, the DWA engaged with the homeland governments in management committees, where representatives of the independent and self-governing territories deliberated on water matters. Working in terms of the Helsinki rules, a number of projects were earmarked for development by the department, in partnership with homeland officials.[1362] A notable feature of the new dispensation was that officials now received market-related remuneration. This had a positive effect on staff morale and there was a significant decline in the number of resignations from the department. In the three years preceding the transition to the new department there was an average annual resignation rate of 81 engineers, whereas from 1984 the situation changed completely, with a greater number of engineers joining the department.

The revived Department of Water Affairs

Chief directorate of administration

One of the major innovations in the Department of Water Affairs was the creation of a chief directorate for administration. The group of administrative officials who had been part of the former Department of Environmental Affairs simply split up. One half joined environmental affairs and the other joined water affairs. The components of the chief directorate of administration included the directorates of personnel administration, legal administration and

1359. RP46/1986 (1986:51).

1360. Redaksioneel (1984:2).

1361. RP46/1986 (1986:1).

1362. SAWHAR DH11/JD1634 J.G. du Plessis Collection (1985:1–2).

financial administration. Sub-directorates included those of organisation and work study, special services, and the liaison division. There were still staff shortages, and one matter of concern was the significant shortfall of experience and institutional knowledge in the department. The Department of Water Affairs was able to render a high standard of service, largely because of the constructive sequences of departmental adaptation that officials were exposed to, and the cross-pollination of strategies for executing complex tasks. In some sections of the department there were still shortages, especially at the entry and supervisory level. In the administrative section there was an over-reliance on temporary staff, while engineers were 15% below capacity. A total of 64 of the 410 existing posts of engineer and senior engineer had not been filled.[1363] With the exception of the Department of Transport, the Department of Water Affairs had the largest number of civil engineers in the country's public service.

An institutional climate study of the engineering human resources category in the department brought to light that as a rule, the engineers believed the department was too large and far too structured, with low responsibility levels. There was discontent with the low salary scale, and there were few rewards for work well done. In addition, support standards and empowerment in terms of responsibilities were hardly forthcoming. Most of the dissatisfaction emanated from young engineers in the department.[1364]

At the time, the Public Service Commission was engaged in a process of having officials work in the direction of management rather than mere administration.[1365] The approach was to be more businesslike, with a strong focus on economic activity. By 1989, there was a drop in the number of staff in several occupational classes, such as personnel officers. There were still too few engineers and industrial technicians. The exodus of people from the civil service was said to have taken on critical proportions.[1366]

Finances of the Department of Water Affairs as of 1984

In the 1984 transition to the new dispensation, the department used R228.163m of a R239.163m budget allocation. The savings were made by delaying expenditure on non-essential works and services, in accordance with the government's call to keep savings measures in place.[1367] For the department this was not an ideal situation. The annual report for 1984–1985 pointed out

1363. RP46/1986 (1986:9).

1364. SAWHAR AHCA5/091 (1985:60).

1365. Rademayer (1985:4–6).

1366. RP91/1989 (1989:7).

1367. Fedderke and Simkins (2012:181).

that for at least a decade there had been restrictions on funding, which added to the backlog of development projects. The consequence was that in future, more money would be required to address the growing water needs in the country.[1368]

Estimates in the department suggested that in future, the funds available to the department up to the year 2000 had to increase by 8% p/a to keep abreast of the need for more water. On 31 March 1985, the department had 16 197 people in its employ. There were 3339 incumbents of civil service posts, and 5318 general assistants, who had been appointed in terms of the *Public Service Act*. People appointed in terms of the *Water Act* of 1956 included 896 white employees and 6644 coloured, Asian and black employees.[1369]

In the new department it was evident that personnel management was of vital importance. There was some form of compensation for innovative technological methods to cut down on expenditure. By 1985 the department was in the process of developing a computerised personnel management system. The drought (1978–1987) also took its toll in the department's revenue from irrigation water in 1984–1985. Water rights sold along the Orange River amounted to R4.7m, but the department still had a deficit of R9.5m at the end of the 1984–1985 financial year. Operating costs increased from R10.8m in 1983–1984 to R14.2m in 1984–1985. In terms of industrial and domestic scheme finances, in 1984–1985 there was a surplus over operating expenses used for interest and capital redemption. The increase from R49.3m in 1983–1984 to R50.8m in 1984–1985 meant that R800 000 could be used for capital redemption.[1370]

Directorate of legal administration

In 1984 the new directorate of legal administration reported that an amendment had been made to the *Water Act*. The *Water Amendment Act, 96 of 1984* aimed at:

- promoting efficiency by removing a great deal of red tape in the administration of irrigation and water boards, and scrapping parts of the unnecessary and/or restrictive clauses that had previously been incorporated in the legislation
- granting the minister greater powers for the control of pollution, and moving the legislation away from actions against polluters, in the direction of prevention of pollution
- giving the minister more power in terms of the abstraction and utilisation of public water

1368. RP46/1986 (1986:1).

1369. RP46/1986 (1986:10).

1370. RP46/1986 (1986:14).

- making provision for promoting the safety of large dams by vesting in the minister the powers to regulate and determine the norms of design, construction and maintenance of larger dams.

The department was well aware of its responsibility to care for the water resources of the country in times of drought. With this in mind, in 1984 to 1985 officials responded to 23 complaints, of which 15 were for contraventions related to water pollution, while six had a bearing on the construction of illegal water works, or the unlawful abstraction of water.[1371] In 1984 to 1985 two decisions were handed down by the Cape Water Court, one by the eastern districts (Eastern Cape) and one by the Transvaal Water Court.

While the private and unlawful construction of water infrastructure started proliferating, to the extent that special legislative measures had to be approved to address the threat to departmental infrastructure development planning, the department appeared to be lagging in its efforts to keep abreast of its development agenda. By 1986, the need for significant expenditure on water resources remained and the department's management alerted government of the need to make provision for potential growth of at least 8% p/a in expenditure on water resources to keep the country's water supplies abreast of general development and population growth.[1372] The 'regions' formally replaced the old 'circles' in 1987 to 1988.[1373] The challenge was to ensure that the country would have sufficient water resources available in the various regions to ensure security of water supply (see Figure 9.2). The long-term projections of 1986 suggested that even if and when the Lesotho Highlands Water Project came on line, there might well be shortages. The country's growing population and widespread development required far more water. The planners worked on an extensive record of past accomplishments and were somewhat pessimistic in terms of the anticipated costs. South Africa's economic growth was low and the prevailing drought conditions contributed to a sense of depression in society at large.[1374]

By this time the department's engineers, in collaboration with local consulting firms and academics, were hard at work securing the right type of data and the ideal computer software for modelling the country's major water systems.

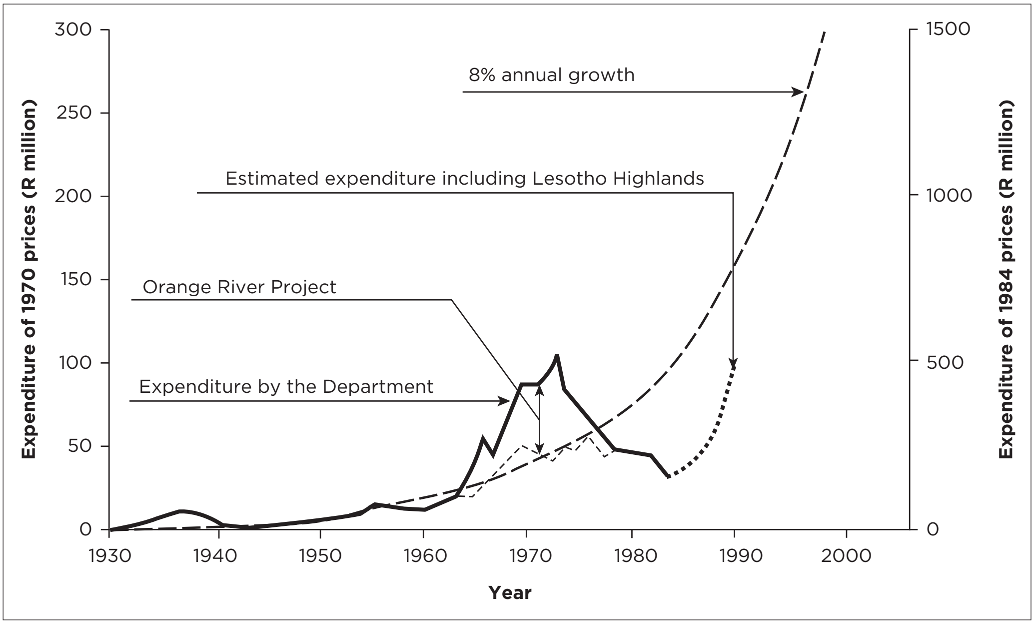
From 1987 to 1988, far-reaching changes followed in the composition of the department. It was essentially divided into two branches, namely, the water resource development branch and the water utilisation branch. The branches were both served by the chief directorate of administration, established earlier.

1371. RP46/1986 (1986:12).

1372. RP75/1987 (1987:3).

1373. Van Vuuren (n.d.).

1374. SAWHAR DH11/JD1603 J.G. du Plessis Collection (1985:3–4).



Source: RP46/1986 (1986:2).

FIGURE 9.2: A 1986 projection of water resource development and the need for capital expenditure estimates between 1930 and 2010.

South Africa's surface area was divided into six geographical regions (please see Figure 9.3). In the process what had previously been the circle offices were reorganised in the six regions, as was also the case with offices, regional organisations and schemes. The new regional offices were:

- Western Cape in Cape Town
- Eastern Cape in Cradock
- Highveld region (in Pretoria)
- Free State region (in Bloemfontein)
- Transvaal region (also in Pretoria).

The six regions fell under the responsibility of the water utilisation branch.[1375]

The reorganisation of the Pretoria head office, along with the devolution of functions, resulted in a number of further changes. A second deputy DG and an additional director's post were created. There was now also a formal director of administration. Six posts of regional directors were created to manage the six regions.[1376]

1375. RP39/1989 (1989:13).

1376. RP39/1989 (1989:13).

Source: RP91/1989 (1989:10).

FIGURE 9.3: The catchment regions of South Africa in terms of the organisation of the Department of Water Affairs in 1987–1988.

■ Marketing water transfer schemes

To backtrack to 1980, the newly formed Department of Environmental Affairs was more than aware of the growing need for sufficient water of a sound quality to be readily available for consumers. In 1981, the departmental DG articulated the focus as being directed at the development of more water transfer systems, in an effort to ensure a sufficient supply:

> Since water in sufficient quantities and of the desired quality is not always readily available in the immediate surroundings of growth points, it has become imperative for the survival and balanced growth of the country that water should be transferred between catchment areas. This will continue in the years ahead, as in the past, in an orderly manner.[1377]

1377. RP96/1981 (1981:1).

In 1984, Van Robbroeck noted that the desirability of transferring water from river catchments which had a relative surplus to those with less water, would come under increasing pressure when the country reached the capacity of its available water supplies.[1378] For many years, he pointed out, there had been a debate on the desirability of this approach. In his view it was absolutely essential to get water from underdeveloped areas to those regions where it could be put to best use. Van Robbroeck explained that viable metropoles had arisen precisely because of their advantageous location in relation to natural resources, transport facilities and the like. In addition, cities had the benefit of a scale effect – there was a greater diversity of services and marketing activities under circumstances of agglomeration.

He went on to say that only once the population began to increase substantially, would negative elements such as crime, traffic congestion and pollution emerge. These and many other factors would then neutralise the benefits of urban metropoles. In the mid-1980s it appeared that the government was not opposed to the ongoing development of metropolitan areas. They would surely not have contemplated stifling urban growth by withholding essential water supplies from these centres of growth and development, for example.[1379]

Inter-basin transfer schemes

In the 1980s the Rand Water Board's engineering division was at the forefront of plans for a water transfer system to increase the supply of water to the Vaal Dam. The board's first-hand experience of water shortages dated back to the 1960s when the utility, at the time of severe drought, was the prime provider of water services to the Pretoria–Witwatersrand–Vereeniging (PWV) conurbation. For obvious reasons the water board was one of the first institutions to make a submission to the government's commission of enquiry into water matters (1966–1969) where the plan was proposed to use the Tugela River as part of a comprehensive water transfer system to the Vaal Dam.[1380]

Originally, the first Tugela–Vaal water transfer scheme relied on the Jagersrust Dam to pump water to the Sterkfontein Dam, which in its first phase was designed to pump 330 ML/d – 440 ML/d from the Tugela via Jagersrust to the new dam. The water was stored in the Sterkfontein Dam for use under critical circumstances of shortfall.[1381] Once the hydropower potential of the Drakensberg region became

1378. Van Robbroeck (1985:93).

1379. Van Robbroeck (1985:93).

1380. Tempelhoff (2003:251–252).

1381. Tempelhoff (2003:290–293).

evident and the Department of Water Affairs engaged with Escom, the water transfer system acquired a totally new significance.

The Drakensberg pumped storage scheme was completed in May 1981, and it then was possible for Escom to provide the first water from the Kilburn Dam to the Sterkfontein Dam.[1382] The project had won an award from SAICE. At the time of its completion the scheme was considered an example of productive cooperation between government departments and other bodies – in this case Escom and the Department of Water Affairs. It was described as an interdisciplinary project with significant benefits for the country. The first phase of Sterkfontein was completed in 1977. By 1981 to 1982 work had started on raising the dam wall by increasing the vertical height of the wall from 30 m to 63 m; the total width of the wall also had to be increased.[1383]

The experience gained at Sterkfontein, and Water Affairs' growing institutional knowledge on water transfer systems and hydropower, became useful elsewhere in the country. In November 1981 in the Western Cape a similar, but significantly smaller, transfer system began operations when the first water from the Theewaterskloof Dam was transferred via the Jonkershoek tunnel system to the Blackheath purification works in Cape Town.[1384] A notable feature of departmental activity in the development of water transfer systems at the time was the accent given to environmental awareness. In 1980, at the time of J.G. du Plessis' appointment at the helm of the directorate of water, in the Department of Environmental Affairs, he stressed the need to pay dedicated attention to the environment.[1385]

The new proposals for development of infrastructure in the 1980s made provision for four large dams in the upper reaches of the Orange River in the Highlands of Lesotho, along with tunnels extending a collective distance of some 200 km. In 1984 the scheme envisaged providing 2200 MCM/a to the upper reaches of the Vaal River at Bethlehem. The largest inter-basin transfer scheme at the time was still the Orange–Fish and Fish–Sundays project that formed part of the Orange River scheme. The 82 km tunnel that linked the Orange River and the Fish River valley was at the time (and is still) considered to be the longest of its kind in the world.[1386]

By 1982 the primary source of supply to the Sasol II plant in the eastern Transvaal (Figure 9.4) was the Grootdraai Dam, situated in the Upper Vaal River

1382. RP105/1982 (1982:1).

1383. Technical information: Dr Paul Roberts [Pretoria] pers. comm., 12 March 2017.

1384. RP105/1982 (1982:1).

1385. SAWHAR DH11/JD1624 J.G. du Plessis Collection (1980:1218).

1386. Van Robbroeck (1985:97).

Source: Schrenk (1982:25).
FIGURE 9.4: Sasol II and III, *c*. 1982.

catchment near Standerton, and capable of providing Sasol with about 200 ML/d and a high certainty of consistent supply.[1387] As a result of South Africa's long-standing shortage of water supplies in general, special plans were made in developing the new Sasol plant to use as little water as possible.[1388] The plant had been developed from the outset for the reuse of effluent.

The Sasol complex used different methods for upgrading effluent. The effluents were from water products that originated in the purification process itself. Secondly, there were saleable products retrievable from effluents in certain streams. The rest of the material was transferred to a biological effluent treatment plant, where chemicals such as phenols, ammonia and other organic chemicals were extracted. Another source of effluent was water that had accumulated as a result of stormwater and oil-water dams via the different stormwater and oily sewers throughout the factory. This water contained oil, alcohols and other chemicals. A third type of water was the blowdown from the process in the cooling towers. The blowdown was essential to keep the salt at acceptable levels. Sewage water from separate domestic sources was also treated in a dedicated domestic sewage plant.[1389]

1387. SAWHAR WLC W1620 (1980:1–7).

1388. Schrenk (1982:24).

1389. Ginster pers. comm., 2018.

Transboundary water relations: The LHWP

The Lesotho Highlands Water Project (LHWP) was a remarkable accomplishment. Ever since the 19th century the mountain Kingdom of Lesotho had been subject to the whims of neighbouring indigenous and European-styled states and colonies. In the 20th century Lesotho was reliant for its economic survival on South Africa. The greater part of its income was from the male population who worked as migrant labourers on the South African gold mines. However, the country managed to remain a largely rural African state where Basotho traditions were passed down from one generation to the next. Lesotho did have one prime trump card in the evolving social ecology of southern Africa. About 50% of the water of the total catchment of central South Africa's Orange River came from a small portion of land – about 5% of the surface area of Lesotho.[1390]

In the 1980s South Africa's military forays into neighbouring states were frequent. The government tried to stave off ANC freedom fighters from launching acts of sabotage from neighbouring territories into South Africa. Despite these political activities, the governments of South Africa and Lesotho had come to an understanding in the early 1980s that for Lesotho to supply South Africa with water would be to the benefit of both states. Talks had been ongoing despite diplomatic and political differences of opinion.[1391]

South Africa's military forays into Lesotho did not find favour with Lesotho's government or its people. South Africa, for its part, also had cause for concern about Lesotho. In 1985 the South African government began an economic blockade of Lesotho after the government of Prime Minister Leabua Jonathan announced the opening of a Cuban embassy in the Lesotho capital of Maseru. In January 1986 there was a military coup d'etat in Lesotho, with Jonathan being overthrown and Major General J.M. Lekhanya taking over. On 24 October of the same year Lesotho and South Africa signed the LHWP agreement.[1392]

In historical terms, South Africa's interest in the mountain water of Lesotho can be dated back to the 1830s' description by Arbousset and Daumas of the 'Blue Mountain' and its water that fed into the Orange River.[1393] Plans to secure the water became a strategic imperative in the years after the Second World War, when the modern South African economy started taking off. In 1955 to 1956 the first studies were conducted by the engineering firm of Ninham Shand

1390. SAWHAR AHCA18/002 (1985:2–3).

1391. Turton et al. (2004:247–251).

1392. Baynham and Mills (1987:52–54).

1393. Arbousset and Daumas (1846).

on behalf of the government of Lesotho, as part of a comprehensive programme to collect hydrological, topographic and geological data.[1394]

In 1968, the same consultancy was contracted by the government of Lesotho with a view to developing storage reservoirs at Oxbow and Pelaneng on the Malibatso River, with tunnels northward to convey water to South Africa. The first phase was a tunnel from the reservoir at Oxbow and another reservoir at Pelaneng to enlarge the yield of water. In 1978, the governments of Lesotho and South Africa appointed a joint technical committee to report on the project. Then followed a joint feasibility project, with each government appointing its own consultants. In the new plans submitted to the governments there were plans for five reservoirs in the Lesotho Highlands (Oxbow, Pelaneng, Soai, Polihali and Taung) and about 102 km of tunnel transfer. As far as Lesotho was concerned, hydropower was a central part of the planning for the project. Planners estimated that if the project was to go ahead it might be possible to have the system in operation by 1992.

From 1980 to 1981, formal deliberations began between South Africa and the government of Lesotho on the proposed LHWP.[1395] There were also talks with the government of Swaziland on joint studies of the Komati Basin and the Umpilisi River.[1396] In 1983 to 1984 the directorate of water affairs submitted a comprehensive report of a reconnaissance study on the Komati River that had been drawn up by its staff members, in collaboration with the authorities in Swaziland. Consulting engineers were responsible for the technical report, which also featured a long-term development plan that included the construction of two dams in the system.[1397] Swaziland's US advisers and counsellors had high praise for the quality of the report.

The first phase of a feasibility study on the Lesotho Highlands project pointed to there being 'no significant economical, technical, and environmental objections against the proposed scheme', but the country's directorate of water affairs kept itself busy with ongoing investigations to determine the layout of the final scheme. In August 1983 the South African team started collaborating with their Lesotho counterparts on a final feasibility study of the proposed project.[1398]

Ninham Shand, who had worked on the original 1950s investigation, conducted yet another investigation into the scheme for the South African government, following deliberations between the two states, who were

1394. SAWHAR AHCA18/001 (1984)

1395. RP96/1981 (1981:2).

1396. RP105/1982 (1982:2).

1397. RP28/1984 (1985:48).

1398. RP28/1984 (1985:1).

both eager for the project to go ahead. The South African requirement was for the LHWP to:

- provide water from the Orange River to the Vaal River system by means of an alternative project located wholly in South Africa
- secure hydropower for Lesotho, in conjunction with the water transfer, by using the difference of elevation between the Senqu and Vaal basins as the driver for generating electricity
- promote the general development of the remote and underdeveloped Senqu region, while ensuring that the measures taken to secure the water and generate the power would not be to the detriment of the local people and their environment.[1399]

Of prime importance was the issue of determining the value of the LHWP. The proposed scheme was then compared to the Orange–Vaal Transfer Scheme (OVTS), which was situated entirely in South Africa. From a strategic perspective, at the time the OVTS made sense. It was technically possible to try and safeguard South African control of the water within the existing boundaries of the state. However, from a financial and engineering perspective, there was a far more effective approach to properly valuing the system.

The department's engineers and the consultants then worked on discounting the cost of the construction project, as well as the operating costs of the two projects, from a 'present day' perspective. In terms of the calculations it transpired that the OVTS was far more expensive than the proposed LHWP. In calculating the value of the LHWP, in the spirit of collaboration between the two states, it was decided to share the nett benefit, with Lesotho securing a benefit of 55% while 45% was scheduled for South Africa. According to Roberts, the calculations of the royalties from the water supplied were complex and constantly calculated to benefit Lesotho.[1400]

The LHWP was divided up into four phases. Phase 1A consisted of the Katse Dam (1950 MCM), and a 45 km transfer tunnel leading to the Muela power station of 72 MW, which fed from the Muela Dam, before rushing down a 36 km tunnel, which then fell out into the Axle-Ash River. Phase 1B consisted of the Mohale Dam, with a total capacity of 958MCM; the Matsoku weir; and transfer tunnel of 6.4 km. Phase 2 was the Mashai Dam (3306 MCM); a second transfer delivery tunnel from the Katse reservoirs to the Ash River outfall. Phase 3 was scheduled to consist of the Tsoelike Dam, with a 2225 MCM capacity and a pumping station. Phase 4 was scheduled to be the Ntoahae Dam and a pumping station.[1401]

1399. SAWHAR AHCA18/001 (1984).

1400. Roberts [Pretoria] pers. comm., 2017.

1401. SAWHAR AHCA18/010 (1992:4).

The LHWP had a profound effect on the Department of Water Affairs. A significant amount of work and planning surfaced in the course of 1986 to 1987. Strategic planners were convinced that the LHWP had to be the future route for South Africa's water supply.[1402] Earlier, the department had been responsible for the construction of weirs on the Orange River in Lesotho to improve the hydrological knowledge of the river. A number of bodies were also established. The Joint Permanent Technical Commission (JPTC) comprised representatives from South Africa and from Lesotho, but this was only one part of the development planning. The JPTC was subsequently renamed the Lesotho Highlands Water Commission (LHWC).[1403]

In addition, there was a Lesotho Highlands Development Authority (LHDA) which was a Lesotho-based autonomous statutory body entrusted with the implementation of the part of the project in Lesotho.[1404] For logistical purposes, a portion of the northern section of the delivery tunnel came under the authority of the LHDA, while the southern section came under the Trans-Caledon Tunnel Authority (TCTA). Both the TCTA and the LHDA were accountable to the LHWC.[1405]

The first phase of the project was the construction of the Katse Dam and the Mohale Dam in Lesotho. The two dams were situated on tributaries of the Orange-Senqu River in the mountain kingdom. Water was scheduled to be transferred at $27\,m^3/s$ via tunnels to the upper reaches of the Wilge River in South Africa. Inside Lesotho, a hydropower system would be driven by the gradient of the tunnels. The water supply to South Africa was scheduled to begin by 1995. However, the full output of the supply was only scheduled to come into effect in 2002.[1406]

The contract for the design of the delivery tunnel was awarded to the Highlands Delivery Tunnel Consultants in April 1987. As a result of survey and additional explorations, the scheme was re-optimised and important changes were made to the original plan. Changes included:

- a substantial increase in the height of the Katse Dam
- the elimination of the Sentelina head-pond of the hydroelectric power station, making it possible for the hydroelectric system to link up directly to the Katse Dam
- the substitution of the Tlhaka tail-pond on the Nqoe River
- the elimination of control valves on the delivery tunnel (Figure 9.5).[1407]

1402. SAWHAR ZKC (1986:Sections, 3.7, 5.4.1, 9.9).

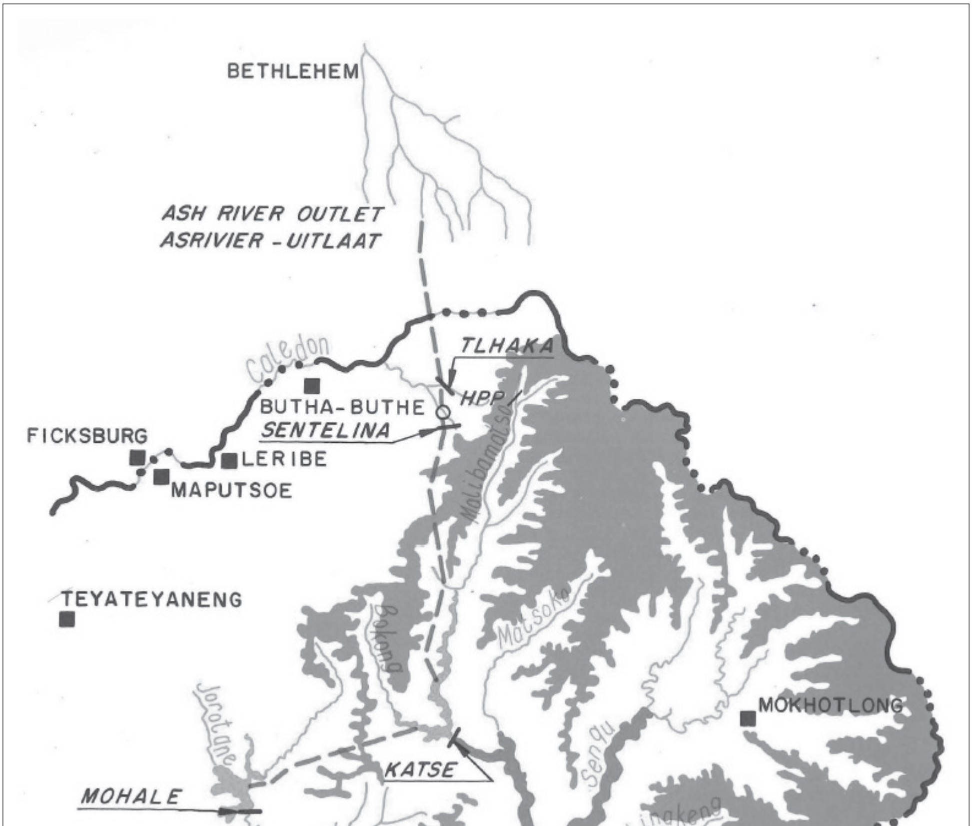
1403. Roberts pers. comm., 2017.

1404. RP53/1988 (1988:9).

1405. Roberts [Pretoria] pers. comm., 2017.

1406. RP53/1988 (1988:9).

1407. RP39/1989 (1989:10).



Source: RP53/1988 (1988:10).

FIGURE 9.5: The proposed Lesotho Highlands Water Project in 1986.

Water consumers were also made aware of the need to start planning for the comprehensive expenditure that accompanied the construction of one of the largest dam systems in Africa. A 1992 estimate suggested that at the time of the completion of Phase 1A of the scheme, the project cost might reach R8.2 billion.[1408]

Strategic water planning for the future was of paramount importance to the management of the department. In 1988, the planners responsible for projections on the need for water by 2025 explained that the proposed LHWP was the most desirable of numerous augmentation proposals that had been tabled. Their projections suggested that the first phase of the LHWP could be a water diversion to South Africa of as much as $851.10^6\ m^3/a$. The final scheme was calculated as being able to provide as much as $2200.10^6\ m^3/a$.[1409]

As a result of the considerable capital investment in the project, the planners pointed out that the best option would be to work on comprehensive reliable forecasting. That was the main purpose of the 1988 report. A long drought, dating back to the late 1970s, had just ended in South Africa. There was more than enough awareness of the need for strategic interventions to counter drought-related water shortfalls. South African water consumers did not require much to convince them of the LHWP's benefits.

Developing an understanding of droughts and floods

Although the water sector had gained significant insight into drought conditions since the 1960s, and had increased the number of water storage facilities substantially in many parts of the country, there was still scant practical experience of dealing with drought conditions. IT and greater familiarity with computer-based data techniques were growing apace. It was now possible to do more accurate modelling and innovative blue-sky speculation.

First-hand experience of dealing with drought conditions still appeared to be absent – especially for a new generation of water sector operators. There seemed to be collective amnesia about drought conditions among the younger generation – many of who had joined the department after the 1960s drought. With the benefit of hindsight, it is evident that memories of drought, and even flooding, do not always register for extended periods of time in society's collective memory. Although the new generation of 1980s water workers appeared to have considerably more technical knowledge than their predecessors, they had little practical experience of these conditions. What was known, however, was that in the period 1974 to 1980

1408. SAWHAR AHCA18/010 (1992:6).

1409. Department of Water Affairs and Forestry (1988:2.3).

TABLE 9.1: State of storage in South Africa's major dams 1974–1980.

Year	Total water % in SA dams
1974	93
1975	95
1976	97
1977	91
1978	85
1979	66
1980	74

Source: Based on data from RP51/1981 (1981:33).

the dams of South Africa went through a relatively stable cycle as inidicated in Table 9.1. But then things changed.

Between 1979 and 1980 the greater part of South Africa experienced a substantial increase in rainfall; in the regions of Port Elizabeth and Pietersburg there were even floods, causing severe damage. But dam levels were lower than in 1974. In 1979 to 1980 there was an extended period of low rainfall in the north-western Cape and drought conditions started taking on serious proportions. In March 1980, the Loskop Dam area to the east of Pretoria experienced good rains, after an extended period of drought[1410] and water restrictions for users of the dam could be lifted. This was the lowest the dam's level had been since 1966. Similarly, in the case of the Vaal River, the inflows into the system only started improving from March 1980.[1411]

By the end of the summer of 1982 to 1983 serious drought conditions prevailed in the summer rainfall areas of the country. In some quarters, it was argued, drought conditions were the worst in over a century – largely because for the first time the country had to import 1.5 million tonnes of food.[1412] The directorate of water affairs then started making contingency plans. One of the options was to introduce water restrictions. However, they remained sensitive, because:

> Since water is the lifeblood of a country, drought conditions follow a fairly fixed pattern, industrial expansion takes place at a reasonably constant rate, and the latter tendency, together with the increase in population, results in increasing demands for water, it is essential that the actual expenditure on the establishment of additional water storage and distribution facilities is increased in future to deal with the backlog and to make provision for future increases in consumption.[1413]

The main obstacle to addressing the crisis of drought was the shortage of state funding. The government had been busy with austerity measures for some time.

1410. RP51/1981 (1981:1).

1411. RP51/1981 (1981:28).

1412. Glantz and Katz (1985:336).

1413. RP58/1984 (1984:1).

Construction work on a number of scheduled dams, dating back to the 1970s, was still on the cards in 1980 when J.G. du Plessis was appointed at the helm of the directorate.[1414] However, in 1982 to 1983 it was impossible to start new water scheme projects. The water directorate, one of the more comprehensive departments, could not even undertake betterment schemes at Vaalharts, Upington Islands or the Kakamas canals.[1415] Clearly, the chickens were coming home to roost. Insufficient government funding on upgrading its water storage resources started taking its toll under drought conditions.

It helped, however, that the Department of Water Affairs once again became autonomous. Almost immediately it was apparent that water security was a prime management objective. The DG, J.G. du Plessis, reaffirmed the department's commitment to essential dam construction. For several years there had been concerns about constraints on money to be spent on the augmentation of the state's water supply. Pointers such as burgeoning urban areas and rapid population growth hardly influenced plans to enhance the state's existing water capacity. The drought conditions forced the department's hand; it had to secure more water,[1416] but the necessary planning would take time. What did augur well for the future was the beginning of negotiations between the South African government and the Kingdom of Lesotho on the development of the Lesotho Highlands Water Scheme. At the same time, the department was working on plans for the Komati River basin, as well as the Umpulisi River, where there were ongoing deliberations between the Kingdom of Swaziland's government and that of South Africa.[1417]

The water department's public relations team acted skilfully in creating an awareness of the seriousness of the drought situation. In their engagements with the public, officials in all sections of the directorate called for water conservation. There was an increased public presence of the directorate on the radio and television services of the SABC. At the national level, in 1983 the department designed three posters with a strong water conservation message, and also printed a brochure for public distribution. The public relations staff followed suit, taking the opportunity to distribute new material on water and pollution matters.[1418]

In 1983, the directorate's hydrology division worked on drought studies. Experts reported that the flow of rivers had decreased alarmingly in the eastern and northern areas of South Africa. The first signs of the onset of the new

1414. SAWHAR DH11/JD1624 J.G. du Plessis Collection (1980:1218).

1415. RP58/1984 (1984:1).

1416. SAWHAR DH11/JD1634 J.G. du Plessis Collection (1985:1–2).

1417. RP58/1984 (1984:1).

1418. RP58/1984 (1984:25).

drought, the department's researchers suggested, were apparent as early as October 1976 when there were reports of serious drought conditions in the catchment of the Kalkfontein Dam. In other areas of the country the drought began in about October 1978. Natal and the Eastern Cape were the hardest hit, followed by the Vaal catchment area and the south-eastern Transvaal. The drought flows of water were comparable with a probability of occurrence of only 0.5%. Apart from noting the subnormal rainfall and its scattered distribution, hydrologists also noted that the drought had an impact on agricultural crops, dam catchments and forestry regions. In the entire catchment of the Vaal River the total rainfall was only 375 MCM for the period 1982 to 1983. This was the lowest since the first records started in the Vaal catchment in 1923.[1419]

Drought research conducted in the hydrology division, in collaboration with the University of Stellenbosch, paved the way for the development of an extremely effective way of daily modelling of the rainfall stations at 2500 points in South Africa.[1420] When the drought persisted and water restrictions were introduced by the Rand Water Board, the geohydrological division of Water Affairs was inundated with 650 enquiries in the municipal area of Pretoria about the potential of using groundwater resources.[1421] Subsequently the division, in a regional context, made comprehensive recommendations for water drilling operations in dolomitic areas south of Pretoria; in an area west of Krugersdorp; and another area south-west of Johannesburg. The implications of the drought registered profoundly in the country's energy sector in 1982 to 1983. A White Paper to parliament explained why it was necessary to double the pipelines between the Grootdraai Dam and the Trichardtsfontein balancing dam, at a cost of R16m. It was all in an effort to counter the impact of drought conditions on the water supply to Sasol's plants at Secunda in the eastern Transvaal.[1422]

Energy security was an important component of the department's hydraulic mission. Because of the drought conditions special measures were taken to assure supplies of water to the energy sector (please see Figure 9.6). In 1982, when it appeared that there was no drought relief in sight, the department began contingency plans for water. The Komati, Usutu and Usutu–Vaal transfer systems had been designed to provide most power stations with alternative water supplies in times of crisis. For example, it was possible for the Matla and Kriel power stations to receive water from either the Usutu scheme, or the Usutu–Vaal lead system.[1423]

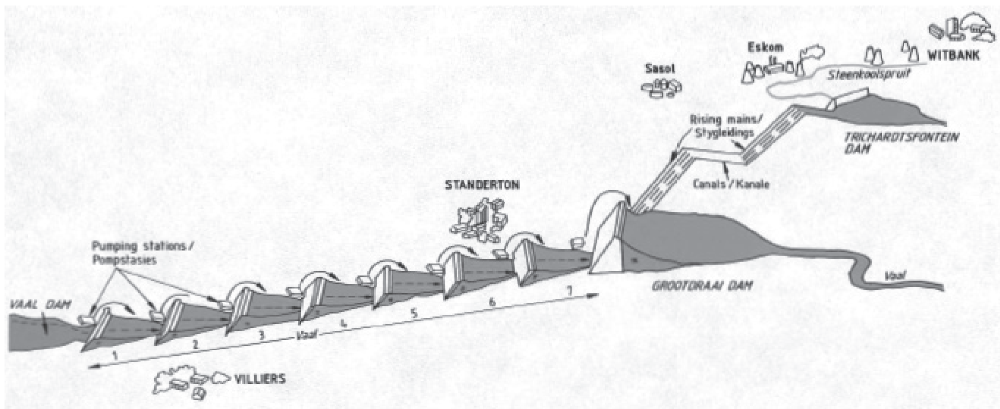
1419. RP58/1984 (1984:28).

1420. RP28/1984 (1984:23).

1421. RP58/1984 (1984:31–32).

1422. RP58/1984 (1984:70); WP K83 (1983); WP F84 (1984).

1423. Department of Water Affairs and Forestry (1986b:12).



Source: SAWHAR AHCA2/018 (1991:12).

FIGURE 9.6: Schematic plan of the 1983 Grootdraai emergency scheme. The plan meant that water would be pumped upstream into seven dams from the Vaal to the Grootdraai Dam to ensure that the eastern Transvaal's energy producing sector did not grind to a halt as a result of drought conditions.

The Grootdraai Dam proved its worth when the Usutu River ran dry in the early 1980s. The level in the Komati River had dropped and regional consumers had to fall back on the Grootdraai Dam for supplies. The country's energy sector now faced an imminent rapid-onset disaster. If the water supply ran out, an estimated 80% of South Africa's supply of electricity would be compromised. Given this dire situation, it was decided to build an emergency supply system to secure water from the Vaal Dam to the Grootdraai Dam.[1424]

Four months before the water supply of the Grootdraai was expected to be exhausted, construction work began on a series of seven weirs that would hold water that could then be pumped upstream in the system from the Vaal Dam to the Grootdraai. The Vaal River's water was meanwhile augmented by the Tugela–Vaal inter-basin transfer system. By introducing this critical measure it was possible to connect the rivers of the Komati, Usutu, Vaal and Tugela. It was a clear indication that the government and the department were determined to ensure that the 'energy heart of South Africa' could be sustained.[1425]

Several emergency measures were introduced by the directorate of water affairs, to contend with what was rapidly becoming a national disaster. The measures taken to address the situation included:

- the prohibition of water abstraction from certain public rivers
- a drastic reduction in the water quotas at government water schemes
- the reduction of water supplied from government water schemes to local authorities and water boards
- the establishment of emergency schemes.

1424. Department of Water Affairs and Forestry (1986a:Section 6.13).

1425. Department of Water Affairs and Forestry (1986b:12).

The areas worst affected by the drought conditions were Natal, the western and eastern regions of the Transvaal, parts of the OFS and the Eastern Cape.[1426] In an effort to contend with the critical levels of water supplies in a time of drought, the directorate began a series of emergency water schemes to secure the water supply to power stations in the eastern Transvaal, Sasol at Secunda, as well as to Newcastle[1427] and the Durban–Pietermaritzburg region.[1428] Because of the urgency, the work was done in record time to 'avert a threatening crisis with enormous economic implications for the country'.[1429]

In light of the crisis, the Department of Environmental Affairs' public relations engaged actively with the media on drought conditions in the country. At first the media appeared to be antagonistic. However, once they became more familiar with what officials in the directorate of water affairs had been doing, relations improved.[1430] The department then began a more systematic and sustained process of releasing information. By 1984 there were at least two radio programmes a week in which the drought situation in the country was discussed. The SABC was responsible for broadcasting in nine of the indigenous African languages, while the department focused on a potential audience of about 20 million South Africans.[1431]

One of the important departmental strategies in the critical drought period was to showcase the remarkable engineering feat of the Sterkfontein Dam and its value in a time of drought. On 18 July 1983, the Minister of Environmental Affairs, S.A.S. Hayward, opened the dam's sluice gates. This symbolic event came at a time when the water crisis was at its peak in the PWV region. The opening of the Sterkfontein Dam ensured that copious water supplies reached the almost empty Vaal Dam. Sterkfontein proved its worth. The depth of the dam, at a high mountainous elevation, ensured that much less water evaporated than would have been the case in the Vaal Dam. Sterkfontein is slightly larger than the Vaal Dam. Its capacity in the 1980s was 2660 MCM and the surface area of the dam was five times smaller than that of the Vaal Dam. Its prime task, from the outset, had been to augment the Vaal River system under conditions of severe drought.[1432]

1426. RP28/1984 (1984:1).

1427. WP M83 (1983).

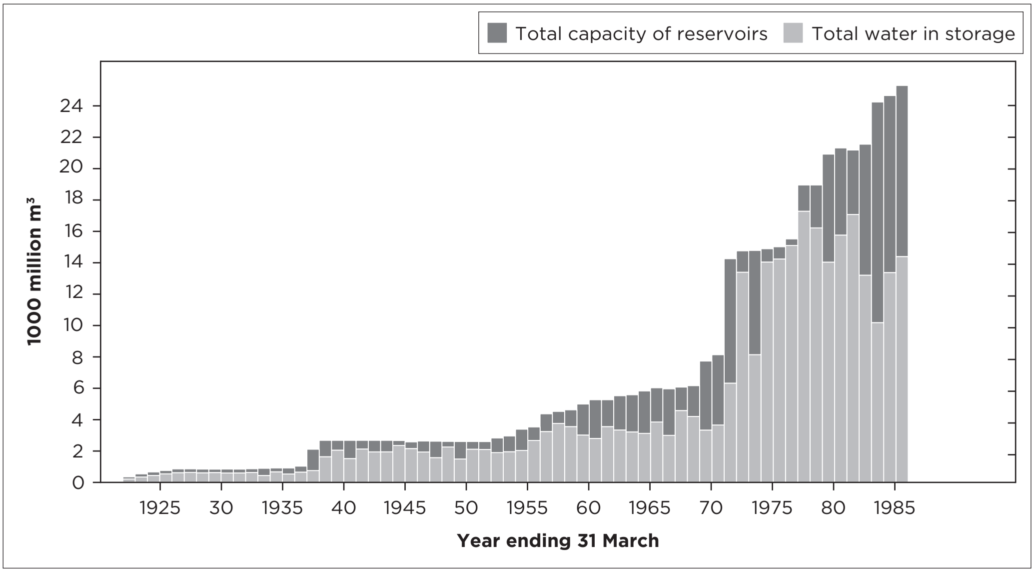
1428. WP N83 (1983).

1429. RP28/1984 (1984:1).

1430. Tempelhoff (2003:410–437).

1431. RP28/1984 (1984:14–15).

1432. Department of Water Affairs and Forestry (1986a:Section 1.9, 3.30, 34.10).



Source: Graph in RP46/1986 (1986:16).

FIGURE 9.7: South African water storage capacity and the decline in water supplies 1920–1985.

Behind the scenes, the department's water branch had been working hard at raising of the weir of the Sterkfontein Dam. A project first mooted in 1980,[1433] now received dedicated and urgent attention with construction work on an earth-fill wall that required placing 4 524 970 m³ of construction earth-fill in a single year.[1434] Neither did the government hesitate to make funding available for increasing the pumping capacity of the Sterkfontein Dam system, at a cost of R110m. The 0.8 cents per cubic metre that industrial and urban consumers had to pay for greater water security on the Tugela–Vaal was negligible in comparison with the accomplishment of mitigating water insecurity.[1435]

As the drought persisted into 1984 and 1985 in what was described as 'the most severe drought the country has yet experienced', the DG of water affairs praised the work done by the department, and pointed out that the drought had not taken on critical proportions. This, he said, was the result of advanced planning and the devotion to duty shown by a large number of public servants, who had performed their apportioned tasks with dedication.[1436]

In a diagram included in the 1984–1985 annual report of the department, it is clear there were distinct phases in the development of South African water resources between 1920 and 1985 (please see Figure 9.7). It displays

1433. WP H80 (1980).

1434. RP28/1984 (1984:90–91).

1435. WP J84 (1984:3–4).

1436. RP46/1986 (1986:8).

a static phase during the Second World War (1939–1945), followed by moderate development (1945–1970) and finally rapid development (1970–1985).[1437] There were, of course, links with drought conditions, but the jury was out on how to interpret the evidence to make sense of the most recent drought.

In 1985, Mark Dent, a research fellow in the Department of Agricultural Engineering at the University of Natal, took a critical view of the main drought periods of the century. His research suggested that the drought of the 1960s was possibly longer and even more intense than that of the 1980s (please refer to Figure 9.8). However, Dent was not convinced that the so-called 'big' drought of the 1930s was half as bad as that of the 1980s. More important, in his view, was the rapid process of modernisation starting in the 1950s, which increased the number of urban water consumers by the 1960s.[1438] The process of urbanisation and population growth persisted well into the 21st century. The body of datasets used in the water sector by the 1980s provided insights into South African rainfall and drought patterns, and made it possible to draw some valuable new conclusions. The planning division of the department compiled a comprehensive management report, which became the precursor to the national water resource strategy (NWRS) after 1994.[1439] The report featured a set of maps on all the available data, based on annual rainfall patterns. It shed a completely new light on rainfall patterns and the way in which they shaped hydrological drought conditions in South Africa. For the first time it was possible to give an illustrated impression of rainfall and drought conditions in the 20th century, with some convincing arguments that appropriately contextualised the drought of the late 1970s to the 1980s, giving an indication of their seriousness.[1440]

The major areas of concern remained the Vaal River system, with the Vaal Dam and its upstream emergency supplier, the Sterkfontein Dam, along with the Bloemhof Dam further downstream.[1441] In the Vaal River system, water consumption in 1985 was restricted by 30% for urban and industrial consumers and 50% for irrigation activities. The actual savings amounted to 22% for the urban and industrial consumption sector, while in the case of the irrigation sector there had been a drop of 47%.[1442]

1437. RP46/1986 (1986:15–16).

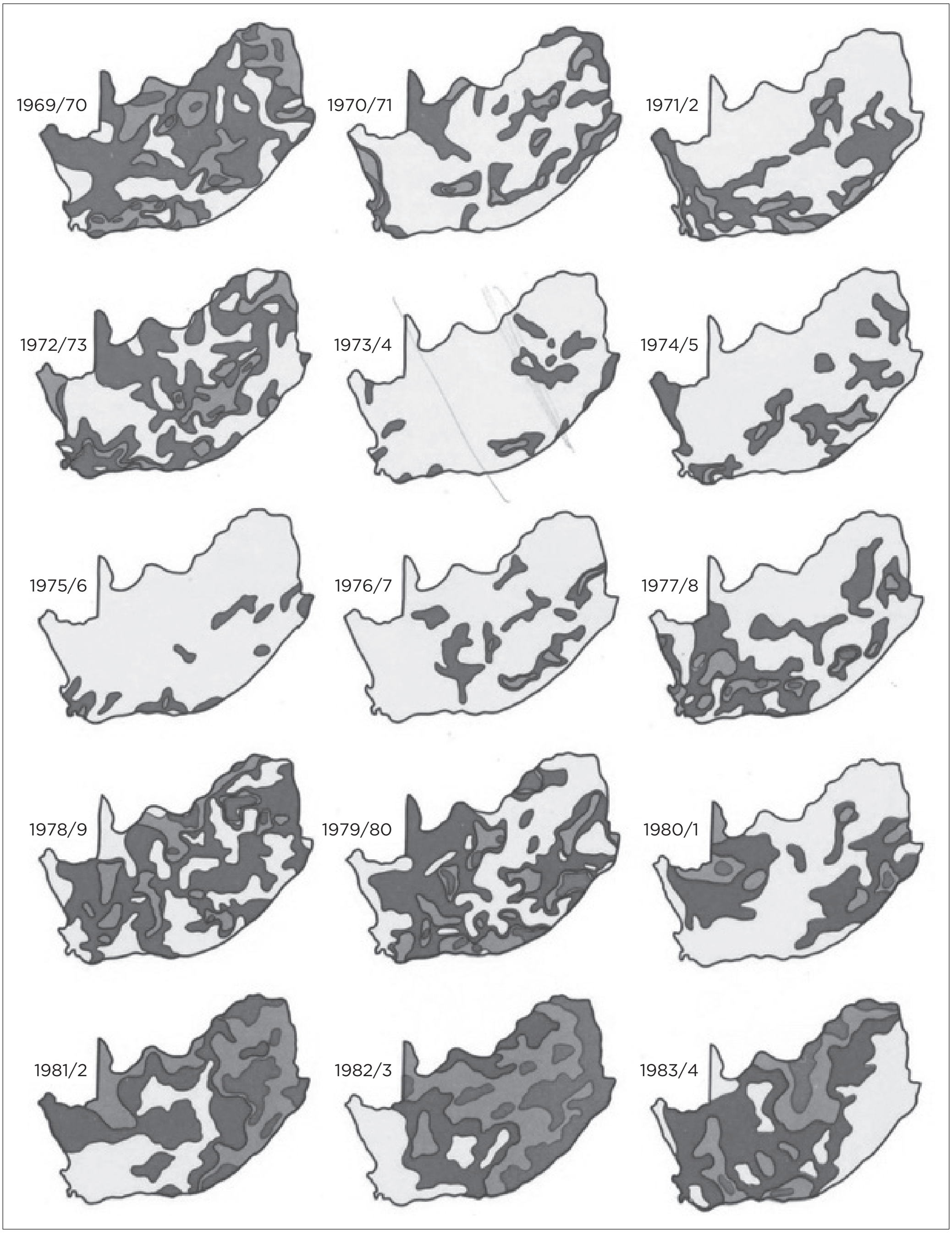
1438. SA Water Bulletin (1985:10–11).

1439. Department of Water Affairs and Forestry (1986a).

1440. Department of Water Affairs and Forestry (1986a:Section 1.5, 6.4, 6.5).

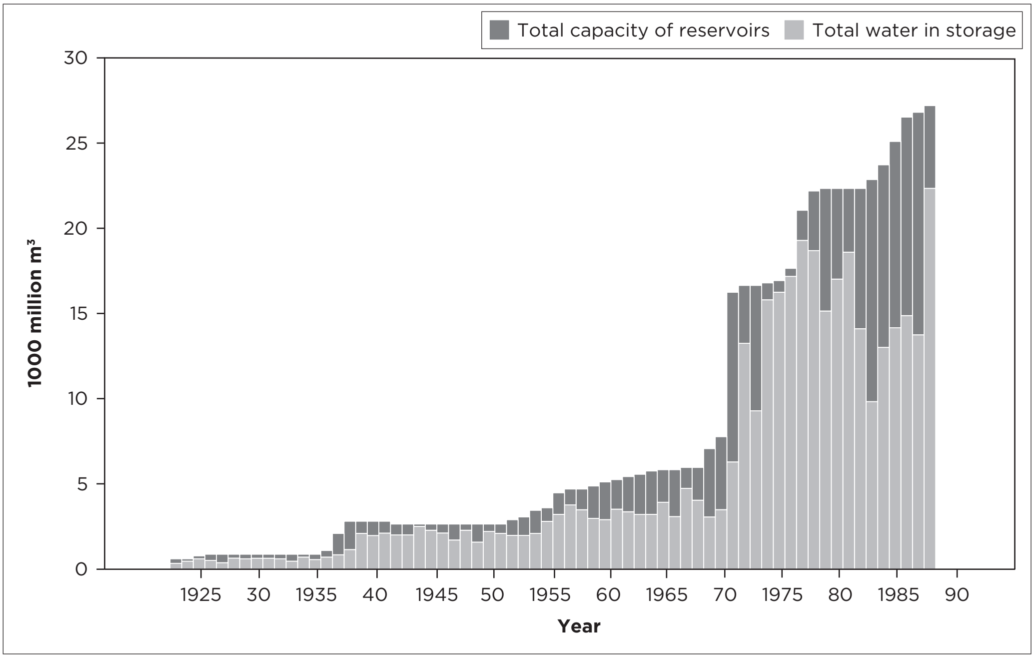
1441. WP E82 (1982).

1442. RP46/1986 (1986:16–17).



Source: Department of Water Affairs and Forestry (1986a: Section 6.19).

FIGURE 9.8: Drought map, South Africa, 1969–1984.



Source: RP39/1989 (1989:26).
FIGURE 9.9: Total capacity of South Africa's reservoir and water storage, 1988.

In the mid-1980s, American scholarship suggested that sub-Saharan Africa had been subject to persistent drought conditions since 1972.[1443] There was a growing consensus that the phenomenon could be ascribed to El Niño and La Niña conditions. South Africa seemed to fit the larger picture of abnormal conditions prevalent in southern Africa. In 1985 to 1986 the drought conditions persisted, although in most parts of the Cape Province, the summer rainfall season of 1985 to 1986 saw significant rainfall (please refer to Figure 9.9).

In an area southwest of a marginal line between Umtata and Kakamas the entire summer rainfall was good. Other parts of the country were less fortunate. The western and far northern Transvaal were the areas hardest hit. In the case of the Vaal Dam catchment and the Bloemhof Dam the drought that started (officially) in 1978 had still not broken. The cumulative flow of water into the Vaal Dam and the Bloemhof Dam over the eight-year period from 1978 to 1987 was only half of the run-off (flow) in the Vaal River in the 1930s. The drought period was described as the worst suffered in South Africa for more than 100 years.[1444]

In the case of the Vaal Dam, water restrictions remained in place and could not be lifted for the duration of the year. The department's geohydrological

1443. Kerr (1985:1453–1454).

1444. RP75/1987 (1987:1).

investigation teams started looking at the groundwater of the Witwatersrand for emergency supplies. Relatively good results were achieved in the course of 1985, but the major provision of water to the Pretoria–Witwatersrand–Vaal (PWV) region came from the Tugela–Vaal system, Phase 2, which saw the maximum importation of water from the Tugela increasing from 11 m^3/s to 20 m^3/s by August 1986.

The Sterkfontein Dam, which served as the major storage facility, was able to augment the water level of the Vaal Dam, playing a key role in the water supply to the PWV region. It kept the national economy going in a time of severe water stress. In addition to the Tugela–Vaal project, the Heyshope Dam and the pumping station at Geelhoutboom and its related aqueducts and canals in the Usutu–Vaal system also provided water supplies for the industrial areas of the country – not only on the Witwatersrand, but also to the eastern parts of the Transvaal.[1445] The construction of the Heyshope Dam was speeded up as a result of the severe drought conditions experienced in the early 1980s.[1446]

An interesting aside on the history of the Heyshope Dam provides an example of how by the 1980s the government, in the aftermath of Soweto, was prepared to make compromises on the homeland planning of the apartheid era. This pointed to a political awareness that it was running out of options to keep white minority rule afloat, and was beginning to question aspects of the homeland system.

In KwaNgema and the neighbouring area of Driefontein in the Wakkerstroom district of the Transvaal, there were black-owned farms. In the years between 1904 and 1914 the responsible colonial and state authorities had given the resident African communities full property ownership. However, in 1965, as a result of the NP government's identification of undesirable 'blackspots' in close proximity to white residential areas, it gave the local African community notice that they would be relocated to the homelands of KaNgwane and KwaZulu.

However, nothing came of these plans until 1981, when the Department of Water Affairs was hard at work planning the Heyshope Dam. It was to be extended to meet the energy sector's demand for reliable water supplies. The properties of KwaNgema and Driefontein formed part of the land that had to be expropriated for the construction of the dam. As a rule, in such cases, the department would mediate with the affected parties and weigh up the advantages and disadvantages of the proposed project. More often than not, a reasonable compromise was reached and those who had objections managed to get their way.

1445. RP75/1987 (1987:1).

1446. WP F81 (1981).

From the outset, local residents opposed the department's plans for the Heyshope Dam, on the grounds that they were the legitimate owners of the land. They felt uncertain about moving away because they were fearful of not having access to the same type of land and housing that they had called home for such a long time. They even opposed the *Native Administration Act* of 1927, which was used by the authorities to justify the move, insisting that it did not have any bearing on them because they were the rightful owners of the land. However, they did indicate that they would be prepared to move to available, uninhabited land nearby.

A relentless protest followed, with the land owners and a number of civil society groups coming out in clear opposition to the state's plan. There were also violent protests and even the murder, under very suspicious circumstances, of a local leader. These events came at a time when there was growing public discontent, on a national scale, with the government's forced removal policy to the so-called homelands. Perhaps most important was the political climate in the 1980s; throughout the country unrest was rife, and criticism of apartheid policies was increasing. The outcome was that the department's advisers managed to negotiate with the local community for an exchange of land, and the residents moved willingly to nearby vacant land in the area of their birth.[1447]

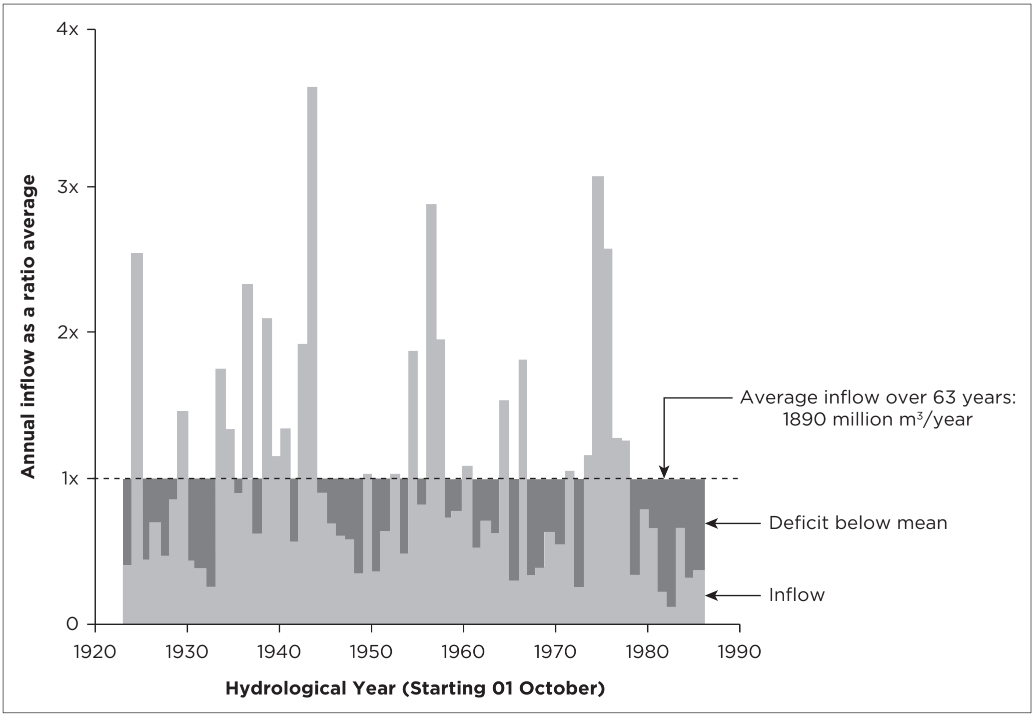
One of the major advantages of Heyshope was that its water, coming from the Usutu, was of better quality for generating electricity than the water of the Vaal River system.[1448] By March 1987 water restrictions in many parts had not yet been lifted. In fact, in addition to those in the Vaal River system region, consumers relying on the Doorndraai Dam, the Ebenezer Dam and the Albasini Dam were running on tight water allocation schedules. Between 12 June and 29 October the Sterkfontein Dam was used to supply water to the Vaal Dam. The supply now not only met the needs of consumers in the PWV economic hub of the country, but was also sufficient to assist downstream Vaal River users in the catchment of the Bloemhof Dam and the Vaalharts Irrigation Scheme.[1449]

The Vaal River system as a whole was a source of control for the department's hydrologists, with the consequence that restrictions were maintained, with savings of 30% on the unrestricted consumption figures for 1982 to 1983 for urban and industrial consumers, and 75% for irrigation consumers. In the OFS, irrigation farmers operated under restrictions at the government water works of the Riet River, Modder River, Lower Riet, as well as those of the Sand–Vet system. In the Western Cape the water supply of irrigation farming operations was satisfactory, as was the case in Natal. However, by the end of 1987,

1447. Ndaba (1998).

1448. Department of Water Affairs and Forestry (1986a:18).

1449. RP53/1988 (1988:4).



Source: RP53/1988 (1988:34).

FIGURE 9.10: Theoretical assessment of inflow into the Vaal and Grootdraai dams in the period 1923–1986.

water restrictions had to be introduced in the Western Cape in the Olifants River (Vanrhynsdorp) scheme. On the Highveld, modelling studies on the Grootdraai Dam and Vaal Dam showed that the water deficit of the 1980s was far more extensive than in the 1930s and 1960s (please see Figure 9.10).[1450]

The drought ended in what the annual report of the Department of Water Affairs described as 'a spectacular way', with widespread penetrating rain in September 1987. Dam levels rose significantly to an average capacity of 82%. The good rains brought a 32% improvement in the water capacity of the country's dams.[1451] In the wake of the drought, the department's strategic planners underscored the need for an assured water supply in the future. This was essential for the country's power stations, fuel refineries and certain industries in the urban centres.[1452] By 1989 the Department of Water Affairs' management was quite satisfied with the existing water supply. Of the 132 major dams on which the department reported every week, 67 were now more

1450. RP53/1988 (1988:4, 33).

1451. RP39/1989 (1989:5).

1452. Department of Water Affairs and Forestry (1986a: Section 9.11).

than 90% full. In total the 132 major dams were 79% full, in comparison with 82% the previous year – a year that was notable for its high rate of floods. Although in general terms the country now had sufficient water supplies to meet its needs, there were still indications of drought conditions in the Eastern and Western Cape. In the course of 1988 to 1989 it was necessary to introduce restrictions in parts of the Eastern Cape. The Paul Sauer Dam, one of the three large dams in the region, was only 12% full. As will be shown in the next chapter, despite gaining significant experience in the 1980s on how to deal with drought conditions and make preliminary predictions, the department was again well off the mark on the drought of the 1990s.[1453]

■ Gaining new insight on floods

Combining environmental affairs, forestry and water affairs in the early 1980s did prove to be of value in creating a better grasp of the need for collaboration. Once officials in the new department were able to communicate, they conducted valuable work in the regionalisation of water catchments in South Africa. The special task team of the former Department of Water Affairs, which had been kept in place since the 1970s, played a major role in creating valuable new knowledge. In 1980, the team pioneered the use of satellite photographs to determine how much water some of the department's water consumers, such as irrigation farmers, were using.[1454]

The special tasks division continued with its focus on water use, hydraulics and environmental studies. These were subdivided into environmental impact assessments and landscaping. In 1981, the division reported on water use studies, based on locality numbers of a drainage region. The system made it possible to draw a finer picture of the division of water consumption in low cost housing developments. In the field of hydraulics and river mechanics studies they looked at damage caused in 1981 by the floods, and focused on the Laingsburg event in particular. Members of the division also presented papers and lectures to students at the University of the Witwatersrand, Stellenbosch University and the Engineering Association of South Africa.[1455]

From 1981 to 1982, the hydrological division of the directorate of water affairs completed a study in which they divided the country up into nine regions. They developed a formula to estimate the mean annual run-off[1456] by using the catchment size and its MAP. In developing the system, they used cluster and discriminant

1453. RP91/1989 (1989:3).

1454. RP51/1981 (1981:92).

1455. RP96/1981 (1981:80–81).

1456. Roberts [Pretoria] pers. comm., 2017.

analysis techniques on the existing computer facilities.[1457] According to Roberts, at the time there was a 'revolution in the making' in the international field of hydrology.[1458] Conventional deterministic views of overland-flow, interflow and base-flow were considered quantitatively misleading. Instead there was acceptance of the fact that storm run-off mechanisms which gave rise to flood hydrographs were much more complex than those represented in conventional models. Roberts maintained that there were new models that were far less deterministic. For that reason the field had been split up into empirical, deterministic and regional hydrology.

In empirical hydrology there was considerable diversity, and a number of South African universities were working in the field. Deterministic hydrology tended to focus on predicting the quantitative and qualitative effects on water resources of changes in land use, for example with regard to irrigation, afforestation, cultivation, livestock grazing, veld burning and urbanisation. Regional hydrology, on the other hand, tended to regionalise hydrological information collected at various points throughout the country, in an effort to provide water resource planners with information in the form of design aids and manuals.[1459]

At the time of the Laingsburg flood of 25 January 1981, 105 people lost their lives when freak floodwaters came down the Buffels River, causing damage of more than R800 000 to the gauging stations of the hydrological division.[1460] The event was said to have been South Africa's worst natural catastrophe in human memory.[1461] The flood followed a heavy, three-day rainstorm upriver. It was never very intense, but did provide a flood peak estimated to have been as much as 5700 m^3/s in the Buffels River. An atypical aspect of the event was a low pressure cell that moved exceptionally deep into the interior. A 'black southeaster' apparently brought a strong high pressure system to the south of the continent. It then fed moist warm air into a low pressure system over the southern parts of the country. On 24 January, an upper air portion low broke off from its source region south of the continent to form what meteorologists call a 'cut-off low' that moved into the interior along a ridge of high pressure.

By 25 January, the low reached its maximum level of development in terms of atmospheric motion and 'vorticity'. These conditions made for heavy rainfall. To the north and north-west of Laingsburg a great deal of rain fell, possibly as much as 160 mm. Along the coastline on the same day, in the vicinity of George,

1457. RP96/1981 (1981:33).

1458. SAWHAR WLC W3798 (1982:2–3).

1459. SAWHAR WLC W3798 (1982:2–4).

1460. RP96/1981 (1981:25).

1461. Department of Environmental Affairs (1981:24).

there was 1202 mm of rain. Later, researchers maintained that the pattern of rain over a period of three days was largely as a result of the position of the cut-off low, and topographic conditions that played an influential role.[1462]

Disaster struck twice in the Cape Province in 1981. Apart from Laingsburg in January 1981, there were simultaneous floods in other river valleys. The Touws River area, as well as the tributaries of the Breede River were flooded. The Floriskraal Dam on the Buffels River had to accommodate a flow at the weir of as much as 4200 m^3/s. These floods were reasonably localised. The second major flood was at Port Elizabeth on 26 March 1981. Drought conditions had been prevalent in the Eastern Cape for some time and these had not broken as a result of the floods in the interior. The annual report of the director of the department noted that the water levels were still low at the Van Ryneveld's pass and Waterdown Dam.[1463]

The Laingsburg disaster caused considerable damage to 300 of the 367 private and public properties in town.[1464] A subsequent assessment of the Port Elizabeth event determined that the flow of water through the Bakens River was similar to the floods of 1968. At the Loerie Dam, 40 km west of the city where there had been a significant flood in 1977, the flood of 1981 passed a metre higher over the dam wall than in the previous event. Another flood event of significance was the March 1981 flood in the Vaal River, when 12 flood gates had to be opened for the release of 680 m^3/s.[1465] During the year more than R7m was paid out to flood-stricken farming communities to repair the damaged waterworks in their respective areas.[1466]

The hydrological division of the directorate of water affairs worked on a comprehensive research project on the floods at Laingsburg and Port Elizabeth in 1981.[1467] The study formed part of its probabilistic studies on South African hydrology – an area the team had been investigating, along with historical data and meteorological information, for a number of years. At the time of the floods there were lower run-offs from the rivers in comparison with previous years. The diminished dam contents, with the exception being the Eastern Cape after the floods of 1981, suggested that the available supplies had reduced significantly.[1468]

1462. Departmen of Environmental Affairs (1981:25).

1463. RP96/1981 (1981:25–26).

1464. Roberts and Alexander (1982:17).

1465. RP96/1981 (1981:24–26).

1466. RP105/1982 (1982:1).

1467. RP96/1981 (1981:33).

1468. RP105/1982 (1982:24).

The department's annual report did point out that there was a change in the statistics for the full supply capacity (FSC), largely as a result of the inclusion of the Woodstock and the Steynskloof Dam and some alterations in the FSC of 25 dams, following recent silt surveys. Moreover, the 1984 cyclones Domoina and Imboa were responsible for more than 700 mm of rainfall between 28 January and 02 February, and from 17 February to 20 February that year. The floods were, according to the hydrology experts, the highest ever experienced in southern Africa. A total of 412 of the department's river flow-gauging stations were damaged. The affected areas were from the Komati River in the north, to the Mfolozi River in the south. Hydrologists of Mozambique and Swaziland also helped their South African counterparts in securing information on the events.[1469]

Although there were no floods in the Vaal River in 1983 to 1984 the flood studies subdivision had a team working in Natal and it collected data on the affected areas, making calculations on water releases into dams. Part of the planning in the case of the Vaal, was to install a cableway across the Wilge River at Frankfort to monitor the inflow of water into the Vaal Dam during flooding conditions.[1470]

In late January 1984, cyclone Domoina caused havoc in the Transvaal Lowveld (now the provinces of Limpopo and Mpumalanga), northern Natal, Swaziland and southern Mozambique (Figure 9.11). Domoina affected irrigation operations at Barberton, the Lower De Kaap River, Lower Crocodile River, the Lomati River and the Lower Komati River.[1471] It was in the aftermath of these floods that a flood studies subdivision was created in the hydrology division. Ironically, at the time of the Domoina and Imboa cyclones, the directorate's staff were in the process of completing a draft White Paper on the water position in South Africa.[1472] While there were clear indications that drought conditions in parts of the country would be negligible, there was evidence of exceptional and unpredictable rapid-onset flood disaster conditions.

Of particular interest at the time of the cyclones was the performance of one of South Africa's premier dams, the Pongolapoort (Josini) Dam, a double curvature dam in the Lowveld of northern Natal. The dam successfully withstood the relentless onslaught of Domoina, when the dam level rose by 21 m in 60 hours with an estimated capacity gain of 1640 MCM. Within two weeks of the cyclone, there followed three days of rain when 600 mm of rain was registered

1469. RP28/1984 (1984:17).

1470. RP28/1984 (1984:19).

1471. RP28/1984 (1984:1, 104).

1472. RP28/1984 (1984:1, 17).

Source: RP28/1984 (1984:24).

FIGURE 9.11: Evidence of the force and destruction of the Domoina cyclonic floods in January 1984.

in the dam's catchment.[1473] In the aftermath of Domoina there was a keen interest in the sub-directorate responsible for flood studies to do more comprehensive investigations into flooding events, and a report on Domoina subsequently appeared.[1474] Similarly, when there were flash floods in Vereeniging on 05 November 1984 and extensive floods in the Eastern Transvaal and Natal in February 1985, studies were made on tropical cyclones in the south-west Indian Ocean, with an emphasis on their impact in South Africa.[1475]

The researchers looked at cross-section changes in alluvial rivers during times of major floods, using the Mfolozi River in Natal to conduct its tests.[1476] In the course of 1986 to 1987 as many as 33 flood study tasks were undertaken with 20 forming part of the department's dam safety evaluation programme. Completed studies included the Orange River flood of 1974 and the floods of 1985 in the Eastern Transvaal and Natal.[1477]

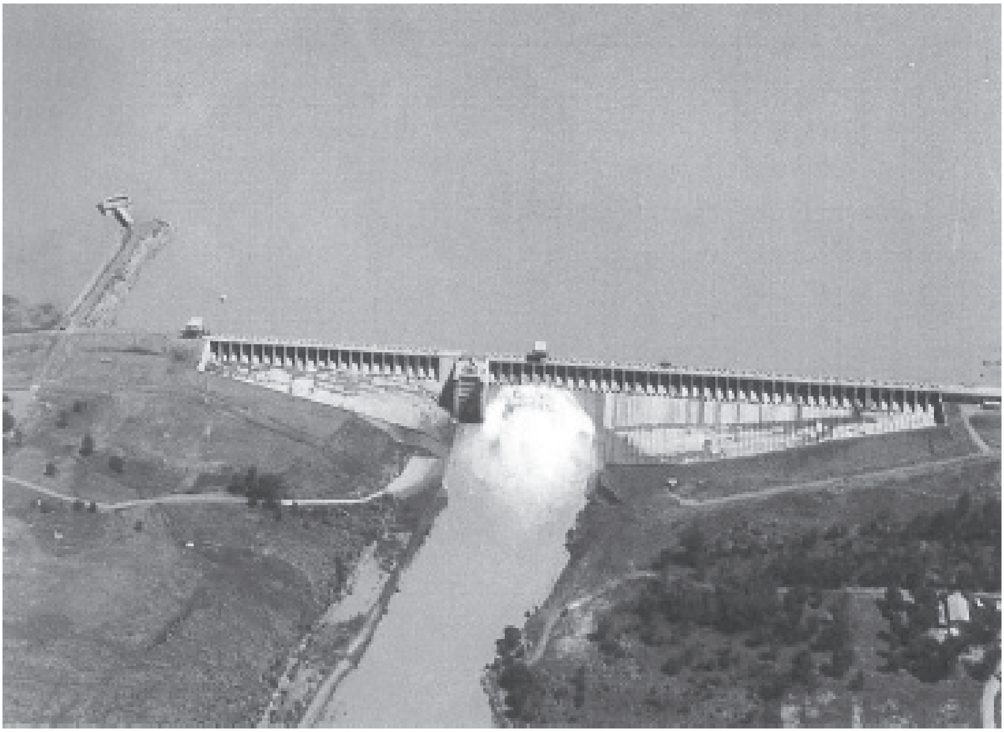
1473. SAWHAR ITC/articles(b) (1984:113).

1474. Kovàcs, Du Plessis, Brachner, Dunn and Mallory. (1985).

1475. Jordaan and Kovács (1985).

1476. RP46/1986 (1986:20).

1477. RP53/1988 (1988:38).



Source: RP39/1989 (1989:11).
FIGURE 9.12: By February 1988 the Vaal Dam was in flood for the first time in many years.

Floods tend to cause substantial damage (Figure 9.12 – Figure 9.14). The financial implications are significant, so the Department of Water Affairs was interested in securing accurate knowledge to assist its engineers in their design plans for dams, bridges and other structures. Attention also had to be given to the management of floodplains, forecasting and the control and management of dams. By 1987, there were records for more than 20 years that had been catalogued in 40 parameters. The information made it possible for the department's flood studies specialists, working in the directorate of hydrology, to conduct detailed work on monitoring river channel stability in five Natal rivers, investigating potential correlations between momentary and daily flood peaks and studying the displacement velocity of floods in South African rivers in an effort to develop a potential early warning system. In February 1988, after a severe drought of more than five years, heavy rains fell and there were severe floods in the OFS.[1478] As a result of the significant losses incurred and damage caused by the flood, the department conducted 25 flood studies in 1987 to 1988. Of these, 22 were part of the department's continuous dam safety evaluation programme. A report that was singled out

1478. RP39/1989 (1989:5).

Source: RP39/1989 (1989:28).

FIGURE 9.13: The Vaal River in flood at Douglas on 25 February 1988.

Source: RP39/1989 (1989:28).

FIGURE 9.14: Flooding at the Inanda Dam in Natal on 29 September 1987.

for the year was one dealing with the flooding at Ladysmith in Natal,[1479] and this study later informed the development of the department's flood control scheme in the Mount Pleasant Dam on the Klip River.[1480]

Two major flooding events stood out – that of September 1987 in Natal, and another in February-March 1988 in the Orange–Vaal region. The research conducted on floods included foci on monitoring channel changes in Natal and the Orange–Vaal drainage areas, and the calibration of departmental flow-gauging stations for the high flood range, which commenced in November 1987.[1481]

Dam safety

With the proliferation of new dams in South Africa in the second half of the 20th century, the issue of dam safety had to be addressed. The construction of concrete dams peaked in the period 1960 to 1970, while the number of earth-fill dams peaked in the 1980s. Trends in dam safety developed rapidly following the 1959 Malpasset Dam disaster in France and the 1963 Vaiont Dam disaster in Italy. In South Africa, the department took the first steps towards establishing a dam safety programme in 1977.[1482]

At the time, many of the older dams in the country did not comply with new, stricter safety criteria. At first a flexible approach was followed in the evaluation of dams, but the department's officials gradually began to apply more rigid guidelines,[1483] and in the 1981 to 1982 period a special dam safety section was established. In view of new international trends and the growing importance of infrastructure development and maintenance, the dam safety section carried out evaluations on all storage structures of water resources in the country. Inspections were not confined to departmental dams. In the first year, as part of standard procedures, the department's dam safety team inspected 31 dams, of which 23 were state property, four were the property of irrigation boards and four were privately owned.

The procedure of safety inspection stipulated that officials should secure as much information as possible on the design of a particular dam, with a focus on existing surveillance and structural behaviour of the dam. The investigating team conducted on-site inspections and then made recommendations to the owners and/or operators. With the establishment

1479. RP39/1989 (1989:29).

1480. WP C90 (1990).

1481. RP39/1989 (1989:29).

1482. Oosthuizen et al. (2011:239).

1483. Oosthuizen and Elges (1988:555).

of the dam safety section, the Department of Water Affairs took the bold step of initiating a routine safety inspection programme for all the department's dams listed in the South African section of ICOLD's World Register of Dams. At 26 of these dams, regular readings were taken with special equipment to monitor the structural behaviour of the dams.[1484] Special training programmes were introduced for engineers and water control officers on the standard reporting procedures and how to identify potential problem areas.[1485]

In 1983 two members of the dam safety division won Blackwood Hodge bursaries to study dam safety practices and legislation in the US, France, Italy and Switzerland. In the US they also attended a seminar at MIT on new perspectives on dam safety. Based on the experience and insight gained, the department's dam safety experts prepared a revised set of dam safety regulations.[1486]

The dam safety principles that had been incorporated in the *Water Act* of 1956[1487] stipulated that all public and private dams in the country with a wall height of more than five metres and capacity of more than 50 000 m^3 had to be listed on a register at the department's dam safety office. For each dam on the register a potential hazard for causing damage to property and lives was assessed and used for the classification of all storage facilities. The information required included:

- the name of the dam
- where it was located
- its FSC
- its wall height.[1488]

These safety requirements were duly updated in the department in 1983, in accordance with the new insight gained on international safety regulations. A departmental engineer, W.S. Croucamp, was the main contributor in establishing a tradition of dam safety that was maintained for many years. The department's regulations were incorporated into the *National Water Act* of 1998 and were again updated in 2012. The work done in the 1980s was so thorough that there was little need for major changes in the new millennium.[1489]

1484. RP105/1982 (1982:61, 76–77); SAWHAR WLC B576 (1986:1); Croucamp (1983:43–44).

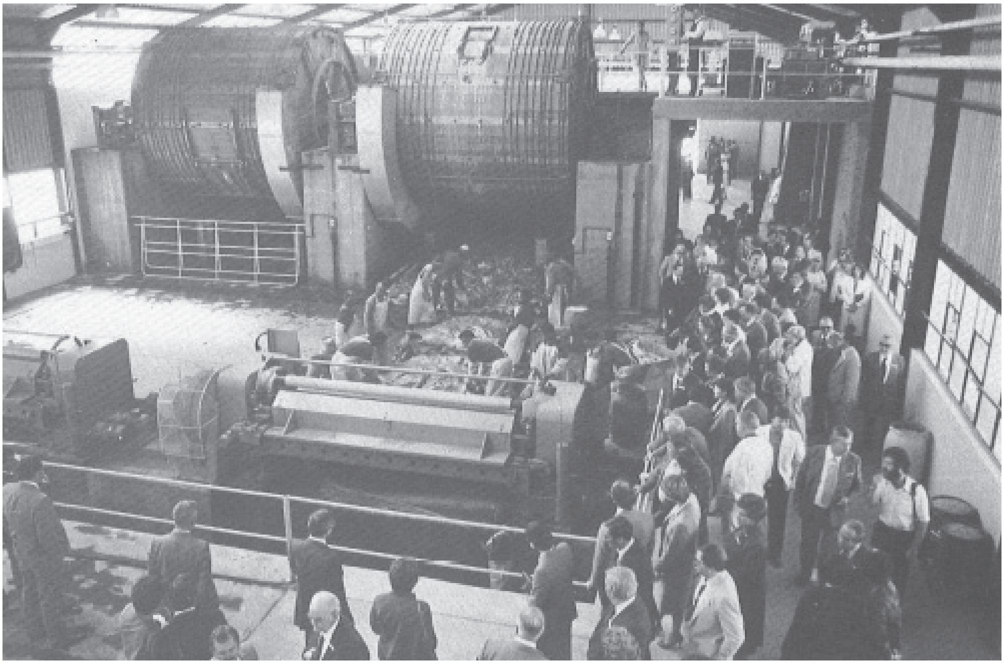
1485. SAWHAR AHCA5/090 (1987:1, 4, 9); RP105/1982 (1982:76–77).

1486. RP28/1985 (1985:65).

1487. Republic of South Africa (n.d.); SAWHAR WLC PAM15033 (1984:1–103).

1488. SAWHAR WLC C1409ac (1993:244); SAWHAR WLC C1327 (1983:38–39).

1489. Roberts (2015:69).



Source: SA Water Bulletin (1982b:18–19).

FIGURE 9.15: In 1982 the new plant of the General Hide Corporation's factory in Harrismith used modern technology that relied on chemical antiseptics instead of salts in the treatment of hides.

Research

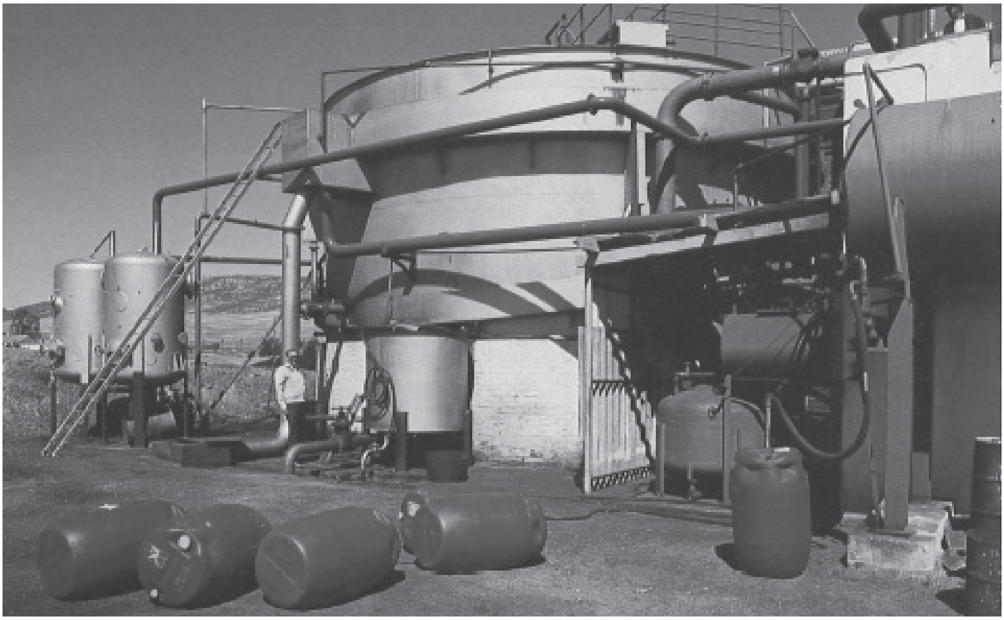
Water Research Commission

In 1982 the WRC's focus was comprehensive but the emphasis was still on pollution. Research focused on, namely, water and effluent problems in the textile industry, the fruit and vegetable canning industry, the mining industry, the meat, hides and tanning industry (Figure 9.15),[1490] and the fishing industry, as well as on sewage treatment systems, technologies of water recycling, health aspects related to water use, water quality networks, solid and toxic waste, and desalination.[1491] In the same year the WRC awarded a research contract to the water research team at the University of Natal to do a situational report on water management and effluent treatment in the processing of pulp and paper, fermentation and pharmaceutical products.[1492]

1490. SA Water Bulletin (1982b:18–19).

1491. SAWHAR WLC W3797 (1982:4–5).

1492. SA Water Bulletin (1982d:9).



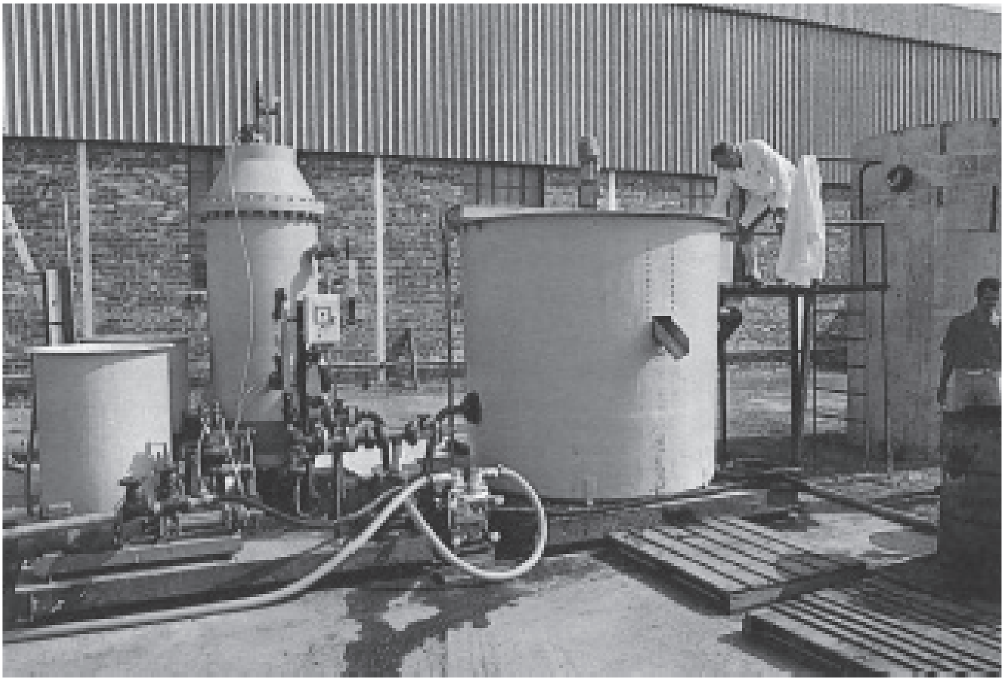
Source: SA Water Bulletin (1982a:1).

FIGURE 9.16: In 1982 a pilot plant was in operation at a fisheries operation at St Helena Bay for the effective treatment of effluents. The project leader Bruce McDonald is standing next to the large storage tank.

In one of the investigations, the pollution load of 21 fish processing industries in the country came under the magnifying glass. The study revealed that during the annual fishing season of about six months, 338 000 tonnes of fish were processed into about 218 000 tonnes of fishmeal, with the remainder being canned. In the course of the investigation it came to light that the fishing industry consumed as much as 490 ML of fresh water and 7800 ML of sea water. Detailed analysis showed that the effluent water of these industries was confined to a few relatively low volume streams.[1493] Among the preliminary findings of this particular project was the suggestion that dissolved air flotation could contribute to reducing the organic loads discharged in the effluent of factories. Moreover, the water consumption of the production process could be optimised. In addition, changes in the offloading of fish from the boats to the factory could become more effective by avoiding dry offloading. A firm of consulting engineers was appointed to investigate the offloading process for the optimisation of water systems, and the outcome was that a vacuum driven offloading process proved more effective (please see Figure 9.16 and Figure 9.17 for examples).

Similar research was conducted by the WRC in the fruit and vegetable canning industry in South Africa. Pilot plants were set up for testing strategies to reduce the negative aspects of effluents, thereby opening up avenues for

1493. SA Water Bulletin (1982a:1).



Source: SA Water Bulletin (1982c:1).
FIGURE 9.17: A pilot plant for treating the effluent of a canning factory at the Strand in 1982.

the reuse of water. Projects of this nature were notable in that the department's pollution control officials and the staff of the relevant industrial sector collaborated in finding solutions for pollution problems.

Hydrological Research Institute

In 1980, the Public Service Commission recommended a change in the conditions and duties assigned to the HRI. In the field of chemical and biological services its primary function was to establish facilities that could render specialised analytical (chemical and biological) services to the department.[1494] Important changes followed with regard to the way the computer systems were used in the institute. Firstly, the focus was on using the computers more effectively in terms of programme time and staff time. Peak times were replaced by synchronous times. Time-consuming reanalysis procedures were replaced by a procedure that improved on the old system of reanalysis by at least 50%.

The HRI's quality control programmes were restructured to deal with historical and new data for each gauging station, checking the calculated and measured conductivities, and comparing total phosphates with the

1494. RP51/1981 (1981:46).

inorganic phosphates. The institute's water quality section focused on problem-oriented research in five projects covering various areas of water quality. Most important was the development of mathematical models to forecast water quality under diverse climatic conditions with a variety of operating techniques. The HRI's water quantity research section investigated the factors that contributed to the run-off in waters in the rivers of South Africa. By 1980, there were six different projects focusing on:

- the effect of land use on run-off
- the significance of ground seepage flows in catchment area hydrology
- the dispersivity of soils
- determining the physical properties of inorganic sediments in rivers and storage dams.[1495]

From its headquarters at the Roodeplaat Dam, the HRI worked on a number of weather stations for gauging solar radiation and net radiation. It also made a start with monitoring the quality of rainwater at various points in the dam. In terms of water catchment hydrology, the HRI's researchers were active in the Bethlehem area with the Department of Transport, the larger Department of Water, Forestry and Environmental Affairs, as well as with the weather bureau with the development of the ALDO mathematical model operating in a grid. The research was focused mainly on stimulating rain. However, there were also strategies of research to determine how ground-plants would typically respond in the modelling process to the effects of moisture.

In its 1981 annual report to the directorate of water affairs, the HRI indicated that it was working on a strategy to predict the rate of water quality deterioration in South Africa. It was also busy consolidating its chemical and biological services. In the organic laboratory, researchers worked on a wide range of organic micropollutants and gas chromatography. Using conventional detectors was an overwhelming task and because the HRI had a significant staff shortage it started combining gas chromatography and mass spectrometry (GC/MS) in conjunction with a computer system. The work contributed to the identification and quantification across a broad spectrum of organic micropollutants.[1496]

From 1981 to 1982, partly as a result of the restructuring of the former Department of Water Affairs, the HRI reported that it had experienced a difficult period. A number of multidisciplinary projects had been launched in the course of the year and these programmes had to be sustained, although the institute had lost many of its experienced researchers. To do the work it needed a full complement of highly skilled staff, and reliable computer services.

1495. RP51/1981 (1981:48–50).

1496. RP96/1981 (1981:43–44).

The main problem was that the HRI was unable to attract more people to join the service. To make matters even more critical, the director of the HRI, Dr W.H.J. Hatting and the project leader of the two main projects, had left the department. Furthermore a newly initiated research project on mineralisation had lost its leaders. For the remaining members of staff in the HRI it meant that they simply had to carry on with their work, fully aware of the fact that the greater transformation and reappraisal of the staff component of the institute formed part of the larger changes in the civil service. Despite these hardships, the institute reported that it was pressing ahead in the knowledge that it had a number of enthusiastic young researchers.[1497]

In collaboration with the NIWR, the HRI formed a research group that was working on a preliminary set of potable water standards. It had compiled a new set of standards for inorganic and physical and aesthetic determinants of water quality. Three standards were suggested for each constituent to make provision for natural variations in concentrations. Essentially, researchers looked at a recommended limit, a risk limit and a crisis of maximum limit.[1498] In 1982 to 1983, eight new hydrologists from overseas were recruited and they were able to give a boost to the chemical and biological services and hydrological studies sections of the HRI.

The HRI's researchers were then transferred to certain regions to work closer to the actual problems requiring research work.[1499] The institute collaborated with a number of external institutions on projects such as:

- research on the water quality of Natal surface water resources, in collaboration with the CSIR's NIWR and the Natal regional laboratory
- working with the NIWR on the Hartbeespoort Dam
- working in collaboration with the NIWR on the Lower Vaal to locate micropollutants
- effect of the new effluent phosphate standard, in collaboration with the Institute for Environmental Sciences at the University of the OFS.

In 1983 to 1984 the HRI was restructured. The four new areas of investigation were:

1. catchment research
2. limnological research
3. chemical and biological analytical services
4. technical and administrative support services.

In the annual report the HRI presented a résumé of its achievements. The institute's management and staff were well aware of the benefits of participation

1497. RP96/1981 (1981:41).

1498. RP96/1981 (1981:43).

1499. RP58/1984 (1984:47).

and cooperative scientific programmes in the field of research into complex water and environmental problems. There was a firm commitment to securing outside research if necessary and making the findings accessible to the department as a whole.[1500]

In the field of IT the HRI emphasised the need for LANDSAT remote sensing services. The researchers and management were clearly of the opinion that the institute had to have its own image-processing facilities. The chemical and biological analytical services of the HRI had become highly specialised and it was possible for the research programmes in the area to focus primarily on the selection, development and evaluation of methods for the analysis of water, and providing a routine and specialised chemical and biological laboratory service for the department in the fields of general inorganic chemistry, trace metals, and organic chemistry in specialised sub-sections of biology and bacteriology. In terms of integrating the latest technological equipment with computer-supported data collecting, by 1984 researchers at the HRI used an inductively coupled plasma spectrometer that was linked to the expanded laboratory computer system and the trace metals laboratory system.[1501]

Technology and the integration of data made it possible for the researchers to work on projects including the occurrence and distribution of metals in water sources of South Africa, organic compounds in the country's water sources, and the biological and bacteriological surveillance of the country's water resources. In the field of limnological research the HRI had the objectives of:

- evaluating ecological and regression-line models for predicting changes in water qualities in reservoirs, based on specific changes in nutrient inputs
- determining the components of, for example zooplankton biomass and rates of production in reservoirs for use in predictive modes
- completing a number of *ad hoc* studies of water quality problems that could arise in various parts of South Africa.

In addition there was a dedicated focus on water resource evaluations, specifically for the problematic investigations initiated by the department in the field of applied limnology.[1502]

The HRI's catchment research studies investigated the management and prediction in the land phase of the hydrological cycle. Apart from working on the quantitative aspects of the country's water resources, they also focused specifically on the salination of soils and water.[1503] In 1985 the department reported on the activities of the HRI under the rubric of research for the year,

1500. RP28/1984 (1984:34).

1501. RP28/1984 (1984:34–35).

1502. RP28/1984 (1984:34–40).

1503. RP28/1984 (1984:40–43).

pointing out that the HRI was focused on doing research of an applied nature, and filled an important space in water management. The emphasis in that year was on the effect of land use on run-off, and the study of the physical behaviour of fresh water in dams and rivers. HRI researchers also worked on the chemical and biological analytical processes that were necessary to determine the quality of water. In the Department of Water Affairs there was also a keen interest in remote sensing by means of satellite technology. The strategy had been put to the test in the department in 1985, and it was now possible to report that remote sensing was working effectively. In catchment studies the department had also made some headway in determining the role farm dams had on run-off, especially in times of drought.[1504]

Research-related technology: Geographical information systems (GIS)

Once the Department of Water Affairs regained its autonomy, it began experimenting with GIS.[1505] In 1986, the WRC provided funding for the establishment of a computing centre for water research at the University of Natal.[1506] The department meanwhile reported that it was in the process of using the system for collecting information that was not otherwise accessible. Its officials had already attended international conferences and were working closely with service providers in the United Kingdom and Europe. The department's officials explored the field thoroughly while conducting investigations into the Caledon–Modder River government water scheme, responsible for water supplies to Botshabelo–Bloemfontein. Part of the same investigation also included a study on the Welbedacht Dam, which was reportedly silting up. The department's second GIS project was on the South Namaqualand government water scheme, which provided water to Bitterfontein and Nuwerus. The investigation had a bearing on the development of a desalination plant for brackish water.[1507]

In the management sector of the department, GIS was seen as an interactive, computer-based geographic information system that was tailored specifically to assist analysts in dealing with difficult and ill-structured problems. The GIS was an aid in assessing the impact of alternative strategies more effectively than in former times. Above all, the objective was to gain insight and solve problems rather than merely reporting on data in a standard format. The introduction of GIS was not confined to a single

1504. RP46/1986 (1986:5).

1505. RP75/1987 (1987:8).

1506. Dent (1989:42).

1507. RP53/1988 (1988:11).

government department. It had to be far more comprehensive. Management took it for granted that the introduction of the system would be costly and time-consuming. However, in the long-term GIS was a cheaper alternative than strategies previously employed.[1508] The Department of Water Affairs merely joined a national system that changed the way local systems had been managed previously. With more information at its disposal, the department was in a good position to make well-informed decisions on the governance of the country's water resources.

Computerisation: Data coordination

In 1980, J.G. du Plessis reminded officials in the Department of Environmental Affairs that there was a wealth of data available on the computer systems of the directorate. The local computer systems at Water Affairs offices in many parts of the country were complementary to the main system operating in Pretoria.[1509] Decentralisation created opportunities for equipping more outside offices with better computer infrastructure. It also enabled the outside offices to operate with comprehensive, transferable information services.

From 1984 to 1985 the department launched two important projects with the WRC to create databanks for hydrological and geohydrological research and water quality monitoring. The projects were intended to make water resources data available to a greater number of users.[1510] The plan was for specific committees to identify problems, compile research plans, make recommendations on relevant research priorities, evaluate progress made, and to plan for the testing of research findings.[1511] The department's focus on computer services for securing and processing data suggests that the intention was to maintain a high level of research output, but at the same time to ensure that the data and some findings would reach a larger audience of consumers.

Conclusion

For the most part, the 1980s was an era of maturation within the department. As well as institutional changes, the country's civil service was influenced by the introduction of a new constitutional dispensation, with a tricameral legislative system, and a President's Council that replaced the former senate of South Africa's parliament. Then, for four years, the Department of Water Affairs

1508. RP53/1988 (1988:58–59).

1509. SAWHAR DH11/JD1624 J.G. du Plessis Collection (1980:1218).

1510. RP46/1986 (1986:5).

1511. SAWHAR WLC W3797 (1982:4).

formed part of a conglomerate department because of the government's austerity programme in the face of a weak economic climate.

The transition to a new system of governance saw the former administrative circles of the department being absorbed into regional operational systems that reported to the national head office. The department's once strong research division, the HRI, passed through deep waters of decline and then made a partial recovery. In terms of human resources, there were numerous vacancies that could not be filled, at a time when there was a need for more experts to contribute to some of the ground-breaking work in South Africa's water sector.

Through the ability and efforts of engineers, the department's management, senior government officials and the political leadership, a feasible plan was negotiated for the realisation of the LHWP. This was an impressive breakthrough, a plan that had been under discussion among South Africa's engineering fraternity since the 1950s. There were numerous political obstacles, but ultimately in 1986 it was possible for South Africa's Pretoria–Witwatersrand–Vaal Triangle region, as well as parts of western Transvaal to secure access to water from Lesotho.

The LHWP enhanced the capacity of the department to distribute water supplies from the Vaal system to consumers further downstream in the Orange River system. Not only did the transboundary engagements in early IWRM benefit South Africa and the Kingdom of Lesotho; it also meant South Africa's closer engagement and collaboration with Swaziland, and made it possible to create working relationships and bonds of friendship in the collaborative use of the water resources of southern Africa.

The remarkable skill sets of experts in the department made it possible for South Africa to become a leader in the field of water transfer systems. Interdepartmental collaboration, engagement with the private sector and officials in neighbouring states began to open up the southern African region for South Africa. However, because of its apartheid policy South Africa's international status was compromised and it was not a partner in the UN' international decade of water and sanitation of the 1980s. However, South African scientists managed to remain at the forefront of international trends and development – thanks to long-standing relations between leaders in the international water sector.

With access to basic facilities such as computers, more GIS, a research funding and management organisation such as the WRC, and the department's own operational researchers, South African researchers made progress in drought and flood studies, for example. It made a substantial contribution to the corpus of functional knowledge, essential for the development of the country's water sector.

The inherent capacity within the department was evident in the department's national water development strategy, which was released in 1985 to 1986.[1512] It was a sound assessment of the department's capacity and its ability to work in the direction of a long-term plan. However, by 1989 there was growing uncertainty about the future South Africa, and the department's management used consultants to help explore privatisation strategies.[1513] In November 1989 the in-house publication, *Water*, reported on the memorable events of the year, but informed its readers prophetically, 'We are caught up in the maelstrom of life. A swift current sweeps us along, a sudden turbulent eddy whirls us into brief confusion.'[1514]

1512. Department of Water Affairs and Forestry (1986a).

1513. SAWHAR AHCA12/199 (1989:3).

1514. SAWHAR AHCA12/199a, 1989 , 'Hold up the mirror to 1989', *Water*, November, 1989, p. 1.

Chapter 10

Developments en route to a new South Africa (1989–1994)

The political economy of South Africa's transition

From the 1980s, South Africans in all walks of life veered towards a more non-racial mentality and a willingness to engage actively with fellow South Africans regardless of race. This was most evident in extra-parliamentary politics and in the media, where new ideas circulated in response to political debates in parliament and strident political views in the public realm. The rise of the UDF in the early 1980s, and, in 1986, the departure from parliamentary politics of Frederik van Zyl Slabbert, leader of the Progressive Federal Party to find an extra-parliamentary solution to South Africa's political dilemma, created an enabling environment for deliberations with the leadership of banned organisations, notably the ANC.

There was a greater willingness in the white electorate to accept black South Africans as fellow citizens of the state.[1515] In 1989 there were signal

How to cite: Tempelhoff, J.W.N., 2018, 'Developments en route to a new South Africa (1989–1994)', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 381-412, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.10

1515. Lodge (2012:482).

changes on the parliamentary front. F.W. de Klerk replaced P.W. Botha as president of South Africa, when Botha stepped down because of bad health. De Klerk was more sensitive than his predecessor to the civil politics of the day. Unlike Botha, since 1984 De Klerk had been working on strategies aimed at coming to a better understanding of the economic, political and civil aspirations of South Africans of colour as part of a parliamentary committee.

Although a committed Afrikaner nationalist, De Klerk did not hesitate to oppose the rising Afrikaner right wing. He took a stand of moderation towards transformation, in the aftermath of the global collapse of the East-West divide in late 1989. In southern Africa, as was the case in the rest of sub-Saharan Africa, the end of the 'communist threat' improved the prospects for an upsurge of democratic aspirations.[1516] The international political change did not come a moment too soon. South Africa's economy was in dire straits. After an all-time peak in 1981 it spiralled downwards in a 13-year-long decrease in per capita income that ended 18% lower in 1994. There was a slight improvement in the economy when F.W. de Klerk released political prisoners and agreed to embark on negotiations that eventually led to South Africa's multiracial democracy.[1517]

The transformation process began on 02 February 1990 when De Klerk announced in parliament that the iconic ANC leader, Nelson Mandela, who had been incarcerated for 26 years, would be released. At the same time all the remaining political prisoners not guilty of violent acts against the state were to be released. With immediate effect the government also legalised the previously banned and exiled political organisations.[1518] Interventions of this nature represented a significant shift in the style of government. The Botha era was notable for the government's strong-arm tactics, militarisation and increasingly authoritarian executive decisions – far removed from the basic principles of civil governance. De Klerk was more sensitive to social developments (a 'dove' rather than a 'hawk' as some commentators would have it), and shaping the way forward towards democracy.

In the period following 02 February 1990, government engaged in bilateral talks with the ANC that culminated in the Groote Schuur Minute of May 1990 and the Pretoria Minute of August 1990. These agreements paved the way for negotiations and the ANC's commitment to refrain from acts of violence. While government and anti-apartheid organisations prepared for negotiations, a multilateral National Peace Accord was signed in September 1991. It laid down the token codes of conduct for the process of negotiation.[1519]

1516. Giliomee (1995:92); Clapham (1993:423–438).

1517. Fedderke and Simkins (2012:181).

1518. Lodge (2012:481).

1519. Sommer (1996:61–62).

The ANC had meanwhile established itself as a strong united political front and by 1992 the ANC and its partners, as well as the government, had reached a point where they were prepared to abandon their intransigent positions. In civil society the Mass Democratic Movement (MDM), dating back to 1989, started consolidating support among South Africans in the trade union sector, where the Congress of South African Trade Unions (COSATU) strengthened its position by orchestrating mass workers' strikes. Together with the SACP it supported the ANC to form a tripartite alliance. The UDF was also active and helped to organise the Congress of Traditional Leaders, which drew substantial support from disaffected homeland elites who opposed the homelands system.[1520]

An opponent of the liberation movements was the ethnic Zulu Inkatha movement under the leadership of Chief Mangosuthu Buthelezi, who remained wary of the overtures of consolidated support of the liberation organisations and local groups that sprouted around them. Inkatha was said to have been responsible for several attacks on UDF supporters. The strength of Inkatha was its close allegiance to the authority of the Zulu monarchy.[1521]

From the outset, the groundswell of political thinking among extra-parliamentary groupings was that the bureaucratic apartheid system should be ousted. However, there was an awareness that the future majoritarian government might be unable to operate effectively without the experience and skills of governance.[1522]

At the end of 1991, negotiations began at the Convention for a Democratic South Africa (Codesa) in Kempton Park with the objective that all parties would negotiate and eventually reach consensus. By mid-1992 there were disputes about the nature of a government of national unity that would be responsible for paving the way to a future democratic South Africa. Prominent groupings in the deliberations were at loggerheads; each had their own agenda. The ANC was determined to reconfigure itself from a liberation movement to a political party, while the NP government tried to gain in status as the initiator of negotiations.[1523]

Meanwhile, there were incidents of escalating public violence, of which the 17 June 1992 Boipatong massacre in the Vaal Triangle region south of Johannesburg, was the most horrific. When 45 township residents were attacked by residents of the nearby Kwamadala Hostel, most of whom were Inkatha supporters, the ANC laid the blame at the door of a 'third force',

1520. Lodge (2012:483).

1521. Lodge (2012:484–485).

1522. Swilling (1990:151).

1523. Horwitz (2001:10).

alleged to have been behind the disruption of harmonious relations. It claimed that the government had orchestrated the massacre.[1524]

The conditions were symptomatic of the inability of non-government groupings to make a choice between a democracy and a negotiated constitution that made provision for power sharing.[1525] Angered by the Boipatong violence and the intransigence of the NP government, the ANC withdrew from negotiations until the end of 1992. When talks finally resumed it was possible, by late 1993, to come up with an interim constitution that laid the foundations for a liberal democracy.[1526]

A feature of the political climate in South Africa was that society had moved beyond 'reform' and 'revolution'. Instead, Swilling suggests, it was all about 'transition'.[1527] The NP government favoured transition through transformation. In other parts of the world, such as Spain and Brazil, similar processes in the transfer of political power had yielded good results. Moreover, as historian Hermann Giliomee suggests, using Samuel Huntington's theory of democratisation, it was a matter of 'backward legitimacy'. It was a case of wanting a democratising state to legitimise a pre-existing authoritarian order by claiming that it was responsible for giving birth to the new.[1528]

Departmental developments in Water Affairs as of 1989

The political transition of South Africa had a marked effect on staff mobility in the Department of Water Affairs. In 1989 to 1990 there were 505 resignations, pointing to intrinsic changes, not only in the department, but in the country as a whole.[1529] By 1991 the resignations were down to 343,[1530] but in many sectors of the department there were concerns about the loss of experienced people. A special departmental committee was appointed to attend to the staff shortage.[1531] Changes in the structure of government departments did not put officials at ease. On 14 November 1990, the name of the department was once again changed to the Department of Water Affairs and Forestry, with forestry and water matters making up the new consolidated department.

1524. Kane-Berman (1993:16–27).

1525. Du Toit (1995:220).

1526. Marais (2001:85–93).

1527. Swilling (1990:151, 153).

1528. Giliomee (1995:94).

1529. RP35/1991 (1991:12).

1530. RP35/1991 (1991:14).

1531. RP35/1991 (1991:1).

The transitional phase to an emergent new political dispensation saw the department's leadership undergoing significant change.

General Magnus Malan, a former chief of the South African Defence Force, who was an influential minister of defence in the P.W. Botha era, became Minister of Water Affairs and Forestry in the De Klerk era. He retired from politics with effect from 01 March 1993 and was succeeded by J.A. (Amie) van Wyk, who had previously served as deputy minister. In the case of the DG, G.C.D. Claassens' term was extended by one year from 01 September 1992.[1532] A strong candidate to take over leadership of the department in future was T.P.C. van Robbroeck, the deputy DG responsible for water resources development. However, he was promoted to the post of DG, public works and land affairs from 01 June 1991. Van Robbroeck had earlier made a name for himself as a water diplomat with sound engineering skills. He had a reputation for pioneering work in the department.[1533] His departure weakened the management of the department.

Conducting strategic planning against the backdrop of the socio-political developments in the country presented many difficulties. The new mission statement of the department by 1991 was, 'To accomplish the management, development and utilisation of water resources for the economic and social prosperity of all the inhabitants of the Republic of South Africa.'[1534]

Of paramount importance to the management of the department was the effect of the political transformation and its economic consequences on the limited water supply of the country.[1535] It was aware that water was vital for afforestation, but stressed that the existing afforestation permit system had been in place for 20 years without any revision. By implication this meant that it was to the detriment of the country's water catchment areas. Management was intent on securing savings on water consumption. DWAF's strategic planners worked in collaboration with the WRC in identifying and describing the competing sectors of water consumption. These included forestry, irrigation, industry, environmental conservation and developing communities.

The chances were good that government departments would be at loggerheads. Some agencies could even hamper the establishment of river basin authorities. This concept had formed part of the department's planning agenda for the better governance of water resources since the mid-1980s, but it did not always synchronise properly with the regional development plans of

1532. RP75/1994 (1994:8).

1533. RP33/1993 (1993:26–27).

1534. RP35/1992 (1992:11).

1535. RP35/1992 (1992:39).

the government. Yet the planners were convinced, from a strategic point of view, that the catchment principle deserved priority.[1536] The department's planners focused on the way the first, second and third tier of government had influenced the role of water agencies after the introduction of the 1984 constitution.[1537] There were clearly a number of areas of overlap, but also a number of issues that might hinder the effective management of the country's water resources. One of the first WRC reports to appear on the subject dealt with scenario-based policy planning, focusing on multiple criteria.[1538] There were a number of gaps in the governance systems of the 1980s. It made Water Affairs vulnerable.

Forestry, now coming under the Department of Water Affairs, had become a major factor in the preservation of the country's water resources. As government prepared for the privatisation of its 30% share of the country's commercial forestry operations, the environmental journalist James Clarke warned against the random privatisation of South Africa's forest areas. His concern was that the indigenous forests might be jeopardised by the sale of state forest lands. In his view the conservation activities of the Department of Forestry were vital for the holistic preservation of the country's indigenous forests.[1539]

As the country moved towards multiracial democracy, private forestry increased. Fears of imminent land claims and restitution became the driving force in securing and maximising the potential value of the land, along with maximum profit potential – to the detriment of the natural resources in many of the country's water-rich areas. The industry had started flourishing in the 1960s, at a time when the department focused on the Orange River development scheme and securing sufficient water supplies in the eastern Transvaal coalfields for thermal electricity power generation. At the time, private sector companies such as Mondi, Sappi, and Hunt, Leuchars and Hepburn, took the lead in a process that saw the private sector gaining ownership of at least 75% of the country's plantation areas. Between 1982 and 1992 there was an increased focus on water-thirsty hardwood (Eucalyptus) forests.[1540]

It did not augur well for the country's southern and eastern mountainous woodlands. In the early 1990s, in an era of drought, DWAF's water resource managers were interested in measures aimed at the preservation of the

1536. RP35/1992 (1992:40); SAWHAR AHCA2/043 (1990:1–29); SAWHAR AHCA2/067 (1989:1–23).

1537. RP35/1992 (1992:40); SAWHAR AHCA7/013 (1993).

1538. AHCA7/013 SAWHAR (1993).

1539. SAWHAR AHCA2/019 (1992).

1540. Carrere and Lohman (1996:189–202).

country's water resources.[1541] They engaged with private sector forestry operations in formulating ways of conserving river catchment resources along the Drakensberg escarpment. Economically, forestry was important for the country, as South Africa was a prime paper producer. Forestry had an important role to play in bolstering the economy, and there was little political will to stem the tide of expanding forestry.

Ramifications of the country's economy on DWAF

In the 1989 to 1990 period, because South Africa's economy was in dire straits, the department emphasised economy. In the pre-negotiation period until early 1991, management accentuated cost-effective departmental services. The annual report for 1989–1990 outlined the focus as follows:

> The Department administers a major national strategic resource – water – which has a direct as well as indirect effect on the entire spectrum of the national economy. It is not practically feasible to operate water supply [...] on a cost-recovery basis and accordingly great emphasis was placed [...] on the cost-effective use of State funds [...] to derive maximum benefits from [...] Departmental spending. In the process interested organisations, interest groups and individuals were consulted increasingly in order to give effect to the aims and objectives of the Department.[1542]

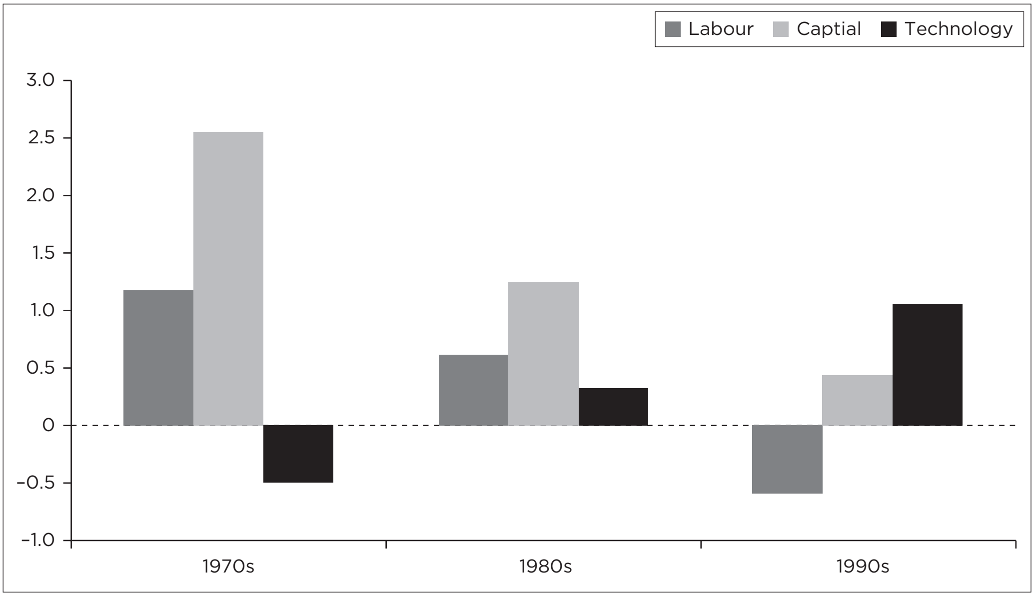
Consumers identified by the department were industry, power generators, the irrigation sector, and the public. The department sought at all times to enjoy the confidence of the public and maintain a sense of partnership. Importantly, the development trend in the department coincided with an interesting phase in the country's economy. It was later described by Fedderke and Simkins, whose theoretical analysis examined the effect of the changing economy on the operations of a typical government department, such as Water Affairs and Forestry (see Figure 10.1). Working from the concept of total factor policy they focused specifically on labour, capital and technology as production factors. The backdrop was the implicit growth of the country's gross domestic product (GDP) between the 1970s and 1990s.[1543]

Interpreting the growth trend in the context of the Department of Water Affairs and Forestry the following assessment presented itself: in the 1970s the department relied extensively on labour and capital to realise technological growth, which tended to be underdeveloped. In the 1980s more capital was available. The department paid for more technology, but there was a decline in the demand for labour. By the 1990s the demand for labour dropped significantly in economic terms, while capital also declined. At the same time technology made substantial headway.

1541. SAWHAR AHCA2/043 (1990:1–29).

1542. RP35/1991 (1991:1).

1543. Fedderke and Simkins (2012:181–182).



Source: Fedderke and Simkins (2012:182).
FIGURE 10.1: Fedderke and Simkins' analysis of the production factors (labour, capital and technology) and the implicit growth decomposition in real GDP in the period 1970s–1990s.

The theoretical macro-economic analysis clearly corresponds with what was going on in the Department of Water Affairs and Forestry's (DWAF) devolution of direct control over the system of water supply governance. In 1993, the process culminated in the transfer of a number of government water schemes and purification works to statutory bodies.[1544] Judged from the perspective of the technological production factor, it is evident that boosting the technological infrastructure (for example information communications technology) paid dividends by the 1990s.[1545] The system was able to support the growth in demand for industrial purposes (generating electricity) and for potable water – despite the fact that in many cases consumers did not always pay for service delivery. It represented what Fedderke and Simkins described as a 'decomposition of growth' in real GDP,[1546] but, as will become evident, the availability of water for all the country's residents was far from uniform in the early 1990s.

The need to democratise access to water and proper sanitation became one of the major rallying points of the extra-governmental groupings that took control of government in 1994. Moreover, the apparent collapse of labour, in Fedderke and Simkins' view of things, allowed for technology to flourish. As the availability of cash diminished, technology was in demand because it was

1544. RP75/1994 (1994:8).

1545. Lumby, Matete and Rwelamira (2005:95–96).

1546. Fedderke and Simkins (2012:182–183).

less cost-intensive than labour. As will become evident in the chapters to follow, there was a consistent decline in the number of DWAF officials.

The emergence of a new social ecological hydraulic mission, foregrounding people and the environment, was the result of a process of creative destruction at the end of a panarchy cycle notable for concerted efforts to secure and conserve the country's water resources at a time of economic constraint.

Towards privatisation and decentralisation

In the early 1990s the water resources branch of DWAF pursued decentralisation proactively. Consultants who began investigations into privatisation in the late 1980s, submitted a final report to the department in October 1989, and the departmental task group handed its report to the department's management on 26 March 1990.[1547] A number of government water schemes were either partly or completely transferred to water boards, irrigation boards and other statutory bodies, for the purposes of ownership and operation.[1548]

The department transferred a number of its works to other statutory bodies in the course of 1991 to 1992. These included:

- the Pietersburg government regional water supply scheme, which was transferred to the Northern Transvaal Water Board
- the Loerie Dam and Charlie Malan Dam, which were transferred to Port Elizabeth municipality for maintenance and operation
- the Caledon–Bloemfontein government water scheme, including the Lesaka pipeline, which was transferred to the Bloemareas Water Board
- the Withoogte administration centre, which included the Berg River (Saldanha) and Berg River (Swartland) water supply schemes and was transferred to the West Coast Regional Services Council
- the Gamtoos government water scheme, which was transferred to the Gamtoos irrigation board for maintenance and operations
- the Temba and Wallmanstal water purification works, which was transferred to Magalies Water Board.[1549]

With the establishment on 11 June 1993 of the Bosveld Water Board, the number of water boards in South Africa rose to 16. Furthermore, the Bosveld Water Board was ready for absorption into the decentralised system of water governance. In 1993 the ownership of a number of former government water schemes and services were transferred to statutory bodies. These included:

- the White Water River (Da Gama) government water scheme to the White Water River major irrigation board

1547. RP35/1991 (1991:6).

1548. RP33/1993 (1993:10).

1549. RP33/1993 (1993:24–25).

- the White River (Longmere Dam and Primkop Dam) government water scheme, including the Strydfontein water transfer scheme, to the White River Valley Conservation Board
- the Duivenshok rural water supply scheme and the Rüensveld East rural water supply scheme, which were transferred to the South-western Cape Water Board
- the Duiwelskloof government water scheme to the Northern Transvaal Water Board
- the Mossel Bay (Wolwedans Dam) government water scheme to Mossref, the local refinery operation.[1550]

The state, through the department, continued to subsidise the water boards, to the tune of R1.17m in 1993 to 1994.[1551]

Construction work

In line with the department's development policy since the late 1980s, construction work was grinding to a halt. By 1990 the department had a number of construction projects of which four, Amatole, Greater Brandvlei the South Namaqualand and Lower Sundays River (extension) were the responsibility of private contractors. The South Namaqualand water supply scheme, commissioned in March 1990, was unique. It made use of a reverse osmosis desalination plant capable of supplying as much as 155 m^3/d to Bitterfontein and Nuwerus. The plant processed local brackish water received from a number of boreholes, of which about 70% was desalinised. There were also some innovative new engineering works, despite the relatively quiet period as far as construction projects were concerned. In 1989 to 1990 the Ebenezer Dam, in the north-eastern Transvaal, was provided with a floating telescopic tower to abstract water of good quality from a selected depth of about 5 m below the surface, irrespective of the variation in the water level of the dam.[1552]

By 1992, for the first time in many years, there were no new water projects in the pipeline for the DWAF. What did go ahead was the resumption of the emergency scheme for the supply of Orange River water to Port Elizabeth.[1553] The scheme came into operation in February 1992. In addition, existing construction work continued on 12 schemes. Of these the Caledon–Modder River, Orange–Douglas, Vanderkloof Islands schemes and the Riviersonderend–Berg River were completed in the 1991–1992 financial year.[1554]

1550. RP75/1994 (1994:32–33).

1551. RP61/1995 (1995:17).

1552. RP35/1991 (1991:6–7).

1553. WP A90 (1990).

1554. RP33/1993 (1993:13).

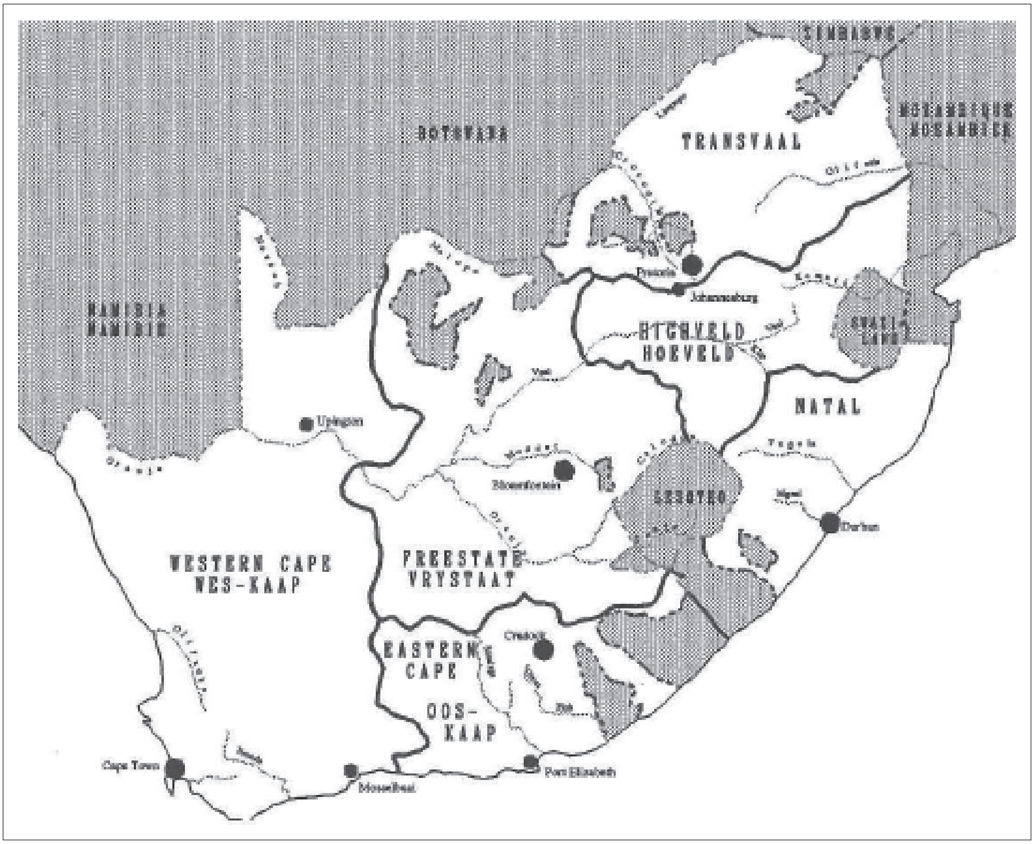
Source: RP75/1994 (1994:44).
FIGURE 10.2: The Driekoppies Dam under construction by 1994. The R488m dam was funded by the Development Bank of Southern Africa.

Once the Usutu–Komati link system and the Pongola betterment scheme materialised, following the conclusion of agreements with Swaziland, the contract for the construction of the Driekoppies Dam on the Komati River was given to the department's directorate of construction by the Komati Basin Water Authority (KOBWA) the transboundary Swaziland–South Africa governing authority responsible for the management of the water scheme (please see Figure 10.2). The director also acted as construction contractor for the Eskom pipeline to transfer water from the Usutu government water scheme to the Komati River.[1555]

Water resource management and regionalisation

In May 1990, C. Triebel, the managing engineer of water affairs, pointed to a number of water management areas that had become problematic. It was difficult to introduce regionalisation and decentralisation while still maintaining control of the country's water resources. It was evident that there were more competing demands for the available water resources; and there were not enough forums where stakeholders could make their claims. The existing constitutional dispensation, he explained in departmental correspondence,

1555. RP75/1994 (1994:11).



Source: RP61/1995 (1995:46).
FIGURE 10.3: Operational regions of the Department of Water Affairs and Forestry in 1993–1994.

complicated the distribution of water. Uneven distribution systems did not correspond realistically with the demand for water. The free market mechanism was not working properly because riparian water users were adopting a system of summarily asserting their rights to water. Triebel singled out certain interest groups that were simply not competitive enough for the free market to work. These included disadvantaged communities and the agricultural sector. The ecological system could not withstand such pressure.[1556]

The solution was said to be for regional services councils and water boards to take responsibility for developing their regional service area infrastructure, within the framework laid down by government. The regional services boards and water boards had to take control of water-related issues in their areas. At the same time, they had to create forums for each region, where water issues could be deliberated (Figure 10.3). The role of Water Affairs was to see to it that the policy framework was applied, and

1556. SAWHAR AHCA2/006 (1990).

to do this a responsible official from the department should participate in regional water management steering committees.

The issue of how the self-governing and independent homelands were to fit into the oversight role of the Department of Water Affairs remained a problem that had to be addressed. In July 1990, officials of the Department of Development Support who were responsible for the self-governing areas, held a meeting with strategic planners from the Department of Water Affairs. They wanted to know who would be responsible for the assessment of water resources and infrastructure in Lebowa and Kwandebele. A consultant who also attended the meeting, recommended that a comparative study be made of the two self-governing territories to form an impression of conditions in well-endowed and less developed areas. The department gave its support for this idea. Water resource managers were now moving into uncharted territory, not yet integrated into the larger regional management system.[1557] It was also an open question whether this type of investigation was relevant in the light of the process of political transition that was under way.

By 1991, regional water management systems started finding their place in the larger picture of the country's water resource management. A highly diversified set of reports featured in the department's annual report. For example, in the case of the Transvaal region there were concerns that the Doorndraai, Albasini and Klein Maricopoort dams were experiencing low inflows. Similar trends were reported from the Koster Dam and Nyelele Dam. This pointed to renewed drought conditions. Water for the coal mining sector was important in the Transvaal region, and the management of the area reported on work in the catchment of the Witbank Dam. There were concerns about the viability of the Middelburg Dam, which required direct action to prevent water pollution. In the OFS, the regional office announced that the Caledon (Welbedacht–Bloemfontein) government water scheme had been transferred to the Bloem Area Water Board as of 01 April 1990. In the Eastern Cape the 'circle office' – a pre-1980s misnomer – saw to the completion of the Haarlem Dam and pipeline for the Haarlem irrigation board, as well as the completion of the Misgund Dam for the Misgund eastern irrigation board. There were plans to import Orange River water, via the Great Fish River, to the Tarka Bridge and Gannavlakte irrigation boards, and an extension of the Lower Sundays River government water scheme focused on supporting the Sundays River irrigation board.[1558]

The Natal region had to manage the lower water supply in the Pongola Government Water Scheme. There were reportedly high coliform counts in the

1557. SAWHAR AHCA2/021 (1990).

1558. RP35/1992 (1992:60–61).

Mzinduzi River caused by a chemical factory at Pietermaritzburg, which had a negative effect on the performance of the river's water; it also held a potential threat to the sea outfall of the river. In addition, officials had been active in mine dump rehabilitation in the Dundee area and rendered a major service by making available 1977 ha of land scheduled for irrigation on the White Mfolozi, downstream of the Klipfontein Dam. In the Western Cape DWAF officials worked on the design and construction of the Sandveld (West Coast) regional water supply for Graafwater and the construction of a storage dam, pipelines and equipment for boreholes. In the Highveld region conditions remained stable. The KaNgwane homeland authority collaborated with the regional office to combat water pollution. The regional officials at Nelspruit who were engaging with local mines, created an awareness of the consequences of pollution in the Waterval River.[1559] The Highveld region included the heartland of the coal mining operations of the eastern Transvaal and northern Free State. It included the eastern OFS area from which the LHWP was scheduled to deliver its water supply to the Vaal River catchment.

In the 1993 to 1994 period, Natal regional officials worked on the problem of defunct coal mines and their acidic mine water that was polluting the rivers. A new focus that emerged was the issue of sewage pollution in informal settlements and the absence of a proper reticulation system. The regional office maintained constant contact with the local authorities responsible, in an effort to address the matter. The office also started using the available database information when there was a flood in the Ladysmith area of the Mfolozi River. The availability of data made it possible for the water resource managers to predict the development of the event. The Eastern Cape region, despite better rainfall, was still recovering from three years of drought. On occasion, the resource managers had to release as much as 4.5 MCM from the Amatole government water scheme to replenish East London's Nahoon Dam. The consequence was that the Wriggleswade Dam (crest: 34 m and 740 m wide) dropped to its lowest level ever recorded (4.41%).[1560]

It was feared that there would soon be political repercussions because of the department's lack of proactive response to the emergent drought conditions. The fragmented nature of the country's water governance system meant that it was difficult to gain a bigger picture of the serious drought conditions that took hold in parts of South Africa at the time.

The water supply from the Orange River via the Great Fish River was still subject to restrictions, and irrigation operations in 1993 never exceeded 90% of normal allocations. The Wriggleswade Dam on the Kubusi River, completed in 1989, was one of a number of South African rollcrete dams that caught

1559. RP35/1992 (1992:61–62).

1560. RP61/1995 (1995:50–51).

international attention for the ground-breaking technology introduced by the department in terms of concrete dam construction techniques.[1561]

The Transvaal regional office of the DWAF oversaw the process of the Crocodile River (western Transvaal) irrigation board taking charge of its responsibilities, while the Bushveld Water Board at Potgietersrust took charge of the regional water supply scheme. Following a more stringent schedule of water abstraction from sources, the regional office's law enforcement officials took steps against transgressors. In doing so they made use of video equipment during aerial reconnaissance trips, to determine where there were illegal dams, or dam walls that were too high and did not conform to regulations. They also linked their information to a database for effective monitoring purposes.

In the case of the Great Letaba River, the supply of water to the Ebenezer Dam and the Fanie Botha Dams at Tzaneen dropped to the extent that in the face of a potential shortfall, the regional office staff had to manage the allocation of water, while citrus farmers were limited in their allocations. The objective was to continue sustaining the anticipated crops, but with more control of the limited supply. Apart from overseeing the establishment of catchment management forums in the Jukskei and Lower Olifants River, the regional office took note and provided support in the establishment of similar forums for the Hennops, Apies, Pienaars and Steelpoort rivers. In addition to focusing on irrigation farming water allocations, the regional office had to monitor industrial water pollution emanating from the Phalaborwa complex.[1562]

In the Free State region, the regional office, in collaboration with water users, had to work on the introduction of restrictions as the levels of the P.K. le Roux Dam (Vanderkloof Dam) and the Verwoerd (Gariep) Dam started dropping, while the irrigation boards of the Leeu and Modder rivers introduced their own restrictions.

The regional office launched a number of studies aimed at gaining a better understanding of the catchment it managed. The studies included:

- an Orange River analysis
- a Vaal River study
- a Sand–Vet catchment study
- a Douglas Weir water catchment quality study.

The information shed light on the nature of the management problems the regional office had to resolve. As a result of the research findings, the management of the Bloemhof Dam improved, with the installation of a

1561. Van Vuuren (2012:233).

1562. RP61/1995 (1955:52–53).

comprehensive telemetric system to monitor the dam. By 1993 to 1994, the drought conditions in the Western Cape region had grown worse because of the lack of winter rainfall. Schemes that had been transferred earlier to statutory bodies had timeous management strategies to deal with the drought. Their activities extended into the Karoo region, to manage the future supply of water in the face of potential drought.[1563]

Further north the Highveld regional office, responsible for the management of the Vaal River system, did not face a shortfall. However, it took steps to establish a more effective monitoring system in the Komati River, and a water quality monitoring system at the Grootdraai Dam. Diffuse sources of pollution were identified and investigated to reduce the implications of negative river health in the region. The regional management of the Vaal River system was under scrutiny in 1993 to 1994. Management wanted to introduce a more scientific approach to the oversight of the system. In view of the region's high rate of coal mining and power generation, the department was well aware of excessive salt loads as a result of mine water pollution. In addition, there were reports of heavy human settlements (mostly informal) along river banks, which caused severe sewage pollution problems. Rent and electricity rates boycotts led to power failures, and sewage pumping stations became clogged. The regional office reported that it was difficult to prosecute local authorities. In an effort to address the problem, forums were created in which the department played an active role. Departmental officials helped local authorities to investigate all potential sources of financing and to consider strategies aimed at cleaning up problematic areas.[1564]

Regionalisation, fragmentation and gaps in the system

In the early 1990s the national DWAF focused mainly on the regionalisation of its management system, transferring substantial responsibilities to local water authorities. But there was a gap in the understanding of the bigger picture. South Africa's regional transformation – the closure of the four provincial structures which previously accommodated regional development structures – meant that vital information did not always reach central management. There was also evidence that the rapid urbanisation and the rise of informal settlements in the highly populated industrial areas of the country in close proximity to the riverine catchments, was having dire consequences for water and sanitation services. There were numerous reports of the collapse of water supply, sanitation and electricity service delivery.

1563. RP61/1995 (1955:52–55).

1564. RP61/1995 (1955:56).

Relaxation of security systems and staff rationalisation

By the early 1990s, the state started relaxing its security measures, after protecting itself strategically for more than a quarter of a century against the onslaught of the liberation struggle. In the DWAF, where many of the infrastructure installations had been heavily guarded, safety and security systems were downscaled. However, the department did remain on the alert and redeployed some security and safety staff members to 360 offices in various parts of the country, where they collaborated with regional security committees. These groups focused mainly on the standardisation of physical security matters. As South Africa entered the phase of regime change, security services were downscaled even further. However, a very competent level of security remained in place at the department's head office and other places considered to be of strategic importance.[1565]

There was yet another rationalisation of staff. Remaining officials were incorporated into occupational safety activities. By 1992 the number of officials of the department's water affairs branch declined from 11150 to 9531. The largest decrease in number was as a result of the general assistants who were transferred to government water schemes and water purification works, water boards and bodies responsible for the management and operations of local infrastructure and water resources. In addition, there was a significant decline in the department's construction activities.[1566]

Dam safety measures

As politically based security measures eased, DWAF started focusing more on dam safety. The special task team, created in the early 1980s, maintained a keen eye on safety measures.[1567] While drought conditions posed a major threat in the next decade, the department's management was more than aware of the significant threat of floods. Working from flood data captured since the 1980s, it was possible to ascertain with a high degree of certainty that floods were costing the country on average R100m p/a.[1568] The careful inspection of dams continued.

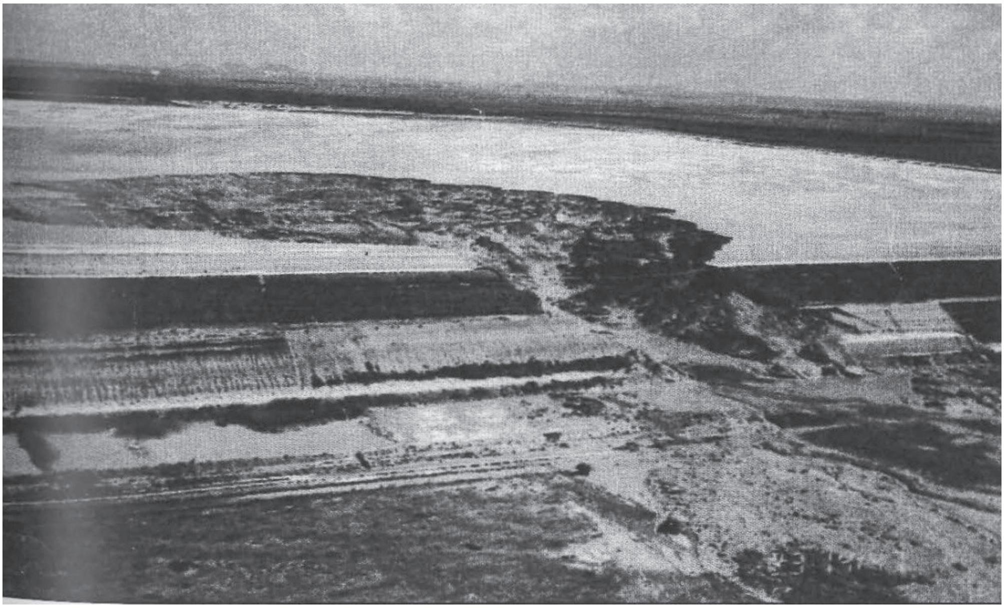
From 1989 to 1990, three dams were inspected in terms of the department's dam safety legislation. Full reports followed. In general, these pointed out that the dams were safe and contingency planning was in place to help people,

1565. RP35/1992 (1992:19).

1566. RP33/1993 (1993:25, 33).

1567. Department of Water Affairs and Forestry (1986a:Section 6.18).

1568. RP35/1991 (1991:36).



Source: RP61/1995 (1995:35).
FIGURE 10.4: The Virginia No. 15 tailings dam (Merriespruit).

if need be, to evacuate from sites downstream in a crisis.[1569] By 1991 a total of 170 dams had been registered – up from 101 the previous year. In total 2782 dams were on the department's records. The dam safety group then started working on tailings dams at mining operations and in the course of the year registered 253 of these dams. By the end of the year, the dam safety management group had determined that the total number of classified existing tailings dams stood at 1856, which represented 67% of all registered dams.[1570] The measure did not come a day too soon.

On 22 February 1994 the Merriespruit tailings dam in the Free State goldfields was responsible for a disastrous mud spill when its northern wall collapsed (please see Figure 10.4). In the process 17 people were killed and hundreds were left homeless. Damage was estimated at about R100m.[1571]

Up to that time the collapse of tailings dams was an uncommon occurrence in South Africa. There were only a few previous incidents on record with one at Simmer and Jack Mine in 1937, one at Grootvlei in 1956, while in 1974 there was also a tailings dam that collapsed at the Bafokeng mine near Rustenburg.[1572]

1569. RP35/1991 (1991:36, 47).

1570. RP35/1991 (1991:49).

1571. Duvenhage (1998:1).

1572. RP61/1995 (1995:1).

In the process of downscaling mining operations in the transition to a new political dispensation, the sites of comprehensive mine operations became more vulnerable to disasters. In view of what had happened at Merriespruit, the department's dam safety office made a concerted effort to work even more stringently than before on the safety of dams in South Africa. For the department it was essential that legislation and specific regulations should be updated and introduced, to ensure that safety was a priority at all dam sites in the country. By 1993 to 1994 the dam safety office had registered an additional 87 dams, which brought the total number of dams on record to 3149.[1573]

Pollution control

Subsequent to the introduction of more effective pollution control measures in the 1980s,[1574] DWAF stepped up its control and enforcement systems. The first catchment studies in the eastern Transvaal in 1985[1575] were indicative of a greater awareness of the necessity of combating pollution.[1576] By 1990, catchment management studies continued in a number of areas, in collaboration with consulting engineers and the CSIR. These included the Witbank catchment and the Loskop catchment area, where partial pollution from sulphate concentrations and AMD from abandoned coal mines posed a threat; the northern Natal coal fields (Buffalo River), where compliance to regulations had to be laid down; the Waterval River (Vaal Dam catchment), where there had been a considerable mineralisation of water as a result of upstream mining activities; the Middle Vaal River, where eutrophication posed a threat to water resources; the Swartkops River (Port Elizabeth), where storm water pollution of the river mouth, as a result of urban development, affected the whole catchment area; and the Crocodile River (eastern Transvaal), where a water management strategy had to be drawn up, in conjunction with water supply and water resource development strategies.[1577]

In 1991, following a draft discussion document submitted to parliament, the department explained there was a new approach to water pollution control. AMD had become South Africa's major water pollution problem.[1578] The department's new management approach was based on the integrated quality management of South Africa's water resources. Elements of the discussion had

1573. RP61/1995 (1995:36, 39).

1574. SAWHAR ZKC (1986:Sections 4.17–14.23).

1575. Van Vuuren (2017:120).

1576. Braune and Rogers (1987).

1577. RP35/1992 (1992:61).

1578. WP F92 (1992).

been present in management discourses for some time,[1579] but now it became more pronounced. The department's water pollution control division had made substantial progress with enforcement measures since the inception of the *Water Act* of 1956.

The new strategy signified a more comprehensive water quality management plan. There had been a shift from an approach aimed at establishing a 'uniform effluent standard', to one that focused on the concept of 'receiving water quality', with plans in place for pollution prevention. By 1991, pollution prevention had already gained significant currency among the majority of industrial water consumers, and the department's pollution control officials wanted to 'secure the sustained assured availability of water of an acceptable quality for all recognised water users'. The document submitted to parliament dealt with the status quo in terms of water quality management policies, as well as potential future trends. There was a recommendation on the need for specific policy strategies. According to the authors of the document, the target group was those people who were interested in the environment in general and specifically those interested in water quality. The water affairs branch argued that those who were affected by its policies, and had concerns about the implementation of these policies, were the ones who should have a say in the decision-making process.[1580]

What was interesting about the 1991 plans was that the department appointed consultants to do 16 water catchment studies. In addition, they worked in the direction of compiling a set of water quality guidelines. The annual report for 1990 to 1991 mentions that the department intended setting up guidelines in collaboration with 'recognised users'. They were interested in quantifying the needs, and integrating them into guidelines based on the water quality requirements of the most sensitive of water users. In collaboration with the department, six industries conducted waste load allocation studies. The objective was to determine how to respond to the requests for general exemption from the standards that had been laid down by the department in terms of the maximum limits in effluents.[1581] The department worked on compliance monitoring based on its pollution monitoring computerised database (POLMON), which had been in operation since the mid-1980s.[1582] Permit holders were prepared, in turn, to participate and to ensure that the required results were secured.[1583]

1579. SAWHAR AHCA2/009 (1990:1–7); SAWHAR AHCA2/016 (1992:107)

1580. RP35/1992 (1992:31–32).

1581. RP35/1992 (1992:32).

1582. SAWHAR WLC B576 (1986:5–7); SA Water Bulletin (1990:17).

1583. RP35/1992 (1992:33).

In 1991, at the time of introducing its new integrated management system, the department referred back to a White Paper on the state of a Natal coal mine site that had closed down before the mid-1950s.[1584] Over the four years that the department had been working on the project, the cost of cleaning the pollution amounted to more than R11m.[1585] Apart from mine water pollution issues, solid waste also came in for scrutiny in terms of the new more environmental and integrated approach to water resources quality management.

Of significant importance was the *Water Amendment Act* of 1991,[1586] which provided for a drastic increase in penalties for parties in contravention of the 1956 *Water Act*, specifically in respect of ongoing pollution and a disregard for water restrictions. In the case of more serious offences, there was a maximum fine of R50 000 for a first offence, and R100 000 for a second offence. The new measures increased the maximum fines and also introduced the option of potential jail sentences for pollution misdemeanours.[1587]

By 1992 the number of culprits contravening the new standards had increased by more than 100%. The management of the department meanwhile worked on addressing the issue with the support of the public relations division of the department.[1588] The department was determined to clamp down on pollution. However, strong-arm tactics were not on the agenda. Instead, the plan was to collaborate with polluters in addressing the problem. But the steady decline in the number of civil servants in the department since the late 1980s inevitably played a role. There were simply not enough officials to do the necessary enforcement.

Mine water pollution 1992–1993

The DWAF annual report for 1992–1993 stated that a comprehensive strategy had been worked out for dealing with mine water pollution and that the matter would be dealt with in collaboration with the Department of Mineral and Energy Affairs. Of particular importance at the time were measures to address coal mine pollution in the eastern Transvaal region (now Mpumalanga) near the urban centres of Ermelo and Witbank.[1589] However, the report suggested that

1584. WP E87 (1987).

1585. RP35/1992 (1992:33–34).

1586. Republic of South Africa (n.d.).

1587. RP33/1993 (1993:11, 37).

1588. RP75/1994 (1994:9).

1589. WP F92 (1992).

some 'aspects' needed to be refined. The department required a legal strategy for the system to become operative.[1590]

One example of what the department had in mind was the development of the Brugspruit water pollution control works, situated on a tributary of the Klipspruit, draining the upper Olifants River.[1591] Since the early 1900s the area had been mined for coal. Several thousand ha of land had been shallowly mined. Over the years, as a result of mining, the local environment had become severely contaminated with AMD. The seepage and flow of old mining operations had a direct impact on the tributaries of the Klipspruit and further down on the Loskop area – the site of one of South Africa's premier large dams. The water in the Klipspruit could not be used for potable or irrigation purposes. The time had come for action.

In 1992, the department developed a water quality management plan for the Klipspruit catchment and proposed the following:

- a combination of stringent pollution control measures at source
- the construction of water pollution control works
- potential future re-mining and rehabilitation of the old mine workings.[1592]

In effect, this meant that the department assumed responsibility, on behalf of the state, to remediate and install water pollution control works to minimise the impact of AMD on the local river system.[1593] In 1996 the department's design services produced a report and plans for the construction of the water pollution control works. The plant was commissioned in December 1996 and officially opened on 17 March 1997 at a cost of R26.5m.[1594]

The operation at Brugspruit included an extensive AMD drainage collection, to intercept and collect AMD from six constructed collection points. AMD flowed under gravity to the treatment plant in a collector pipe system extending over 7.8 km. In the treatment plant, lime was used to neutralise the water. Then there was a point where the bulk of toxic metals were removed, specifically iron, manganese and aluminium. The treatment process saw to balancing the flow, pumping, lime dosage, aeration and final clarification. The metal precipitate that formed was of a sludge nature and this was then removed by means of clarifiers. The final effluent was stabilised with soda ash before being discharged into the adjacent Brugspruit at a rate of 10 000 m^3/d.[1595]

1590. RP75/1994 (1994:10).

1591. SAWHAR WLC C3231 (1998:1–6).

1592. Department of Water Affairs (1986).

1593. SA Water Bulletin (1994:24).

1594. RP186/1997 (*c.* 1997:69); Hobbs, Oelofse and Rascher (2011:424).

1595. Department of Water Affairs (n.d.).

Ironically, from late 1987 when determined steps were taken to check mine water pollution with stricter law enforcement methods, the underlying discourse was that the prime problem was the mining operations that had closed down before the *Water Act* of 1956 had been passed. This meant, in effect, that it was the state's responsibility to make sure that the issue of mine water pollution was resolved. The legacy problem persisted, but in a different framework, with the introduction of new legislation after 1994. Almost as if it had never been aware of the problem previously, for the first time the annual report of the department for 1992–1993, expressed its 'surprise' at the significant amount of water pollution emanating from informal settlements. The DG stated, 'there is a need for an integrated study with a view to formulating a policy and management approach for handling of the problem'. As a first step, he suggested, the existing state of affairs had to be quantified and priorities had to be determined.[1596]

Research and greater digitisation

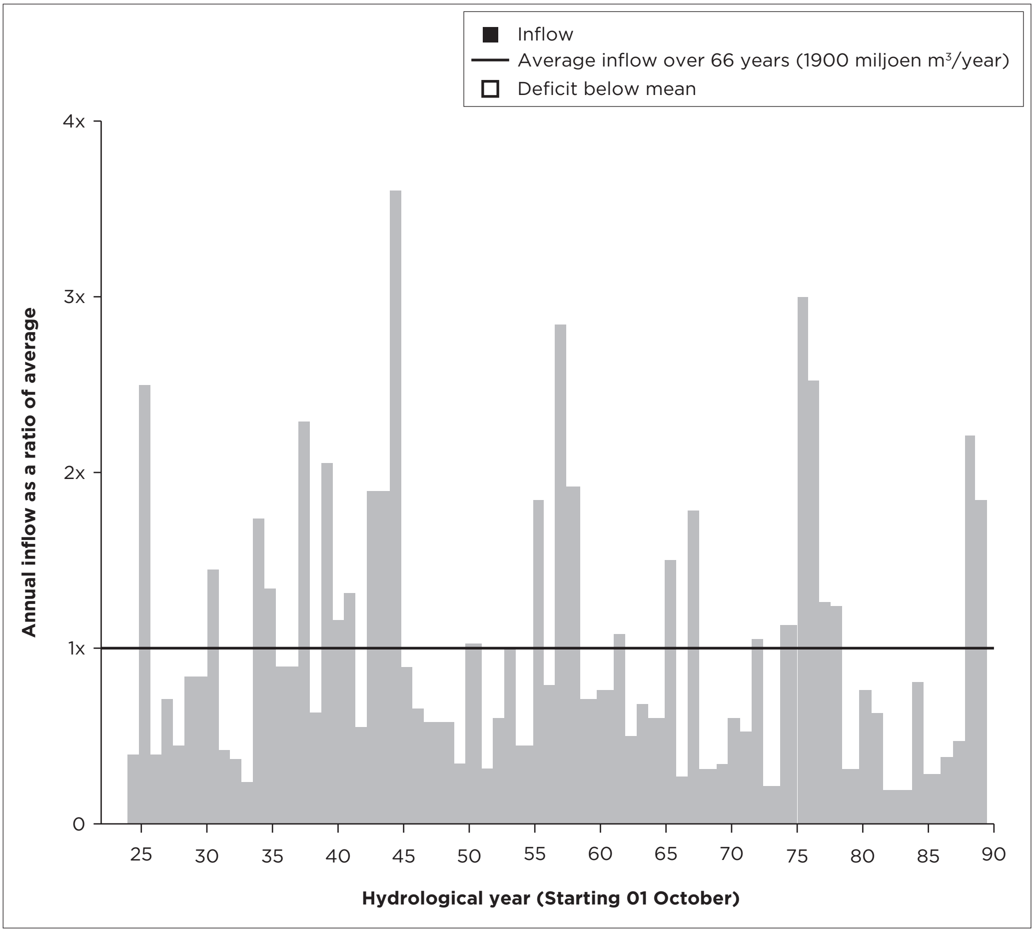
Because the department relied increasingly on electronic data transmission and sophisticated technologies to manage the water resources of the country, the demand for more data increased. Officials at the HRI were deeply involved in the project. By 1990, analysts had been able to secure historical data for the period between 1900 and 1980, in collaboration with a group of the WRC that had been seconded to the department. The WRC group had also managed to capture historical reservoir data. This data was more complex than the river flow data; because the gauging stations under which the dams appeared were listed alphabetically, the data had to be captured in alphabetical order. This meant that all the data from the gauging stations had to be recorded and consolidated before the reservoir databank could be finalised.[1597]

One spin-off of the data capturing process was the increased potential to do complex modelling from diverse data. In 1990, for example, it was possible to calculate the average inflow of water into the Vaal Dam and Grootdraai Dam over a period of 66 years – a storage reservoir completed in 1982 (please refer to Figure 10.5). Working on data from gauging stations and a record of water in the Vaal River Barrage dating back to 1923, when the barrage structure was completed by Rand Water, it was possible to determine an extended time frame of inflow into the two dams that had been completed in 1938 and 1980 respectively.

The hydrological information system database was a combined large system containing information on water levels, flow, water storage, evaporation and water quality. The major obstacle to its development was a chronic shortage

1596. RP75/1994 (1994:9, 26).

1597. RP35/1991 (1991:23–24).



Source: RP35/1991 (1991:23).

FIGURE 10.5: Inflow of the Vaal Dam and Grootdraai Dam between 1923 and 1989 based on the department's databases.

of programmers in the department. Despite the support of the WRC data development team on the project, it remained an enormous task to compile a database of the department's basic station catalogue and then to populate the database with information. For example, the database contained 6639 hydrological observation points at 3065 gauging stations. The database for water level and flow had to be refined and improved. By 1990 the system contained 220 000 observation points, with monthly data from flow-gauging stations dating back to 1930.[1598] The next year the team completed a comprehensive manual on the way the data would be gathered. There were still problems in the proper transmission of data from an older system, but the

1598. RP35/1991 (1991:24).

team had managed to consolidate a catalogue that could facilitate search functions on the system.[1599]

Data management increasingly influenced the way the department managed the water resources of the country. In reporting on the activities of the HRI in 1990, the department's annual report stated:

> Surface water is one of the most important natural resources of South Africa. Development of this resource has steadily progressed over the last decades, accompanied by a significant shift in emphasis from the development of new resources to the management of existing ones. In recent years, this has led to an increased awareness of the need for the development of sound water quality management policies.[1600]

Hydrometric specialists now worked in collaboration with the department's managers. By 1992 the data specialists had put many different technologies to the test. Much of the work meant learning from trial and error. There were data loggers with optic encoders, but by this time they no longer worked well. There were also problems with water level sensors, such as pressure sensors, ultrasonic and float sensors. Whatever technological monitoring equipment was available was put to the test. There was a wide variety of locally manufactured and imported pressure sensors on the market, but these were unsuitable for the high degree of accuracy the department's hydrometric specialists demanded. They started using ultrasonic water level gauging from bridges and found that optic and magnetic encoders could be used where float-driven magnetic recorders had already been installed. Of substantial importance was a meteor-burst communications (MBC) network.[1601] MBC is a radio system that exploits ionised meteor trails when they enter the earth's atmosphere; when they do so, they create communication opportunities between radio stations extended over distances of up to 2250 km.[1602] For the South African water sector MBC proved valuable because of the large distances between water resource control and monitoring sites, some of which were situated in distant and isolated areas of the subcontinent. In addition to MBC, the data-collecting activities included data transmission media working via radio and satellite. In the case of the Vaal–Wilge River, earth radio was used.[1603] Many of these communications systems changed in the face of increasingly sophisticated satellite and cellular communications technology systems.

1599. RP35/1992 (1992:27).

1600. RP35/1991 (1991:25–26).

1601. RP33/1993 (1993:44).

1602. Poole (1995:471–478).

1603. RP33/1993 (1993:44–45).

The new communications technologies made it possible to develop more comprehensive database systems. By 1992 a total of 20 110 water samples were received and registered into a chemistry data bank. Experts working in this area determined the electrical conductivity of 1156 samples and also the concentration of suspended material of 1044 samples. The rest of the information was analysed by the HRI. In the course of the year the number of analysis results increased by 38 310. More than 80% of the data which had earlier been stored in the chemistry data bank, was transferred to the HRI in 1991 to 1992.[1604]

In his introduction to the annual report of 1992–1993, the DG, G.C.D. Claassens, noted that the employment of modern methods of integrated information systems had the effect that users who depended on information were becoming more proficient in the creation of systems that met their needs. Good progress had been made, he explained, in encompassing hydrological information, water permits, pollution monitoring, water quality management, financial control and contract administration.[1605]

In terms of the quality of hydrological data at its disposal, the directorate of scientific services was of the opinion in 1994, that the data received had generally been of a high quality. The HRI was running on 4.5 months for the latest incoming data to be downloaded on to the system. On the whole this was within an acceptable framework of parameters for effective use by scientific services. At the time the department was also busy with the development of the HYDAC 2 data digitisation system. By 1994 the new system had been fully integrated.[1606]

The HRI in a changing research landscape

By 1990 the HRI had made significant inroads into the field of defining the status of water quality in South Africa and how it changed over time – and had captured the information into a comprehensive database (please see Figure 10.6). The database was developed with a view to enable water quality monitoring (WQM) managers to identify existing sources and locate new sources of information to form a more comprehensive impression of water quality throughout the country.[1607]

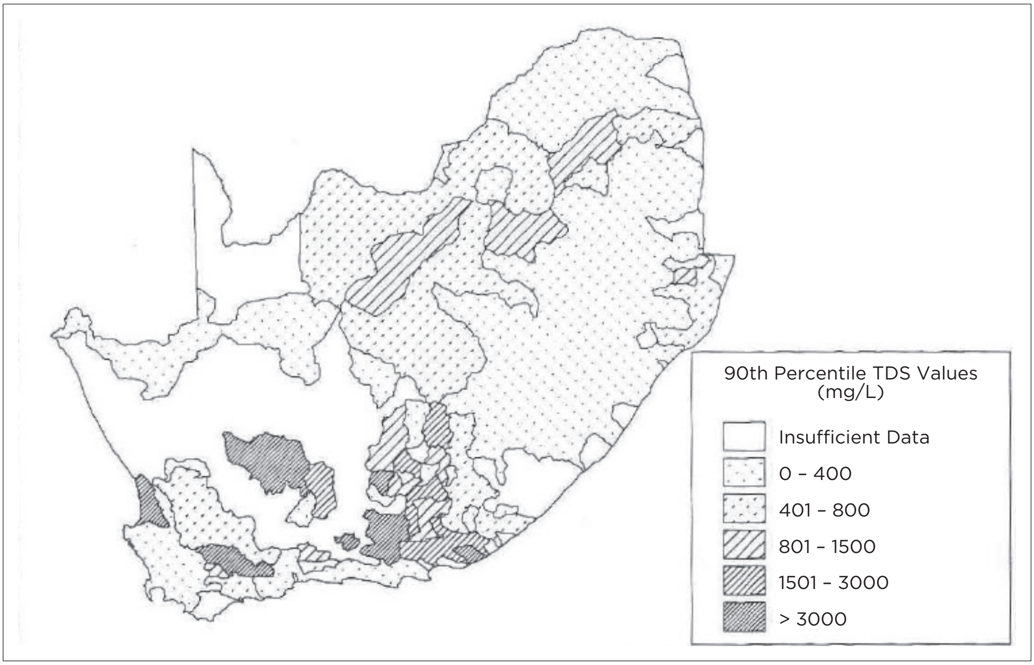
The quality of mapping was still rudimentary, but the HRI was on the right track in terms of the use of data in identifying specific areas of the country for different WQM processes. Research in the 1990s tended to veer in the direction

1604. RP33/1993 (1993:47).

1605. RP75/1994 (1994:12).

1606. RP75/1994 (1994:22).

1607. RP75/1994 (1994:26–27).



Source: RP35/1991 (1991:27).

FIGURE 10.6: By 1990 the HRI's database was used to map the areas in South Africa in terms of total dissolved solid concentrations in surface water for the period 1979 to 1988.

of wastewater. As the department's use of live data systems increased, it was possible to monitor systems and the status of pollution in water resources. This strengthened the enforcement activities of the department.

From 1993 to 1994, the HRI became the Institute for Water Quality Services. At the core of its activities were a number of programmes that focused on the development of measurement techniques and national monitoring programmes to assess the aquatic ecosystem health of water resources. These included:

- national microbiological quality monitoring
- aquatic ecosystem health and ecotoxicology
- national and regional monitoring programmes
- decision support tools for water quality assessment.[1608]

The HRI and the directorate of geohydrology were two essential research institutions within the department, securing and providing information to departmental water resource managers. The directorate of WQM provided a third source of valuable information.[1609] Water quality managers in the catchment areas had to monitor pollution from both diffuse and point sources.

1608. RP61/1995 (1995); Roux et al. (1995:293–299).

1609. RP33/1993 (1993:40).

By 1994, although there had been significant changes in the scientific services of the department, it is evident that the scientists were still on the mark at a time of a research landscape that was changing rapidly. They reiterated, as had been done by their predecessors in departmental research, the need to take note of:

- the issue of changing land use
- increasing population density
- the generation of solid and liquid waste
- the quality and quantity of available water.[1610]

The only difference was that it had now become possible to make far more comprehensive assessments than ever before.

Water resource and water quality management

In the early 1990s the department's integrated management approach was strictly observed in the WQM division. There were no locally developed guidelines for water quality, so the department appointed consultants to assist in the adaptation of 'imported' guidelines to South African conditions and requirements.[1611] Starting in 1990, the HRI coordinated detailed plans for the national water quality network that had been established in the 1970s by the CSIR. It had been responsible for an investigation to determine the shortcomings in the WQM of the system.[1612]

HRI researchers wanted an orderly system of WQM in all the country's storage reservoirs.[1613] They wanted to know which reservoirs had to form part of the monitoring programme; which variables had to be checked; what the most useful statistical methods for analysing data were; and how this monitoring system would be introduced.[1614] By 1992 a national river water quality programme had been developed. Departmental researchers worked with Water Affairs in the area to evaluate river quality, specifically in those areas where there were problems, or where the department's officials were of the opinion that there could be problems in the near future.[1615]

1610. RP61/1995 (1995:20).

1611. RP33/1993 (1993:11).

1612. Ashton (1994:1–7).

1613. SAWHAR AHCA2/030 (1990:1–7).

1614. SAWHAR AHCA2/009 (1990:1–17).

1615. RP33/1993 (1993:11).

Working from the availability of data from local rivers, the researchers in the hydrological studies section were able to conduct 19 hydrological investigations in 1991 to 1992. These included:

- the Port Elizabeth water supply, in which they operated on simulations of the predicted drought flows for varying periods of recurrence (in an effort to determine whether water restrictions had to be introduced)
- the Korrente–Vet government water scheme, where there were simulations of dam operations with short-term stochastically generated flow records to optimise operating rules
- the Duiwenhoks Dam, where they simulated dam operations with long-term stochastically generated flow records to determine the yield/risk ratio
- the Gubu Dam and Wriggleswade Dam, to estimate the expected drought flows of varying periods of recurrence
- the Skeerpoort River, where they estimated the normal flow to determine whether catchment development could be allowed.[1616]

Pollution control was high on the agenda of operations. In 1993 the department was confident that it had finally brought all mine water pollution problems in the northern Natal coalfields to an end. By 1993, 15 catchment studies had been completed in various parts of the country and various information sessions had been held with industrialists and other water users to inform them about the necessity of maintaining high standards of water quality and the need for public participation.[1617]

Groundwater research and pollution in WQM

By 1990, in terms of volume, groundwater only provided about 13% of the country's water use. At the same time more than 60% of South Africa's surface area had been classified as arid and was thus reliant largely on groundwater supplies if and where it was available. At the time DWAF had a groundwater information system that could reflect the characteristics of the country's groundwater resources (incidence, quality and potential) on a regional basis. The system had not yet been completed, but was well on its way to becoming useful.[1618] In 1990 to 1991, the department, in collaboration with the Borehole Association of South Africa, released a brochure for the public in a campaign to promote the more effective use of groundwater.[1619]

The department's groundwater experts reported that they had been collaborating with the Atomic Energy Corporation of South Africa for the first countrywide evaluation of groundwater quality. They conducted intensive

1616. RP33/1993 (1993:47–48).

1617. RP75/1994 (1994:9).

1618. RP35/1991 (1991:30).

1619. RP35/1992 (1992:18).

tests in the highly industrialised Pretoria–Witwatersrand–Vereeniging (PWV) area, focusing on dolomitic areas to determine the rate of pollution that had taken place. Their findings suggested that 'large portions of the PWV's aquifers were polluted'.[1620] Mines, sewage effluent and agricultural activities were responsible for high levels of nitrates, sulphates and to lesser extent chlorides. The *Water Amendment Act,* 60 of 1990, approved the establishment of subterranean water control boards.[1621] The University of Pretoria, in collaboration with the private sector, started working on a comprehensive register based on a water quality strategy, and guidelines for the control and management of groundwater supplies. It was also evident that waste disposal sites posed a major problem in terms of groundwater pollution. In 1990 to 1991 the department's geohydrological specialists evaluated 60 waste disposal sites for permit allocations. In the process they compiled four synoptic reports on groundwater pollution in terms of waste disposal sites and their geohydrological footprint.

By 1991 the computerisation of the department's groundwater data had been about 40% completed. Meanwhile, the geohydrologists were also working on determining a strategy for putting together a countrywide database on the variations of water level monitoring. This meant that external institutions and individuals could download information on the groundwater database. The information was then displayed in a map format. DWAF's geohydrologists had explored 200 boreholes countrywide to determine where there were water-bearing zones, and the nature of these formations. Investigations in Penrith, Graafwater and Mier revealed that more attention had to be given to the development of boreholes to increase their yield capacity. They recommended strategies such as hydrofracking, to determine how the capacities of these resources could be improved. The geohydrologists, the WRC and a consultant, summarised a system for determining groundwater recharge in South Africa according to a number of strategies listed in a guideline manual.[1622]

The department's groundwater researchers were convinced that most promising supplies of groundwater were situated in the country's dolomitic aquifers. In the western Transvaal, in collaboration with colleagues from Bophuthatswana, they began re-exploring the Polfontein compartment, to find a better way of putting groundwater to good use. The objective was to determine what amount could be used for urban consumers and how much was available for irrigation. Also in this section of the department, a start was made by 1990 to determine if it would be possible to begin a groundwater quality monitoring service. Meanwhile, there was a search for more locations of

1620. RP35/1992 (1992:30).

1621. Thompson (2006:102–103); RP35/1992 (1992:22).

1622. RP35/1992 (1992:30–31).

potential sources of groundwater, such as sites in Namaqualand, the Richtersveld and Steinkopf. Researchers in the groundwater group were using electromagnetic techniques in groundwater exploration. The gravitation method was used to great effect in the Kuiseb Delta area near Walvis Bay to determine potential sites of fresh water storage. By 1990 the groundwater database under construction at the groundwater section of the department had managed to secure about 30% of the available historical and current data on the approximately 200 000 boreholes that had been drilled by the state — probably after 1910. The objective was to secure sufficient data for the period up to 1995. Another data collection project undertaken by the groundwater group was the computerisation of all water level data measured countrywide since the early 1950s — of which about 80% had been captured as data. Much of the support in the project came from the WRC.[1623]

In formulating a policy on groundwater quality, by 1992 there was consensus in the department that a preventative approach was the best. It knew that problems with groundwater were closely related to irrigation. Consequently, the department saw the need to communicate with the Department of Agricultural Development on the issue. The department was of the opinion that self-management by community members was probably the best route to follow. The reference they relied upon was the example that had been set in the northern Transvaal.[1624]

One of the testing grounds for self-management was at the Sand River catchment near Pietersburg (Polokwane) in 1991 to 1992, where geohydrologists worked on groundwater levels and abstraction monitoring, as well as mathematical modelling, with a view to securing support for different management approaches. Participants in the research project included the Pietersburg district Agricultural Union, the Noord-Transvaal Koöperasie, the regional services council as well as the DWAF and the Department of Agricultural Development. Once the process had started, it was decided that in the near future a subterranean government water control area and control board would be established.[1625]

The geohydrological directorate launched a programme in 1991 to summarise and evaluate information for the whole country on a regional basis. They worked from a series of 23 groundwater maps and explanatory documents. In addition, they worked on a 1:500 000 map for the whole of South Africa. The national groundwater database had data on more than 70 000 boreholes by 1992. There was also data exchange from the mini-database, HydroCom, which had been developed by the University of

1623. RP35/1991 (1991:32).

1624. RP33/1993 (1993:12).

1625. RP35/1992 (1992:51).

the OFS.[1626] In addition, by 1992, as an extension of their activities to create greater awareness, the directorate made its data on groundwater supplies available to the public. The material was sent to the public on a floppy disk, for use on the HydroCom software.[1627] In 1991 to 1992 the geohydrologists visited 100 waste disposal sites and evaluated their suitability as waste sites from a geohydrological perspective.[1628]

In the 1990s, groundwater acquired a new significance. As will be discussed below, groundwater increasingly became a resource that could be used to provide water in times of drought. Importantly, groundwater resources were ideal for providing the requirements of the country's rural communities. The shift to what will be outlined below as the social ecological hydraulic mission was conducive for the new role of groundwater.

Conclusion

Given the significant changes on the political front, the DWAF maintained a focused approach to its governance responsibilities. There were numerous glitches along the way. The gradual political shifts affected the deep, slow-changing systems of the country's water infrastructure. The economy was sluggish, and this was responsible for a decline in capital to drive the development of water resources. More effective strategies for using the available water resources with conservation in mind, were a prime driver in the department's resource management strategies.

It was evident by the 1990s that information systems technologies would play a vital role in departmental decision-making. Large databases would inform management. Detailed studies and new technologies in the water sector would remain important. And the field of research was also set to change. Researchers were essential for laying the building blocks on which real-time water-related problems would be resolved. However, in the existing framework leading up to 1994 the management systems were preparing for a governance transition.

1626. RP35/1992 (1992:53).

1627. RP75/1994 (1994:48).

1628. RP35/1992 (1992:54).

Chapter 11

Drought disaster and the SCOWSAS political drive towards institutional change in 1994

Introduction

Drought conditions in the early 1990s played a significant role in the transition of political power to a multiracial democracy in South Africa. Typical slow-onset natural disaster conditions, followed by the rapid onset of flood disaster circumstances, became a vehicle for change in the operations of the DWAF. The disaster conditions marked the creative collapse phase of the energy–industrial hydraulic mission that had been introduced almost half a century before. The emergent social, economic and political conditions gave rise to a spontaneous social ecological hydraulic mission. This meant that civil society now took pride of place, in an era in which the environment became part of the national discourse on the future South Africa.

The drought and its repercussions in the emergent new political dispensation, formed part of a growing awareness of the country's people and the way they were affected by conditions of natural disaster. The social

How to cite: Tempelhoff, J.W.N., 2018, 'Drought disaster and the SCOWSAS political drive towards institutional change in 1994', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 413-446, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.11

transformation of the country – even before 1994 – meant that despite the anticipated limits to future water supplies, engineers had to reinvent their perspectives and become aware of future constitutional principles to redress issues of human rights and water rights, especially in the realm of domestic water supplies and sanitation.[1629]

The previous chapter sketched the formal, ongoing processes of the DWAF. On the surface, it was a matter of business as usual. However, under the surface there was a countrywide process of creative destruction in the social, economic and political realm. It was an emergent discourse that shaped the social ecology of South Africa for the next decade. To all intents and purposes, up to 1994 the department functioned in much the same planning mode as it had for almost 40 years. But the exogenous environment now required of the department and its officials to provide governance services to water users at grassroots level – and in communities where officials and government service delivery had never before had a high presence. Operations below the surface were almost subversive and part of a process of governance deconstruction was a dismantling of the existing system to fit the requirements of a future new regime.

Given these conditions, the advent of a natural disaster (drought) became an important political tool. It was at the dry village pumps in the rural parts of the country that the transformation of the system of governance began before 1994. What made the task daunting was that the existing governance system had been in operation for more than four decades.

It all started when, in the early 1990s, a small group of key role players started a non-government initiative, the SCOWSAS, to discuss South Africa's post-apartheid water governance system. SCOWSAS was destined to play an influential role in shaping the future Department of Water Affairs.

The role of drought in the transitional period 1989 to 1994

The drought of the 1990s had its origins in the Eastern Cape. In the winter of 1988 there was a critical water shortage in the Port Elizabeth area, and the department decided to go ahead with the Lower Sundays River water scheme extension to supply Port Elizabeth.[1630] The planning had been completed earlier and was then tabled in parliament in the form of a White Paper.[1631] Certain elements of the proposed scheme were to provide for the future

1629. Hollingworth, Jackson and Muller (1994:96).

1630. WP A90 (1990).

1631. WP C86 (1986:5–7).

needs of the city.[1632] The R102m scheme featured a gravity pipeline from the Scheepersvlakte Dam to the purification plant on the bank of the Sundays River. From there a pumping station and rising main was responsible for transferring water to the farm Grassridge, where a gravity pipeline could transfer the water to Port Elizabeth's Motherwell reservoir. The scheme, partly funded by the municipality, could provide the city with an additional 13.5 MCM/a.[1633]

By November 1989 there was no longer any need for additional water for Port Elizabeth because there had been good rains. Nevertheless, the project had meanwhile made significant progress and, fortuitously, the department's management decided to complete the scheme. The major benefit was that it would diminish the dependence on the Paul Sauer Dam (now the Kougha Dam). The scheme was scheduled for completion in 1992 to 1993.[1634] However, from 1990 there was once again a cycle of drought conditions in various parts of the country. Although rains had fallen in the Eastern Cape, parts of the western and northern Transvaal were in a state of drought.[1635]

On the whole, there was relative consistency in the water supply of the country in 1989 to 1990 and the water branch of DWAF at first downplayed the threat of drought. There was reason to assume, they suggested, that the intensity of drought was low. Of the 132 large dams on which the department reported weekly, 59 still stood at 90% of capacity. A further 10 dams had 80% of capacity. The status of total water supply on 31 March 1989 stood at 82%, but it did drop to 70% by the end of March 1990. At first it appeared as if the drought in the eastern parts of the Cape had come to an end. The department was confident that the existing water supply storage could deal with drought conditions. After all, the Vaal River system was a mere 3% lower than the previous year. In March 1991, the department reported that water supply in its 136 large storage reservoirs stood at 82% of capacity (please see Figure 11.1). This, according to the department, was the highest capacity since 1923.[1636]

The statistics only told part of the story. In the Eastern and Western Cape there was soon a serious drought. In the case of the Eastern Cape it was apparent that the drought conditions – dating back to the 1980s – were only slightly relieved. In fact, since 1989 the capacity of the storage facilities in the

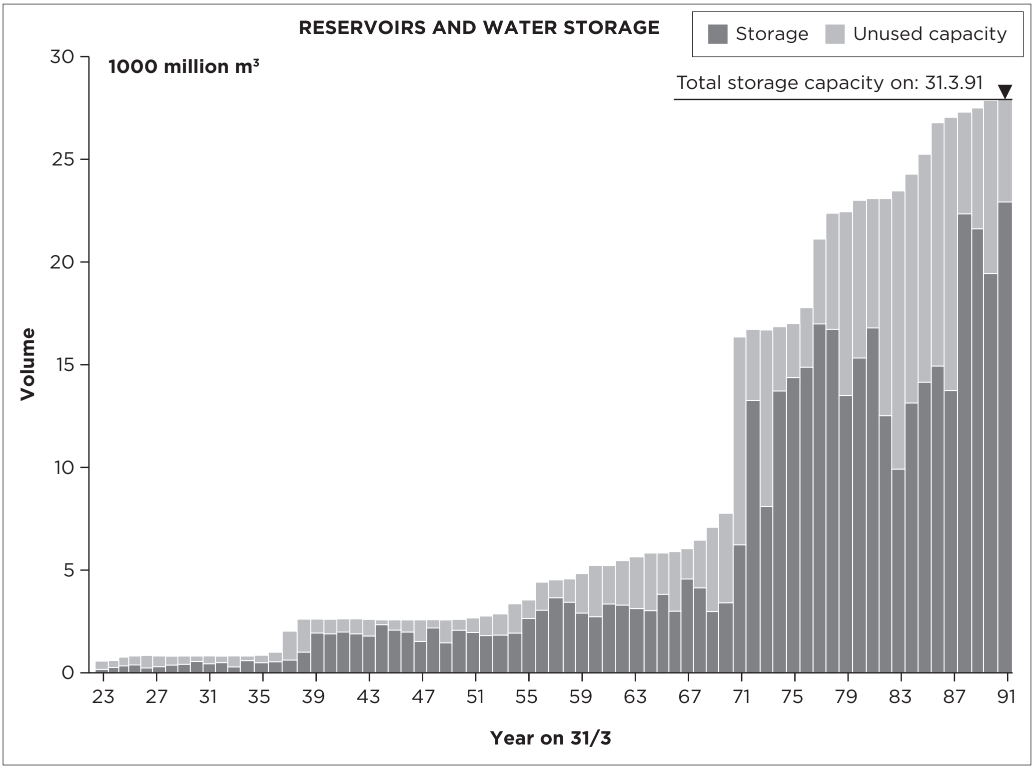
1632. RP35/1991 (1991:2).

1633. WP A90 (1990:4).

1634. RP35/1991 (1991:4–5, 22, 37).

1635. RP35/1991 (1991:4–5, 22, 37).

1636. RP35/1992 (1990:22–23).



Source: RP35/1991 (1991:23).

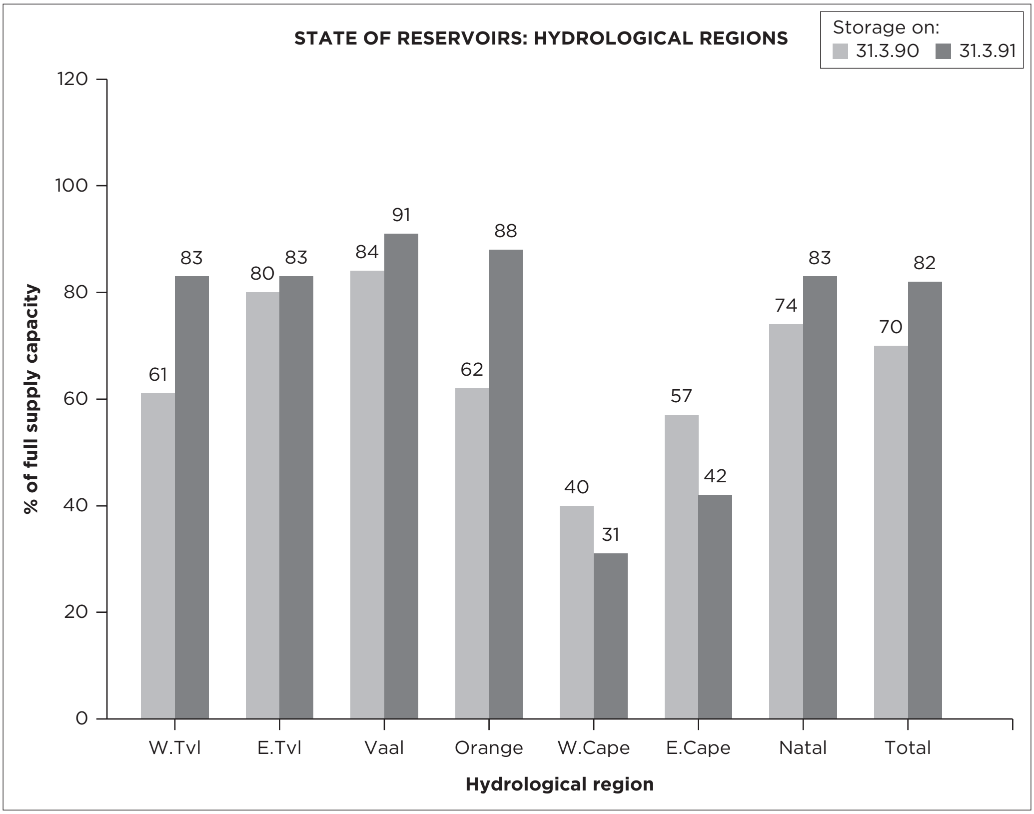
FIGURE 11.1: In 1991 the 136 major dams of South Africa were collectively at 82% of capacity. At the time the department's statistics suggested that this was the best it had been since the first official records way back in 1923.

region had decreased from 57% to 42%. In the department's hydrological regions, the state of water storage was reflected as follows (Figure 11.2).

There is reason to believe that the fragmentation of the DWAF structures in the 1980s had been responsible for a misunderstanding of the bigger picture of the country's water supplies. In 1988 a select group of water sector leaders, Prof. Des Midgley of the University of the Witwatersrand, Dr Bob Laburn, a former chief engineer of Rand Water, and Dr Theo von Robbroeck of the Department of Water Affairs, was tasked with making projections on the Vaal River for the period leading up to 2025. They complained that since 1978, there had been distortions in the records on drought conditions.[1637]

If one of the best managed stretches of water in the country (the Vaal River system) had not registered this discrepancy, the question is: what else did the managers and planners miss? In the mid-1980s the department's planners had called for more interdisciplinary research and had even asked for a standing committee from Water Affairs to oversee research. The fact of the matter was that there were few signs of integrated water resources management.

1637. Department of Water Affairs and Foresty (1988:2.3).



Source: RP35/1991 (1991:25).

FIGURE 11.2: The Eastern and Western Cape reflected a significant undersupply of water by 1991.

In 1986 there was confidence that a new integrated database would absorb and integrate key information systematically and provide management with data on the national water balance. The department's greatest accomplishment up to that time had been the integrated catchment management system.[1638] Although it had been organised institutionally to fit into a complex and admittedly kaleidoscopic categorisation of local, regional, national and international management locations, there was an absence of integrated management strategies aimed at addressing drought conditions – especially a slow-onset drought disaster event at the local level.

By 1992 the drought had taken a turn for the worse. It was reminiscent of the drought of the 1980s, with the overall state of the country's 136 large dams dropping from 82% to 59% in the space of a year. On 31 March 1992, the total volume of water available in the country's reservoirs was the lowest since 1988. The worst affected areas were the eastern parts of the Cape, particularly Port Elizabeth. In the case of the 'Windy City' – as Port Elizabeth is sometimes known – conditions had not

1638. Department of Water Affairs and Forestry (1986a:Sections 1.37, 16.31, 36.34, 36.37, 36.17, 36.65–67).

improved significantly since 1987, the department argued.[1639] The economy reflected hard times and there was a growing number of farm workers – typical environmental refugees – who started migrating from the rural parts and white-owned farms in the Eastern Cape and western Transvaal, to the urban areas.[1640]

In the Western Cape, the water supply in the dams decreased from 40% to 31%.[1641] The impact of the drought, which peaked in 1993, was that 137 of the DWAF's largest dam reservoirs that had been 54% full in 1992, had dropped to 52% by 1993. This was said to be the lowest rate of water storage since 1983 to 1984 when the 119 major dams of the country carried only 42% of their capacity.[1642]

The way society responded to the drought was interesting. As a result of South Africa's transitional period, the country's poor people, resident in the rural and informal urban areas of South Africa, took centre stage, as natural disaster conditions played themselves out. A drought conference was held on 13 June and 14 June 1992, by the Independent Development Trust (IDT) and Kagiso Trust (KT). The objective of the conference was to investigate a coordinated strategy to relieve the effects of the drought. This initiative led to the establishment of the National Consultative Drought Forum, with four subordinate task teams.[1643] DWAF was asked to coordinate the establishment of a water supply task team, in conjunction with the rural advice centre. The department provided information to evaluate the state of the drought and its effect on the communities concerned.[1644]

Then the department was asked to provide staff to evaluate the state of the drought and provide technical help in addressing the crisis. In many respects the concept of disaster management, a prominent international trend in dealing with disasters, was foreign to the existing governance system. However, disaster management in South Africa at the beginning of the 1990s was an all-important function that called upon the assistance of several existing government departments.[1645] In the case of the DWAF, the DG reported that because of the department's lack of experience in the field of emergency water supplies to rural communities, the decision was taken to bring in consultants, a group of engineers called Registered Engineers of Disaster Relief (ReDR), to provide the necessary international expertise. At first, seven field teams of ReDR engineers, clearly a group of experts familiar with disaster conditions, worked alongside South African engineers and community workers to do surveys in Venda, in three districts in Lebowa and also in northern Natal, Transkei, Ciskei and Gazankulu,

1639. RP33/1993 (1993:10).

1640. Vogel (1994b:121).

1641. RP35/1992 (1992:24).

1642. RP75/1994 (1994:3).

1643. Eales (2011:40); Austin (2008:70–71).

1644. RP75/1994 (1994:6).

1645. Vogel (1998:98–100).

Source: RP75/1994 (1994:2).

FIGURE 11.3: The DWAF provided emergency containers for water storage at the time of drought in the rural areas of the country in 1992–1993.

to determine where the water supply did not measure up to the minimum of 15 L/c/d. The surveys were conducted in collaboration with local and regional authorities. The supplementary aid provided complemented the existing aid that communities had already received.[1646]

Strategies for providing relief to drought-stricken communities included:

- the repair of existing supply installations
- opening up and protecting springs
- carting in of water as a temporary measure
- borehole siting and drilling where normal sources had dried up
- the erection of hand pumps or motorised pump installations
- the construction of siphons and reservoirs (Figure 11.3 and Figure 11.4).[1647]

1646. RP75/1994 (1994:6).

1647. RP75/1994 (1994:6–7).

Source: RP75/1994 (1994:2).

FIGURE 11.4: For the first time, officials of the DWAF were exposed to the drought experience of rural communities who were without water supplies and sanitation. Officials now had the additional responsibility of engaging with them to explain support strategies.

In the process the engineers, who were soon to become part of the new dispensation in 1994 and were active in drought relief, were convinced that the top-down system of water governance in the rural areas of the former homelands, would not be workable in the system they had in mind for the future South Africa.[1648]

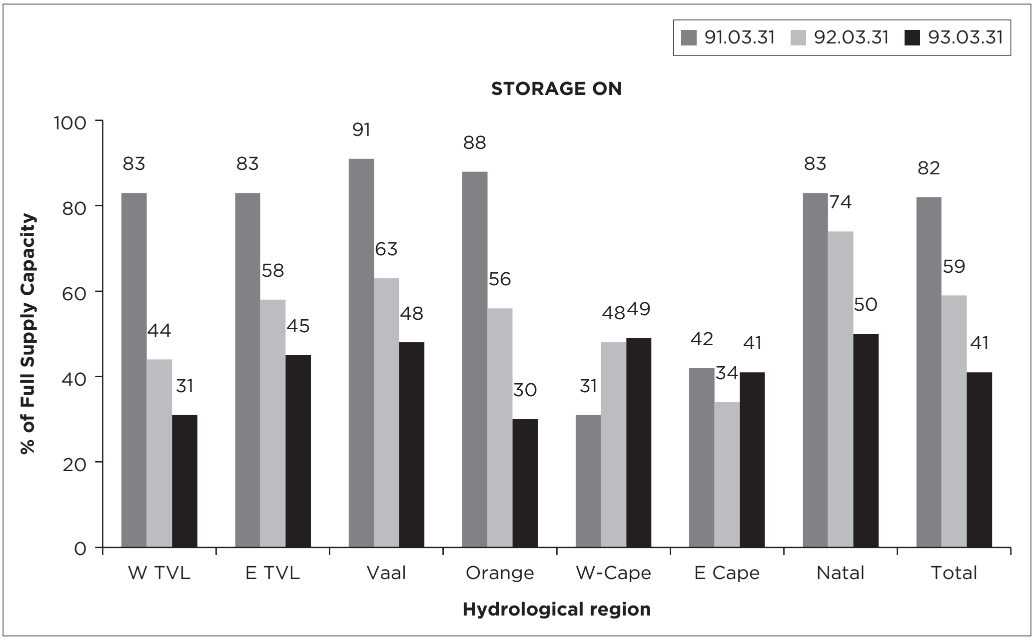
Several government departments provided staff to help alleviate conditions in the drought-stricken areas. The DWAF contributed human resources, equipment, funds, control and coordinating functions and facilities (please see Figure 11.5).[1649] Initially the understanding was that the drought relief programme would end on 31 December 1992, but it carried on

1648. Hollingworth, Jackson and Muller (1994:100).

1649. RP75/1994 (1994:7).

Source: RP75/1994 (1994:2).

FIGURE 11.5: Technologies were introduced to provide water in drought-stricken areas.



Source: RP75/1994 (1994:40).

FIGURE 11.6: Total regional water storage on 31 March in 1991, 1992 and 1993.

when conditions deteriorated further, with no end in sight. Conditions in Natal, Transkei and Ciskei seemed to be in order, but there were still problems in the Eastern Cape.

Meanwhile, the ReDR engineers left South Africa and the DWAF maintained its presence. By the end of the 1992–1993 financial year the department's officials were still engaged in Venda, Lebowa, Natal, Transkei and Ciskei. The department had paid out R5.3m in drought relief.[1650] In the process of providing support work, the department investigated a total of 600 communities. There were 554 repairs to water supply installations and 18 tanker trucks were used to transport water. In total, 442 boreholes were drilled and 187 hand pumps were installed, along with 49 motorised installations to pump water. Officials of DWAF's head office became directly involved with the National Consultative Drought Forum, which paved the way for support from the department's regional offices at Pietersburg, Durban and the Nahoon Dam in the Eastern Cape. The significance of the drought became evident once the national storage facilities were compared over a three-year period (please refer to Figure 11.6).

As a result of the serious drought, many towns in the country started using boreholes to enhance their water supplies. The directorate of geohydrology at DWAF helped in the programme.[1651] In October 1993 the drought forum had to

1650. RP75/1994 (1994:7).

1651. RP75/1994 (1994:47).

TABLE 11.1: Comparative table of DWAF's relief work between 1991–1993 and 1994.

Services rendered	1991–1993	1994
Communities visited	600	155
Repair of installations	554	170
Tankers carting water	18	8
Boreholes sunk	442	285
Hand pumps installed	187	120
Motorised pumps	49	35
Windmills erected	0	2
Reservoirs erected	60	108
Rising mains installed	30	40
Tanker routes for KZN	0	8

Source: RP75/1994 (1994:5).

withdraw its technical human resources from the project. This move had the effect that DWAF was left with the bulk of grassroots support work.

Although the drought had come to an end by 1994, DWAF's relief teams, the Department of Agriculture and the oversight planners of the National Consultative Drought Forum remained active in providing emergency supplies and services in rural areas. The aid continued into 1994. Because of sporadic labour unrest in Venda it was impossible for relief workers to be active in that region.[1652]

Based on experience gained, the emergency water supply programme to rural communities made a contribution to:

- a draft drought management strategy
- the development of various training programmes for communities
- awareness in the DWAF of expertise that could be developed further
- government's positive disposition towards working in the direction of a common goal in collaboration with Non-governmental Organisations (NGOs)
- the need for the development of a computerised information system on rural water supply that could be expanded for national purposes and would be of benefit for future drought conditions.

The management of the department was aware that in future, it might have to become more involved in times of drought, and that it would be better equipped to do so. The experience gained was seen as valuable for future operations (see Table 11.1).[1653] Later, specialised investigations alerted authorities to ensure that before importing maize, it was essential to first take note of local maize production and its availability on the market to avoid counterproductive food security activity.[1654]

1652. RP61/1995 (1995:4–5).

1653. RP75/1994 (1994:7–8).

1654. Austin (2008:74–75).

Senior DWAF officials had gained substantial experience of the need for greater departmental support through community engagement. They seemed to have a better understanding of the concept of environmental refugees. For example, Conley and Van Niekerk, working on the Orange River system in 2000, warned that unforeseen drought conditions could have negative consequences for South Africa and stakeholder states that used Orange River water supplies. They explained how the prolonged drought conditions of the early 1990s had the effect of forcing many people to move from remote villages in the homelands. They ascribed the mobility of the people to the lack of sufficient water supplies, and suggested that the number of boreholes drilled in the early 1990s was insufficient.[1655] They observed, 'During emergency drilling the primary problem was identified as not the drought itself, but a lack of foresight in preparing for drought.'[1656]

In the aftermath of the drought the department's support in matters of water supply and sanitation for developing communities became more pronounced. Later, Eberhard Braune and his colleagues from the department's directorate of geohydrology worked in collaboration with the department's community water supply and sanitation programme, helping to lay down standards and guidelines for groundwater resource development.[1657] This marked the beginning of a far more comprehensive focus on groundwater resource use in post-1994 South Africa.[1658]

Before 1994, DWAF's officials had become more than aware of their new governance responsibilities. Departmental officials served on several advisory forums for drought relief and also worked side by side with NGOs and welfare institutions.[1659] DWAF's management was also aware of a serious shortfall in relevant information on alleviating drought conditions.

Consequently, officials embarked on a campaign to secure information and prioritise the water needs. They began working on a GIS system known as Drought Relief Utilities Management, to provide support under emergency circumstances. The programme was a great help when water supply and sanitation services had to be delivered to rural communities that were in need of assistance. As an additional spin-off of the drought crisis, an extra-departmental SCOWSAS started operations as a mediation group of concerned experts. In the group there were representatives of NGOs, specialist hydrologists and a variety of other groups. The department participated and contributed actively in this committee.

1655. Conley and Van Niekerk (2000:146).

1656. Conley and Van Niekerk (2000:146).

1657. Department of Water Affairs and Forestry (1997b:1–104).

1658. Braune, Adams and Fourie (2014).

1659. RP75/1994 (1994:68).

SCOWSAS and South Africa's reconnection with global water and sanitation

Amid the emergent state of unusual rough and tumble in the water sector to deal with the 1990s drought crisis and poor communities without appropriate water and sanitation, there were serious plans for shaping the country's water future. The SCOWSAS was destined to play an important role behind the scenes in the water sector. It was to become the driver of change for the new system of governance.

Foregrounding the poor: Water and sanitation

In the 1990s, South Africa's route to a reconnection with the international water sector was subject to its affirmation of poverty and, in the water sector specifically, the need for access to water and sanitation. The basic principles of access to water for the poor had been in circulation for some time in international water sector circles. South Africa had not been privy to these developments since the 1970s.

The United Nations International Drinking Water Supply and Sanitation Decade 1980–1990 programme was formulated at a 1977 UN Water conference held at Mar del Plata in Argentina. The UN General Assembly later endorsed it. The relevant UN resolution promoted a greater awareness of government's role in providing essential water and sanitation services in many developing countries of the world. Partially as a result of the Cold War, the programme had not been fully implemented worldwide in the 1980s.[1660] The tumultuous change in 1989 to 1990, with the collapse of the political divide between the capitalist West and the communist East, changed all that. It also opened the way for South Africa to join the international community once again. However, the country was ill-prepared and not fully informed on what to expect in the new unified global society.

In 1980s South Africa there was considerable talk about the country's poor people. But it was dislocated from the international discourse. At the national level, there were ongoing investigations on the social implications of rural water supply and sanitation. Earlier, the second Carnegie investigation of 1982 produced substantial evidence of the rate of poverty in South Africa's rural areas and the homelands.[1661]

In respect of water, the report noted significant shortages in the rural homelands of Venda and Gazankulu in the north-eastern regions of the country. Residents interviewed in Venda told researchers that, in 1982, the death of 30

1660. United Nations (1985).

1661. Wilson and Ramphele (1989).

of the 86 babies born in one village was because of a lack of clean drinking water. Meanwhile, in the eastern part of the Cape, not far from Port Elizabeth, rural residents said that water had been laid on, but it was so brackish that people simply could not drink it. They had to resort to buying water by the drum, which cost about R8.40 for 1000 L, which was significantly more expensive than the rates white residents of the country's urban areas paid for municipal water.[1662]

Officials in government departments, such as DWAF, were occasionally informed about what was going on in the country's non-governmental sector. In 1985, Prof. Francis Wilson, leader of the second Carnegie project at the University of Cape Town, addressed a workshop at the CSIR on basic needs. He shared detailed information on the rural and homeland areas, saying that there was a desperate call for sufficient water supplies. In his view, there was not necessarily a shortage of water supplies, instead there was a regrettable absence of a reliable distribution system.

Investigations in rural South Africa suggested that women, the primary water managers in the domestic environment, walked from 4 km to 12 km each day to secure water supplies for the family. Water was often contaminated because in the mid-1980s only 7% of the country's river water could be used for household purposes.[1663] In due time, senior DWAF officials became well informed about the state of affairs and on the international commitment to the poor in South Africa.

The 1985 Carnegie investigation, launched more than a half century after its first report (on the poor whites in South Africa), focused on the poverty of South Africans of colour, at a time in the mid-1980s, when government was in the process of introducing a new constitutional dispensation aimed at excluding black South Africans from the new tricameral legislative assembly system. This Carnegie investigation played an important role in keeping extra-parliamentary groups and international observers informed on South African developments. The first Carnegie project, in the late 1920s, had included the South African government as an active participant. Because of its apartheid policies, the NP government was excluded from the 1985 investigation.

In tandem with the introduction of the unpopular new tricameral constitutional dispensation in 1984, several non-government social support groups started operations in the country's rural areas. Some were directly related to the second Carnegie investigation. Others, particularly at a time when government was increasingly forced to move from its hard line apartheid policies, operated as non-violent initiatives. The objective was to improve the

1662. Wilson and Ramphele (1989:48–51).

1663. SAWHAR AHCA1/10 (1985).

plight of people of colour in the rural and fringe areas of the new informal settlements in the country's urban industrial areas.

While law enforcement authorities were engaged in suppressing the activities of organisations like the UDF and the trade unions, NGOs operated in a non-violent manner and mustered support at grassroots level in communities where the government's new plans for local government authorities had been introduced. In the southern Transvaal's Vaal Triangle, regional political conflict escalated in phases of increasingly intense violence. This had a direct effect on politics in other parts of the country.[1664]

In the process, government lost support and credibility in the country's townships and at local government level. It also influenced national politics. Internationally the government was isolated from its traditional support base (the governments of the US and Great Britain for example) in the Global North.[1665]

South Africa's water sector was not a complete outsider to what had been circulating in the international water sector. In 1989, as a result of the rapid changes in the international political arena and the changing face of politics in South Africa, two South Africans, Alan Conley, a senior manager in DWAF, and Ian Pearson, a CSIR researcher, attended the 'Water 29' UN conference in Bangkok, Thailand, where the focus was on progress made in the global decade of water and sanitation and looking ahead towards the 1990s.[1666]

Emergence of SCOWSAS, 1990

The emergence of SCOWSAS was partly because of the complex political environment in South Africa by February 1990. After the ban on the ANC had been lifted, the organisation gave its commitment to the principle of the 'independence of civil society'. On the Witwatersrand, the Civic Association of the Southern Transvaal played a decisive role and ensured that there would be autonomous and non-party-political influences in its operations.[1667] As the political parties embarked upon political deliberations, NGOs and advisory groups stepped to the fore in a number of areas. It was at this point that plans for the formation of SCOWSAS started.

Mike Muller, who became a key role player in later years, attended a meeting on 15 May 1990 at the Development Bank of Southern Africa (DBSA) in Midrand to determine if it would be possible to establish, within the institutional

1664. Du Toit (1995:131–162).

1665. Bell (2000:499–500).

1666. SAWHAR AHCA1/007 (1989).

1667. Swilling (1990:156–158).

framework of the Water Institute of South Africa (WISA), a new division to work on water supply and sanitation in developing communities.[1668]

WISA had earlier approved a set of guidelines for the establishment of technical divisions under the umbrella of the institute.[1669] Securing a role for water and sanitation as part of WISA's new technical division initiative provided an ideal platform for the planners of the new specialist group. The initiative, driven by the DBSA's Barry Jackson and Mike Muller, was attended by representatives of the WRC, CSIR, consultants and several academics. Their objective was to establish Water and Sanitation 2000 (WS2000) as a subdivision of WISA. The mission of WS2000 was to function as:

> A multidisciplinary southern African working group to promote appropriate strategies and approaches to improve water supply and sanitation on an integrated, affordable and sustainable basis for all communities in a situation of increasing needs and limited resources.[1670]

On 03 August 1990, Ian Palmer, on behalf of the WS2000 group, proposed the formation of a technical division and the prospect of a key event to be held soon.[1671] The response of WISA was favourable and at the WS2000 group meeting on 11 September 1990, members discussed the way forward. There was consensus that the status of a technical division of WISA suited the group well. However, they clearly had in mind the establishment of another institutional body under a different umbrella, to create a more representative grouping of stakeholders.[1672]

In the months to follow, the WS2000 group started focusing on forming a steering committee representative of many stakeholders.[1673] It was accepted that standing committees on water and sanitation could not be created in every community. Therefore, a coordinating committee had to take the lead and drive home the urgency for dedicated attention to matters of water supply and sanitation services.[1674]

In January 1991, Muller drafted a paper that was later presented to WISA. The theme was the institutional options for water and sanitation in South Africa. The existing institutional arrangement, he explained, left much to be desired. Governance in South Africa was in a fragmented state. There was no single agency to see to it that households were properly provided with

1668. SAWHAR SCO 1 144/3/3/81 (1990:1).

1669. SAWHAR SCO 1 144/3/3/80 (1990:1–8).

1670. SAWHAR SCO 1 144/3/3/81 (1990:1–3).

1671. SAWHAR SCO 1 144/3/3/78 (1990:1–3).

1672. SAWHAR SCO 1 144/3/3/76 (1990).

1673. SAWHAR SCO 1 144/3/3/76 (1990:1–3).

1674. SAWHAR SCO 1 144/3/3/45 (1991:104).

adequate services. Neither was there a single agency committed to the realisation of that goal. Of relevance for the purposes of water and sanitation were the Department of Water Affairs; the Department of Planning and Provincial Affairs; and the National Department of Health.[1675]

It was evident that, as a rule, in the urban areas local authorities tended to focus on matters along racial lines. White urban local authorities functioned in a relatively ordered manner, but it was not the case in the black areas. Township people were traditionally considered to be 'illegitimate' and temporary residents. Ultimately, the understanding was that, that they would return to the homelands. In reality these people formed part of the permanent residents in urban African settlements. In essence, local authorities did not necessarily represent the communities they were supposed to serve. For Muller, this was one of the burning issues of political conflict in the country's urban areas in 1991.[1676]

Drawing a comparison between urban and rural areas, as well as between white and black urban areas, he was thinking in terms of a 'one-city' conceptual idea to give an institutional impression of a single country's governance in terms of water supply and sanitation.[1677] For Muller it was evident that South Africa's water and sanitation sector had paid little attention to the UN International Drinking Water Supply and Sanitation Decade, 1980–1990.[1678]

Reliable and relevant information on the 'other' South Africa's water and sanitation situation was scant. Nevertheless, Muller and his colleague at the DBSA, Brian Jackson, managed to form a reasonable impression of the status quo from material contributed by the Urban Foundation, Dr P.H. Formanek in Johannesburg, Ian Palmer in Cape Town and Mark van Ryneveld of the University of the Witwatersrand.[1679] By July 1991 there were statistics available on rural and urban water and sanitation in South Africa's homelands, the provinces of the country, the rural population, and on commercial farming operations in the country as a whole.[1680] Later in the year a report on strategies for the development of rural water supply schemes by a Pietersburg (Polokwane) consultancy became available.[1681] It provided a data benchmark for determining typical development conditions in the rural areas of the country.

1675. Muller (1991b:2–3); Muller (1991c:1–9).

1676. Muller (1991b:2–3).

1677. Muller (1991a:1).

1678. Muller (1991a:3).

1679. SAWHAR SCOd 1 111/111/7/7 (c. 1991a:1–5); SAWHAR SCOd 1 111/111/7/7 (c. 1991b:6–12); Formanek (*c*. 1991:20–24); Formanek and Muller (*c*. 1991:1–5).

1680. SAWHAR SCO 1 111/1151/1/1/5/9 (1991).

1681. SAWHAR SCO 1 111/1151/1/1/5/4 (1991:1–8).

WS2000 workshop August 1991

On 01 August 1991, the Water and Sanitation 2000 group presented a workshop that was attended by a broad spectrum of stakeholders in the South African water sector. There appeared to be consensus about significant problems in the water and sanitation sector. An estimated 12 million South Africans lacked proper water supplies. Additionally, 21 million did not have access to proper sanitation – a statement that would become a refrain until the end of the 1990s. Preliminary estimates suggested it would require as much as R30bn to eliminate the backlog. Moreover, there were concerns about the absence of coherent policies to address the problem. On 26 September 1991, a meeting of interested parties took place, where it was decided to establish a standing committee to address the issue.[1682]

Representatives of the democratic movement that included Mark Swilling of PLANACT, an NGO established in 1985 as a voluntary organisation promoting alternative developments to those of the apartheid government, Thozamile Botha (ANC), Paul Theron (ANC) and Vernon Campe of the National Council of Trade Unions were of the view that WS2000 should become part of the negotiation process between government and the former exiled political movements. Delegates at a subsequent September 1991 meeting believed that water was a matter that had to be addressed politically. Technology was of secondary importance.[1683] Representatives of the DWAF and the Department of Health attending the meeting acknowledged that water and sanitation could not be seen in isolation of social and political issues. They saw links with housing and primary health services. There was consensus that collaboration between political parties and government departments had to become part of the political discourse. Health representatives had grave concerns about the absence of sufficient data.

Ultimately, the most heated debate came from the NGOs. They accentuated the politics of water issues. According to the DBSA's Barry Jackson, the gist of this view was that technology experts were not in a position to decide on policies. Engineers, for example, needed to focus on technical matters and how they would implement the outcome of the forthcoming negotiation process.[1684] Specialists in the field of politics (NGOs) clearly had a role to play. There was consensus that a committee of such people could play an important role in the political deliberations.[1685]

1682. SAWHAR SCO 1 141 (*c.* 1992:21); Trends Reporter (1991:12).

1683. SAWHAR SCO 1 144/3/3/3 (1991:1).

1684. SAWHAR SCO 1 144/3/3/3 (1991:1–2).

1685. SAWHAR SCO 1 144/3/3/76 (1990:1–4).

An extensive process of communications began with officials and representatives of several institutions. A number of people were identified as influential role players in the water sector. They were then invited to attend an inaugural meeting of SCOWSAS. Some came from institutions outside the water and sanitation sector but were individuals who had shown an interest in what the new committee planned to do.[1686]

A critical voice

In the run-up to the inaugural meeting, Neil Macleod, executive director of Durban Water and Waste, launched a scathing attack on the planning and deliberations that had been initiated since the meeting of 01 August. Macleod was critical of the standpoint that water and sanitation problems could only be resolved at a national level. He stated:

> Many such approaches have been tried here and internationally with dismal consequences – the United Nations Water Decade is a classic example where more people in the world today are without water and sanitation services than before the water decade commenced in the 1980s.[1687]

Macleod distrusted the argument at the nucleus of the WS2000 deliberations. He pointed out that local authorities were not necessarily in as much disarray as some presumed they were. Fragmentation was by no means a negative element of the dispensation, it was a phenomenon that addressed the singularity of each water and sanitation entity that required to be managed in a unique way.

Macleod was adamant that there was no single national way forward. It therefore seemed natural that a more comprehensive and representative grouping of relevant role players had to be invited to participate in the deliberations of the proposed standing committee. He was critical of assertions at the earlier WS2000 workshop that the private sector should be excluded. Instead, he argued that for more than a century the private sector had been directly involved in the activities of local authorities. They had, therefore, to form part of the group to seek solutions. Macleod was also critical of the activities of the DBSA and some of its projects that were executed without 'consideration to the existence of an acceptable management authority or sufficient funds to cover operating expenditure'.[1688] He was of the opinion that there were other stakeholders that should be part of the SCOWSAS deliberations.

In bringing these issues to the attention of Muller, who was the convenor of what would become SCOWSAS, it was now up to the water and sanitation

1686. SAWHAR SCOa 1 144/3/3/3 (1991).

1687. SAWHAR SCOa 1 141 (1991:167–168).

1688. SAWHAR SCOb 1 141 (1991:168).

policy unit of the DBSA to direct the platform of engagement it wanted to secure for the committee.[1689] Macleod's strong stand played an important part in bringing a more representative collective of role players into the SCOWSAS group.

The formation of SCOWSAS, January 1992

At the inaugural meeting of SCOWSAS on 21 January 1992, Muller was elected chairperson.[1690] The committee was notable for its high-profile membership. Leaders in the country's water sector participated, but there was also a significant presence of representatives of NGOs and previously banned organisations on the committee.[1691] A notable exclusion on the list of invitees was the DWAF.

Muller focused strongly on broadening the representative membership of SCOWSAS. At the same time, he engaged with the management of the Convention for a Democratic South Africa (Codesa) where the political deliberations between the government and the former exiled groups were conducted. Muller wanted to bring the activities of SCOWSAS to the attention of the negotiators.

Within SCOWSAS, a focused perspective emerged on what was wrong in the water and sanitation governance sphere in South Africa, and what needed to be done. In Muller's correspondence for the period 1991 to 1993 a document 'Water management considerations during constitutional change', is grouped in chronological sequence along with his correspondence to Codesa's management. The introductory statement was that since 1912, South Africa's water legislation had focused on a centralised system of control and administration of water matters. The system, at that time, enjoyed considerable recognition in many parts of the world where water management was fragmented. Subsequent to the creation of the homelands and, in some cases, even independence, as well as the introduction of a tricameral parliament, this centralised water management had become increasingly difficult to manage in the best interests of all users. The document pointed out that at the time of the demarcation of the independent homelands' boundaries, the effective management of water had received little attention. In some catchments, local water consumers were severely affected by pollution caused by exogenous water users, who now shared the local catchment. There was a distinct need for more ethical dealings in the complex water supply and demand process.[1692]

1689. SAWHAR SCOc 1 141 (1992:168).

1690. SAWHAR SCOd 1 141 (1992:60); SAWHAR SCOe 1 141 (1992:453).

1691. SAWHAR SCOa 1 111/111/7/7 (n.d.:5).

1692. SAWHAR SCOc 1 141 (1992:22–24).

What was needed was an end to the fragmented management of water supply and water quality in a semi-arid South Africa. There had to be ethical and humanitarian management of water and water-related pollution issues. Muller stressed the importance of fostering regional, national and international cooperation in matters of water management to meet growing demands. If there was a willingness to use a holistic model, it was possible to provide a decentralised system that could function more effectively.

The SCOWSAS leadership had meanwhile accumulated substantial information. By April 1992, the DBSA's infrastructure policy application unit had a comprehensive corpus of information available for the bank's executive management on water and sanitation coverage in South Africa's urban and rural areas. SCOWSAS estimated that the overall cost of bringing the country's water infrastructure up to standard would be about R28bn. It was envisaged that it would take between 20 and 30 years to improve rural water and sanitation. Urban water and sanitation problems, the team estimated, could potentially be resolved within 10 to 15 years.[1693]

Mission of SCOWSAS

The mission of SCOWSAS in May 1992 was outlined as being responsible for developing policy options and communicating these in the form of technical advice to the policy makers and the broader committee. In other words, its objective was to influence policy makers.[1694] SCOWSAS was in a good position to fill this role because the Palmer Development Group (PDG), associated with the University of Cape Town, was commissioned by the WRC to undertake the first of a series of investigations.[1695] The University of Cape Town had been the headquarters of the second Carnegie report and many local researchers had accumulated significant amounts of information that by the 1990s proved to be of use to SCOWSAS.

By the end of 1993, the leadership of SCOWSAS saw the committee as a broad-based forum interested in developing policy options and promoting appropriate strategies to improve water supply and sanitation for all communities.[1696] In terms of marketing their activities, SCOWSAS decided to work with a newsletter. At first, they made use of Umgeni Water's facilities, but there was a firm understanding that they would be 'going it alone'. As tasks they identified:

- the issuing of a newsletter
- the production and distribution of a report on institutional options

1693. SAWHAR SCO1 111/1151/1/1/5/2 (1992:3–8).

1694. SAWHAR SCO 1 144/3/3/76 (1990:1).

1695. Emmett and Rakgoadi (1993:30).

1696. SAWHAR SCOb 1 111/114/1/1/1 (1993:1).

- issuing press releases and the general placing of media stories
- providing advice on the management of organisation(s) and individual contacts
- active public affairs lobbying.[1697]

At meetings the members deliberated on the nature of the many bodies and organisations involved, the identification of key issues and principles by means of debate, and the crystallisation of concepts concerning the institutional framework that would best meet the water-related needs of all South Africans.[1698]

SCOWSAS was able to provide background information and formulate options on a number of issues aimed at addressing what were seen as distinct water problems in the country. By November 1993, based on the research done by members of SCOWSAS, it was apparent that they had identified a number of sources of information on the extent of water and sanitation coverage in various parts of the country. SCOWSAS researchers were familiar with the random selection of criteria for determining what infrastructure was required for the national system.[1699]

In principle, the leadership of SCOWSAS was of the view that:

- all institutions should ultimately be accountable to the people
- organisations and individuals would have to be accountable for the tasks they performed
- a bottom-up approach would be followed.

The proviso was that the demand had to emanate from the consumer, but national bodies would be held responsible for setting and maintaining minimum standards.

There was agreement in the committee that a three-tier system would be used. However, there was a firm understanding that that boundaries and powers of the institutions, particularly at second and third tier, still required agreement. A matrix was designed to identify the lowest level of accountability within the three tiers. It was accepted that accountability could be delegated downwards to second and third tiers, as well as to NGOs and commercial organisations.[1700] SCOWSAS was clearly a think tank that paved the way for the new South Africa's water sector. It was up to government to create an enabling space for change to take place.

1697. Muller (1992).

1698. SAWHAR SCOc 1 111/111/7/7 (n.d.:1).

1699. Emmett and Rakgoadi (1993:2).

1700. SAWHAR SCOc 1 111/111/7/7 (n.d.).

Mvula Trust and accommodating the DWAF

Part of SCOWSAS' legacy was The Mvula Trust. In 1993 the DBSA, KT (with financial support from the European Union) and the IDT established The Mvula Trust as an NGO. The objective was to use Mvula as a mechanism to provide water and sanitation support to poor and disadvantaged communities in South Africa.[1701]

The trust began operations in August 1993 with a grant of R48.5m from the IDT and KT and a further R48.5m in the form of a loan from the DBSA, as well as an amount of R3m to start operations. There were 57 staff members, of whom 35 were based at the trust's headquarters in Braamfontein, Johannesburg. The other 22 members of staff worked in five field offices at Bisho, Kokstad, Durban, Nelspruit and Pietersburg. Provincially, the focus of Mvula was on the future provinces of the Eastern Cape, KwaZulu-Natal, Mpumalanga and Limpopo.[1702]

On 24 September and 25 September 1993, SCOWSAS held a national workshop in Johannesburg attended by 120 delegates from all parts of South Africa. One of the major themes up for discussion was the future of SCOWSAS. There was consensus that the committee had to link with other national forums and promote national policy development. It was necessary to address immediate service delivery needs by means of local negotiations and local partnerships. There was also a suggestion that SCOWSAS should expand its activities to include regional representation.[1703]

The workshop was attended by a comprehensive group of representatives of local and international institutions that collaborated with the ANC, the water sector, government departments and consultancies. At the time SCOWSAS worked from the understanding that the national debate on water and sanitation had intensified significantly since 1991, and that the process of transition was uppermost in the minds of most South Africans. At the same time there were grave concerns about the prevalent drought conditions; it became clear how vulnerable the very poor people were, particularly those who lived in the country's rural areas. SCOWSAS was also aware of the collapse of services in many parts of South Africa's urban areas. The forum expressed its concern over the threat these conditions posed from a health perspective.[1704]

There even appeared to be confusion about who was in control of water and sanitation services, because local government was said to be in a state of shambles. Non-payment for services was at the heart of the collapse. The

1701. SAWHAR SCO 1 121/121/1/5 (1996:4); SAWHAR SCOb 1 121/121/2/5 (1996:5).

1702. SAWHAR SCO 1 121/121/1/5 (1996:10).

1703. SAWHAR SCO 1 111/114/1/1/1 (1993:4).

1704. SAWHAR SCOb 1 111/1151/1/1/5/1 (1993:1).

ANC's deputy chairperson for the PWV region, Mathole Motshekga, told the workshop that although it was necessary to separate the struggle for water from the political struggle, there was evidence that people refused to pay for services because they believed that local authorities were corrupt. He also predicted that the slow-down in local government reorganisation would lead to an intensification of the water crisis in the future.[1705]

DWAF's Alan Conley, who addressed the workshop on DWAF's standpoint on water and sanitation in the transitional period, explained that the department had already published a guide on water management in South Africa, in which there was a section on providing water to poor communities. In 1991 DWAF had developed a draft policy on this and invited contributions and advice from the public on these matters. Conley accentuated that from DWAF's perspective there was no shortage of water, but he admitted that it was poorly managed.[1706]

In response to DWAF presentation there were several questions dealing with issues such as, the 43 different acts of parliament that had a bearing on water, the need to streamline the system, and the need to get rid of the principle of riparian water rights. Participants also enquired about how many people of colour were serving on the DWAF's management.[1707]

Conley explained that the 1956 *Water Act* needed revision. It was framed in terms of British and Roman Dutch law and needed adapting to suit the semi-arid conditions in the greater part of South Africa.[1708] He also explained that the global trend was for governments in arid regions to nationalise water and move away from the riparian principle in the interests of society.[1709]

In response to a question, Conley explained that South Africa had not participated in the UN's decade on water and sanitation but this was not seen as a serious matter since the country's *de jure* black population in the urban centres was relatively small, while the rest of the indigenous population had been provided for in terms of the apartheid regulations (homelands).[1710]

Asked if it were possible to involve people of colour in the provision of water to the public at large, Conley replied that the department's goal was to accommodate all people and that in this respect it was part of a wider interdepartmental initiative. He emphasised that the department did not want to impose a solution on the people. Instead, it was intent on consultation.

1705. SAWHAR SCOc 1 111/1151/1/1/5/1 (1993:15).

1706. SAWHAR SCOc 1 111/1151/1/1/5/1 (1993:19).

1707. SAWHAR SCOc 1 111/1151/1/1/5/1 (1993:22).

1708. SAWHAR SCOd 1 111/1151/1/1/5/1 (1993:55).

1709. SAWHAR SCOd 1 111/1151/1/1/5/1 (1993:56).

1710. SAWHAR SCOc 1 111/1151/1/1/5/1 (1993:22).

Referring to the recent drought, he explained that the department, in addition to rendering technical services, also educated communities and operated mobile workshops.

After the workshop of September 1993, SCOWSAS' research group, which included representatives of the South African Labour and Development Research Unit at the University of Cape Town, the Human Sciences Research Council, the PDG and the CSIR, published a summative report.[1711] It was evident that it was of vital importance for all people to have access to proper drinking water and sanitation. The estimate was that the per capita daily water need for the country's population was between 20 L and 30 L. In addition, sanitation services were of vital importance.

In 1993, as the attention shifted to the formulation of a new interim constitution for South Africa, the work of forums took on a new relevance. Distribution of power once again became important and decisions had to be taken on these matters. In a fractured society, forums acted as a valuable source of advice to the political role players in formulating strategies for accommodating all South Africans. SCOWSAS declared that there was a need for a national agency to take responsibility for overall water supply and sanitation. For SCOWSAS, the second tier of governance in respect of water had to be efficient regional water institutions that that were based on natural physical boundaries rather than political divisions.[1712]

Information garnered from consultation and research had SCOWSAS stating that the systemic need for water and sanitation in South Africa included:

- (new) national water legislation
- multi-regional and international water schemes
- internationally recognised water relations
- inter-regional water resource planning and development
- inter-regional conflict mediation
- long-term national water resource planning
- a national water information system informed and bolstered by research.

SCOWSAS had been instrumental in determining that 19% of the urban population of South Africa did not have access to proper safe water, and 31% of the country's population did not have proper sanitation. There was evidence of extreme discrepancies in access to water-related services between whites and people of colour. There were clear indications of overlap in these inequalities between the urban and rural areas of the country. The worst conditions were in the homelands. Africans resident outside the homelands generally had better water supply and sanitation services. In the eight metropolitan areas of

1711. Emmett and Rakgoadi (1993:10–11).

1712. Muller (2014:186–187).

South Africa, where 64% of the country's population resided, a total of 90% of the country's urban water was consumed.[1713]

By May 1994, shortly after the new government came to power, SCOWSAS had moved the offices of The Mvula Trust to Braamfontein in Johannesburg and in its newsletter urged members to get down to work. The forum's target was to focus on the government's Reconstruction and Development Programme (RDP), specifically in respect of water and sanitation.[1714] Its newsletter suggested that the move be made from analysis towards proposals for action, in the new dispensation. With the country's interim constitution in place, SCOWSAS wanted to alert the country's legislative leadership to its report on institutional options for the governance of water supply and sanitation.

Governance views of SCOWSAS

In a 1994 position paper, SCOWSAS outlined the responsibilities involved in devising a water governance system for the benefit of all South Africans. In a paper written by Len Abrams, an attempt was made to inform the public about the issue of sanitation in South Africa. Abrams emphasised that South Africa's poorest people living in the remote, underdeveloped parts of the country and those in informal settlements, living on the fringes of the urban areas, suffered the daily impact of not having proper access to water and sanitation. For Abrams, sanitation extended beyond the infrastructure required for maintaining sanitary environments conducive to peoples' health. It had to inculcate a family culture of hygiene practices that hinged on toilets being upgraded. He saw education as vital.[1715]

In a January 1994 paper on waste management, Mike Muller, who was later to become the DG of the DWAF, made a number of observations that provide valuable insights into the way he viewed water and sanitation governance in a new dispensation. He was confident there was consensus that water and sanitation had to be given priority. There were also plans in place outlining precisely how these services were to be paid for by both the state and consumers. Muller pointed out that the institutional structure of the water sector had been identified as one of the major reasons why so many South Africans had no proper water supply and sanitation.[1716]

A number of factors were singled out as being desirable in the new system of water governance. The system had to be:

1713. Emmett and Rakgoadi (1993:185–186).

1714. SAWHAR SCO 1 111/114/1/1/2 (1994:1).

1715. Abrams (1994:1).

1716. Muller (1994:1–9).

- focused
- comprehensive
- equitable
- responsible
- sustainable
- accountable
- efficient
- committed to empowering the consumers.

Above all, the system had to be representative of the consumers. SCOWSAS, according to Muller, was convinced that regional boundaries would have to give due attention to catchment boundaries, bearing in mind that water usage and water quality could be compromised should this consideration be ignored.[1717]

In terms of the interim constitution that came into force in April 1994, SCOWSAS had a people's focus in the management of water resources and sanitation. There was to be a comprehensive focus on the whole country and not only certain areas and certain parts of the population, and equity would be uppermost in enforcing compliance with the governance system.

SCOWSAS in retrospect

In 2014, while reflecting on water governance over a period of two decades, Muller explained that at the time of preparing for the transition to a democratic society, South Africa was reaching the capacity of its easily exploitable water resources. This was evident from the deficits in major basins, which had to be met by means of water transfers. As the first steps were taken to review the existing management practices and approaches there was a growing willingness to emphasise a 'soft' management option and the relative size of the available resource, rather than the 'hard' issue of addressing the matter of infrastructure development to increase the available supply. One phenomenon that played itself out in a notable manner was that large water consumers, such as the commercial farming sector and big industrial concerns, which had previously enjoyed hegemony over the minority's water policy, no longer dominated the debates that now included the disenfranchised majority. As political negotiations began, there were significant discussions on the way power should be distributed. The consequence was that powers and functions were distributed between different spheres of government, bearing in mind technical recommendations, rather than heeding the pleas of a lobbying group.[1718] There was a clear knowledge gap that needed to be filled.

1717. Muller (1994:1–9).

1718. Muller (2014:181).

SCOWSAS was essentially a water forum. According to Muller, as a grouping it deliberately avoided a focus on negotiations, because it had to consider the technical challenges facing the sector. It had to advise the political role players, instead of directly taking a specific political position.[1719] The country was already water-stressed; it also relied on water transfers between catchments, and transfers across local, provincial and international boundaries.

Muller emphasised that one important outcome of the democratic transition was to ensure that water resources management would be conducted on a national basis; this would resolve many of the challenges presented by the previous dispensation.[1720] The contribution of SCOWSAS lay in contemplating these issues before the final transition to a new democratic dispensation.

Transboundary water engagements

The advent of the 'new' South Africa of the 1990s made it possible for South Africa's water sector to engage more freely with neighbouring states on common water issues. As a result of initial steps taken in 1989 towards positioning South Africa for political change, the country's water sector could engage with greater ease in negotiations with counterparts in Lesotho, Botswana, Swaziland, Mozambique and Zimbabwe. In terms of transboundary water relations there was evidence of exemplary and transparent dealings.

Lesotho Highlands Water Project

Since the mid-1980s the LHWP, one of southern Africa's mature water supply development plans, became a flagship for South Africa's dealings with its neighbours. By the 1990s the Orange River catchment was the most developed catchment region in southern Africa, and the LHWP was poised to become the prime supplier of water to the Witwatersrand region (Gauteng Province).[1721] In 1989 to 1990 the design stage of the LHWP was completed. The managers of the project in the department anticipated that a group of seven major international construction consortia were scheduled to submit their tenders in April 1990. In financial terms the water levy on water consumers in the Vaal River system of 2 c/m^3 was raised to 4 c/m^3 on 01 October 1990.[1722] It was apparent that in future the augmentation of water resources for the country would increasingly have strong businesslike features. Water consumers had to prepare themselves to materially contribute in the development of much needed water resources and infrastructure. It was costly.

1719. Muller (2014:186).

1720. Muller (2014:192).

1721. Chenge and Johnson (1996:170–171).

1722. RP35/1991 (1991:5).

In 1992, Deloitte and Touche prepared a report for the TCTA in which it explained that when Phase 1A of the LHWP came online in 1997, the tariff by the TCTA would have risen from 9.1 c/m^3 to between 45 and 34.81 c/m^3. The accountants were of the opinion that the tariff should be increased to 21.5 c/m^3 in 1989, to cushion consumers from significant increases after 45 years, when the scheme should have paid for itself.[1723]

By 1994, the LHWP Phase 1A project had experienced some setbacks. There were technical obstacles that had not previously been identified, so the first delivery of water from the LHWP was postponed to January 1997.[1724] The main problem was in a section of the tunnelling project where there was a complex basalt area. Based on the experience of Brazilian tunnelling, engineers initially decided not to concrete the basalt area. However, the nature of the Lesotho basalt was different. Consequently, the tunnelling construction team had to line large basalt portions of the tunnel with concrete. This additional work caused delays.[1725]

The LHWP with its LHDA (in Lesotho) and the TCTA (in South Africa) also had a JPTC on which both countries had equal representation.[1726] The project was scheduled to be implemented in four phases. Construction Phase 1A, which was under way in 1993 to 1994, consisted of the construction of the Katse Dam, the transfer tunnel and the delivery tunnel. The foundations of the Katse were completed in 1993 to 1994 and the tunnels were completed by August 1993 (Figure 11.7 and Figure 11.8).[1727]

The project was held up for a while by 'non-engineering' matters, when rural development projects, such as schemes related to fishing, mountain horticulture, land use planning and the like, halted work. Then the World Bank required compliance with internationally accepted standards, so the necessary remedial work had to be done to the satisfaction of the international funding organisations. South Africa and Lesotho required a mere 4% from the bank in the form of a loan for the construction of Phase 1A, but the bank played a useful role as a neutral participant and observer.[1728] As a result of the extension of its responsibilities, DWAF's chief directorate for the LHWP was renamed the chief directorate of international projects.[1729] The measure was introduced after the development of the Komati River government water scheme in partnership with Swaziland came up.[1730]

1723. SAWHAR AHCA18/003 (1992:TCT05).

1724. RP75/1994 (1994:7).

1725. Pers. comm., Dr C.P.R. Roberts, Pretoria, 10 March 2017; Boniface (1999:31).

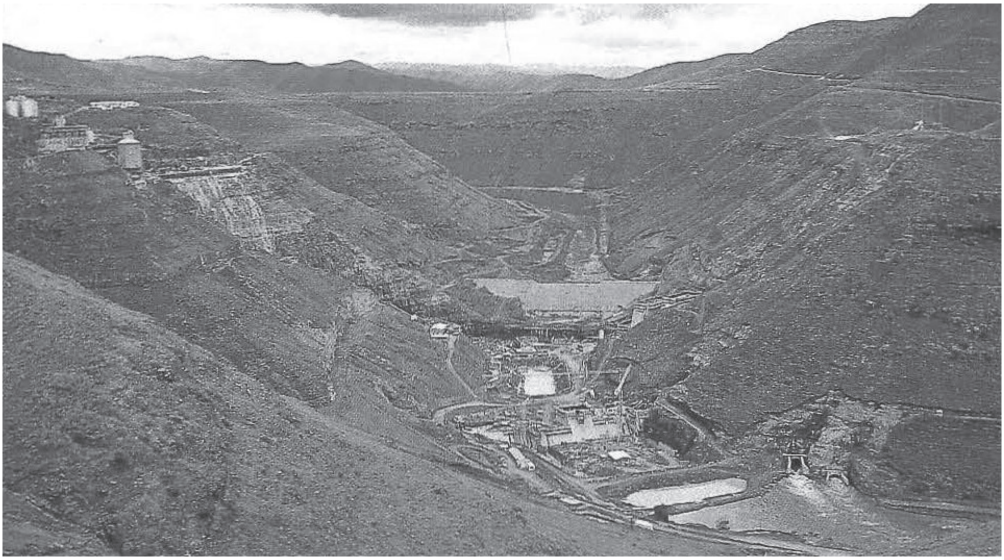
1726. RP61/1995 (1995:40).

1727. RP61/1995 (1995:42).

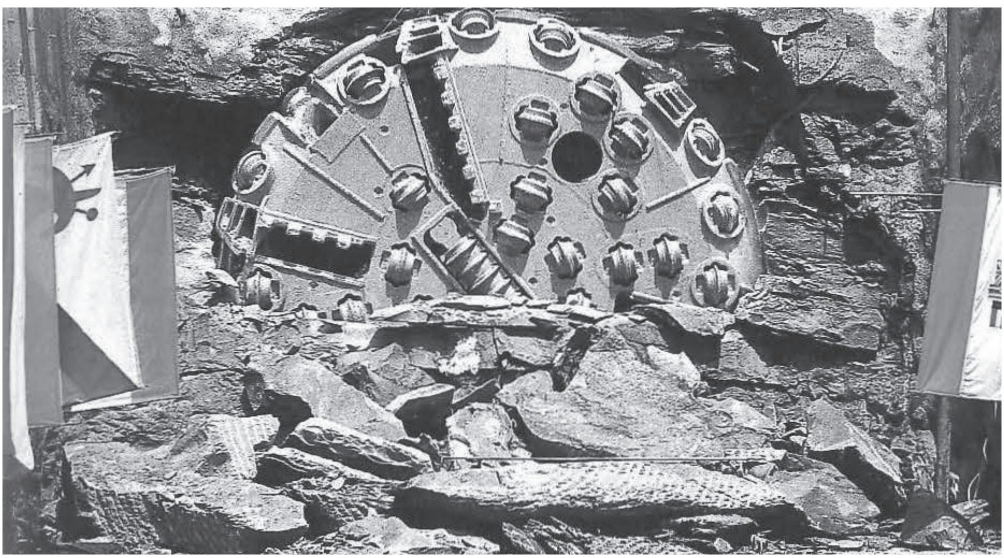
1728. Pretoria News (1996:22).

1729. RP75/1994 (1994:8).

1730. RP75/1994 (1994:28).



Source: RP61/1995 (1995:41).
FIGURE 11.7: The Katse Dam under construction in 1993–1994.



Source: RP61/1995 (1995:41).
FIGURE 11.8: The Ash-Axle River tunnel boring machine breakthrough in 1994.

For the new South Africa there was considerable food for thought in terms of planning how the water of the LHWP and the Orange River should be distributed. Conley and Van Niekerk warned that on the way forward there would be tough decisions to be made, specifically in the case of the Orange River, as a result of all stakeholders requiring more supplies from

Source: RP35/1992 (1992:n.p.).

FIGURE 11.9: The Minister of Natural Resources and Energy of Swaziland, Enock Richard Senzenjani Tshabalala and his South African counterpart, the Minister of Water Affairs and Forestry, General Magnus Malan, sign the agreements on the development of the Komati Basin.

the river.[1731] In recent research, there appears to be recognition that local institutions have a significant role to play at the regional and local level of integrated resource management. In turn, the national department's key role is one of greater responsibility to facilitate the interface with political governance, and to enable appropriate policy adjustments.[1732]

Swaziland and Mozambique

As negotiations towards the transition to a new dispensation in South Africa gained momentum, DWAF's engagements with the water sector in neighbouring countries went ahead in a spirit of cordial collaboration. In 1990 to 1991 there were talks with Swaziland and Mozambique on the development of the Incomati/Komati River and the proposed construction of the Driekoppies and Maguga dams. The parties reached agreement on a number of matters. In the Limpopo area there were deliberations between South Africa and Botswana

1731. Conley and Van Niekerk (2000:133).

1732. Muller (2014:192).

on the use of the river – with a combined water use project outlined.[1733] On 13 March 1992, representatives of South Africa and Swaziland met to sign two treaties (please see Figure 11.9). The first had a bearing on a Joint Water Commission that would act as a technical adviser to both countries on matters of the development and utilisation of common water resources.

The second treaty was on the development of the Komati River catchment (as the project was described on the South African side). Part of the plan was the construction of the Driekoppies Dam in KaNgwane and the Maguga Dam in Swaziland, as the first phase. Both dams were scheduled for construction and operation by a statutory body called the KOBWA. Both countries had equal representation on this water authority, which was in turn responsible to a Joint Water Commission.[1734]

Linking up South Africa with the international community

In the early 1990s South Africa appears to have comfortably drifted into the mainstream of engagements in the international community, particularly in matters of water supply, sanitation and poverty. A massive field of expertise opened up for South Africa's water sector. For example, a South African, John Briscoe, a PhD in environmental engineering from Harvard University, who was working at the World Bank, specialised on issues of poverty.[1735] South Africa's Department of Water Affairs was also privy to the African Development Bank's strategy, which saw all the continent's states collaborating on a continental strategy for water and sanitation in the 1990s.[1736] National Water Week was introduced for the first time in March 1992 and was intended, from the outset, to coincide with World Water Day, and simultaneously also the annual World Rivers Day.[1737]

A firm indication of a friendlier international atmosphere came up in 1992, when South Africa participated in the UN's Rio Earth summit. In a report prepared for the summit the South African delegation pointed to the country's anticipated shortage of water within the next 40 years. At the time, South Africa's annual consumption of water amounted to 25 900 MCM/a.[1738] The report, compiled by the Department of Environmental Affairs, in conjunction

1733. RP35/1992 (1992:5).

1734. RP35/1992 (1992:13, 38).

1735. Briscoe (1992:16–17).

1736. SAWHAR AHCA1/011 (1990).

1737. RP75/1994 (1994:33).

1738. SAWHAR WLC C2459 (1992:87).

with experts at the CSIR, explained that South Africa experienced considerable challenges in respect of AMD. The mining sector had started recycling wastewater and was capable of achieving savings of up to 30% on consumption levels dating back to 1982. In terms of surface water, South Africa's main water issues were identified as eutrophication, salination, trace metals and micropollutants. As far as groundwater was concerned the country had a number of secondary aquifers, which were contained by primary aquifers that were rich in water supply. The secondary aquifers' consistency was considered peripheral in terms of supplying usable water to all sectors of society.[1739]

By 1993 an assessment of South Africa's water and sanitation systems was influenced by the Recife Statement of 1988, compiled at a Latin American summit under the auspices of the United Nations Development Programme (UNDP) and the World Bank. Also influential were the New Delhi Statement of 1990, when more than 110 countries' representatives met in India to draw up a programme for safe water and sanitation, and the Abidjan Accord of 1990 when 45 African states reached consensus on strategies to meet the challenges of water supply and sanitation.[1740] South Africa was clearly in the thick of things in the UN network of institutions.

Extra-parliamentary political groups including NGOs and the SCOWSAS group were well informed on the latest international guidelines on IWRM strategies. DWAF's officials had to get up to speed with the latest approaches mooted in the international water sector. In some cases, there were senior officials in the department who had already been working on trends in the international arena.

IWRM rapidly gained international currency. The principles of the 1992 Dublin Statement, which emerged from the International Conference on Water and Sustainable Development that year, emphasised:

- the vulnerability of fresh water as a finite and vulnerable source
- the principle of integrated water resources management
- better understanding of the role of women in the procurement and management of domestic water
- the commodification of water as an economic good.[1741]

However, in its annual report for 1991–1992, the DWAF made no reference to the Dublin Statement, which would, in the next decade, inform South Africa's water governance structures and their alignment with international trends.

1739. SAWHAR WLC C2459 (1992:87–90).

1740. Emmett and Rakgoadi (1993:16–22).

1741. SAWHAR WLC C0909 (1992:2).

Conclusion

As far as the government was concerned, a new department came into existence on 01 July 1994. Until such time as the new interim constitution of the country came into effect, there were 11 'homeland' administrative and political areas, among these were the four 'independent' TBVC states (Transkei, Bophuthatswana, Venda and Ciskei)[1742] and the self-governing areas of KwaZulu, Lebowa, Gazankulu, and QuaQua. After 1994 they were all reincorporated into South Africa. The officials and the departments responsible for water and sanitation were reincorporated into the Republic of South Africa's DWAF.[1743] The advent of the new government in April 1994 started with the establishment of a management team that advised the minister on the process of transformation and on the development of the new DWAF. People from outside and senior officials formed part of the team. The objective was the development of a new organisational structure, a new ethos and a new vision for the department.

1742. States acknowledged by the South African government as sovereign independent entities.

1743. Department of Water Affairs and Forestry (1994b:1).

Section C

Onset of a social ecological hydraulic mission

Chapter 12

A social ecological perspective on water and its governance (1994–1999)

Introduction: The RDP, water and sanitation

The ANC's shadow government formulated the RDP before South Africa's first multiracial democratic elections in April 1994.[1744] In terms of water, the RDP focused primarily on three issues:

- the right to water
- the goals of water management
- the critical issue of water tariffs.

In dealing with the right to water, first and foremost there were concerns that 12 million residents of the country did not have access to clean drinking water and a further 21 million did not have proper sanitation. Addressing these water-related problems called for an objective political strategy on the part of the new government.[1745]

How to cite: Tempelhoff, J.W.N., 2018, 'A social ecological perspective on water and its governance (1994–1999)', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 449-481, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.12

1744. Department of Water Affairs and Forestry (*c.* 2006:6).

1745. Muller (1998:6).

Given the fact that the ANC had committed itself to a Bill of Rights, it was evident from preliminary forays in the field of constitutional thinking that there should be 'water security for all', which implied basic principles such as access to clean drinking water. The new government acknowledged that South Africa was a water-stressed country and that it was necessary to engage with neighbouring countries and ensure that strategies were in place to deal with circumstances of water stress, notably drought conditions.[1746]

In the field of water management, the RDP acknowledged the primacy of meeting the water needs of the country's residents. At the same time there was a need to raise the country's agricultural output and support economic development. Under the rubric of management, the principles were in place for securing roughly 20 L/c/d – 30 L/c/d of water and making it available within 200 m of each dwelling. Over the medium term, water supplies had to be accessible for all the country's people, and at least 75% of the population had to have access to sanitation. The longer term goal was full services for everyone. The RDP set the time schedule at two years, at which stage all the operations had to be in place to secure the services for as many consumers as possible without significant disruptions.

However, the authors of the RDP document were aware of the many complex problems that lay ahead, particularly in the rural areas. With this in mind they made provision to develop appropriate governance institutions and arranged to bring people in at grassroots level in village water committees and direct consultation processes.[1747] In terms of tariffs, the RDP envisaged a strategy for a lifeline tariff to ensure that all South Africans would be able to afford water. In urban areas there would be progressive block tariffs with the addition of potential subsidies. Rural water consumers were also to be cross-subsidised by the urban areas in cases of limited rural affordability. The issue of water tariffs was complex. It formed part of an ideological mindset of historical dispossession and the need to rectify the historical exclusion of indigenous Africans, who had been obliged to serve the interests of a white minority. In addressing the issue of tariffs, the RDP's architects had in mind the large consumers of water and the need to create a framework of departmental and sectoral integration to afford services that the country's poor were unable to pay for.

The RDP was firm on the emergent new government's commitment to restructure specific water-related institutions. The Department of Water Affairs had to take responsibility for the integrated management of the nation's water resources for the benefit of all. It had to see to the establishment of competent local and provincial institutions that were capable of delivering services. In terms of water resource management, the system had to be based on catchment areas to ensure effective control and well-managed water resources. At the local level, municipalities had to take responsibility for the distribution

1746. African National Congress (1994:28–29).

1747. African National Congress (1994:29–30).

Source: RP134/1996 (1996:20).

FIGURE 12.1: DWAF Minister, Kader Asmal, unveils one of the presidential lead projects in 1995–1996.

of water supplies and proper sanitation services and waste removal. These had to be paid for by means of appropriate tariffs and local tax mechanisms.[1748]

Presidential lead projects

In mid-1994, after the new government had come to power, 15 project proposals were submitted to the RDP office. The government accepted 12 of these. In view of the importance attached to the plans, these 12 projects were labelled 'presidential lead projects' and they formed the precursor to DWAF's community water supply and sanitation capital programme (please see Figure 12.1).[1749]

Because the RDP's White Paper was only published in November 1994, it was necessary for government to ensure that urgent plans were implemented in the interim.[1750] Hence, the presidential lead projects. They were primarily large infrastructure projects aimed at improving the quality of life of communities in many of the rural parts of the country.[1751]

1748. African National Congress (1994:30–31).

1749. Department of Water Affairs and Forestry (*c.* 2006:6).

1750. WP J1994 (1994:1–81).

1751. Wolpe (1995:88–102).

Source: RP134/1996 (1996:39).
FIGURE 12.2: The Njaka Dam under construction in 1995–1996.

The 12 projects, with a combined budget of R282m, were estimated to serve as many as 1.7 million people with basic water-related services. As a result of the major transitions taking place, even some departmental officials were not quite sure what the 'presidential lead projects' meant. Some were on standby, waiting for instructions on more projects to come. There appears to have been considerable confusion at the time. Later it became clear that DWAF was not the only funding source for the projects. For example, the Vulindlela project was a giant bulk reticulation infrastructure development project serving several communities in the Pietermaritzburg region.[1752] DWAF paid R71.8m towards the project, while Umgeni Water stood in for R148.2m. A similar scheme was the Mhlatuze water board's Shemula project, in which DWAF was a partner.[1753]

Then there was the Bushbuckridge water board project which was primarily a capacity building initiative to establish a completely new water board with the Njaka Dam, under construction at the time, as the source of the board's water supply (please see Figure 12.2).[1754] The project was partly funded by the US Agency for International Development (USAID), to the tune of US$4.2m, on the understanding that in the period 2000 to 2004 there would be technical

1752. Bailey (2003:18–19).

1753. Department of Water Affairs and Forestry (*c.* 2006:6).

1754. Department of Water Affairs and Forestry (*c.* 2006:6).

assistance in the development of a local authority that would operate as a water services authority. As a result of a number of misunderstandings the project, originally intended to become a decentralised operation, became more centralised, with the Gauteng utility, Rand Water, frequently stepping in as interim management and operations team.[1755]

White Paper on water supply and sanitation 1994

The formulation of policy in the new dispensation was largely based on deliberations well before the advent of the change in government. Once the new government took charge, the department's first White Paper was already in the pipeline. This seminal document is notable for a distinct tone of exuberance, reminiscent of an excited exchange of ideas and ongoing deliberations among former comrades-in-arms who were working under the tutelage of the new DWAF minister, Kader Asmal. The document was written in a provocative style to ensure lively participation and engagement on the best way to realise the objectives of the department.[1756]

The planning phase of the early 1990s was clearly not finished and there were numerous issues that had to be subjected to critical scrutiny and transparent debate. But a start had at least been made. The White Paper's authors saw the history of water in South Africa against the backdrop of a rudimentary settler phase in which agriculture had developed – despite setbacks such as dire drought and economic depression – into a sophisticated industrial economy driven by modern techniques, and in tandem with the relatively advanced Western world.

The 'other' sector of the economy was notable for its poverty. Relentless colonisation and land encroachment had led to the systematic destruction of traditional subsistence economies. Traditional communities had access to very few of the privileges of the wealthy communities in urban areas. Historically the water resources of the country, according to the White Paper's authors, had been developed specifically to benefit the privileged sector of society.[1757]

The White Paper reaffirmed the commitment of government to end the fragmented nature of the country's water sector. The objective was to serve reconstruction and development objectives within the framework of an integrated, sustainable programme. The new department was also focused on gaining insight from international experience in the fields of water supply and sanitation – an area in which there had been growing concerns globally since

1755. Tempelhoff and All Rand Water Portfolios (2015:10, 26, 89); Galvin and Habib (2003:874–876).

1756. Department of Water Affairs and Forestry (1994a:1–2).

1757. Department of Water Affairs and Forestry (1994a:6).

the 1960s. There was reference to the UN's International Decade of Water and Sanitation in the 1980s, to which South Africa had not been privy. The department now, in 1994, had to be brought up to speed with recent international trends in circulation since the UN's conferences at Abidjan (1990),[1758] New Delhi (1990),[1759] and Dublin (1992).[1760]

In addition, correspondence between global strategies of relevance for the country's water sector and the Rio Earth Summit (1992) could not be ignored. The latter event was a first for South Africa's environmental governance sector. For three decades the country had been excluded from environmental deliberations on the world stage. Once the South Africans gained access to an international platform, they reported candidly on developments in the country. Water featured prominently in the assessment of the country's sustainable development goals and objectives.[1761] The greater exposure to new ideas about the environment became a platform for the science community to instil the principles of social ecological systems, for example, sustainable development, into the emergent hydraulic mission of the department.

By 1997 the water supply and sanitation initiative of DWAF was no longer a mere extension of the RDP; it was a focused programme aimed at supporting local government in the process of service delivery.[1762] The department operated water services directly in several previously disadvantaged communities, especially in the former homelands. In terms of local government support programmes, the attention was on developing the capacity of local government to manage service delivery.

National Water and Sanitation Training Institute

One measure introduced was a National Water and Sanitation Training Institute at the University of the North (University of Limpopo). The initiative was an important contribution because it marked the beginning of extensive education and training opportunities in the field, and secured the participation of institutions of higher learning in the water sector. It was also part of a strategy to promote relevant development at previously disadvantaged institutions of learning.[1763]

1758. SAWHAR AHCA1/011 (1990).

1759. CCGUA-Sot UN (1990).

1760. Department of Water Affairs and Forestry (1994a:6).

1761. SAWHAR WLC C2459 (1992:87–90).

1762. RP186/1997 (*c*. 1997:3).

1763. RP186/1997 (*c*. 1997:3); Swartz (2006:124–125).

Ministerial advisory council

Another interesting innovation, recommended early in the new political dispensation, was the idea of a national advisory council to be established by the Minister of Water Affairs. Members of this advisory council included people from unserved communities and those who were unfamiliar with the principles of sustainable development.[1764] In the heydays of SCOWSAS, Mike Muller had just such a commission in mind. However, it took far longer for this valuable structure to take shape. In 1995 to 1996, selection panels for the national water advisory committee were appointed, in terms of the *Water Act* of 1956. A similar committee had also been assembled for the forestry branch of the department.[1765]

Amid the vast array of new ideas and innovative plans for South Africa's water governance, it was evident that the water sector was on a development trajectory that would culminate in a new hydraulic mission. The department's focus was no longer merely on irrigation, industrialisation and energy. In terms of the WEF nexus it was now all about water – especially access to the resource by the country's ordinary and previously almost forgotten people. The time had arrived for a social ecological hydraulic mission.

Transforming DWAF

In his co-authored memoirs, Kader Asmal writes humorously of how he arrived at the DWAF offices in Pretoria on his first working day as the responsible minister. Only the cleaning staff greeted him, while the senior officials in the department (almost all engineers) seemed to ignore him. He shrugged it off, telling himself they were running the department on behalf of the farmers and urban whites and were more interested in matters of a technical nature than social issues. Later he realised that 'my engineers were not interested in politics – other than a fairly unthinking support of apartheid'.[1766] Asmal was not popular with all the staff of the department, but he did accomplish much in terms of his contribution to planning, policy and the formulation of what, at the time, was internationally recognised as South Africa's ground-breaking water legislation.

Formally, the new department came into existence on 01 July 1994. There was an acute awareness of the magnitude of the work to be done. There were water and forestry officials, functions and budgets of the previous homelands, and other structures that influenced the department's budget significantly. In addition, several changes needed to be made. Consequently, a strategic management team was established to facilitate DWAF's transformation process.

1764. Department of Water Affairs and Forestry (1994a:12).

1765. RP134/1996 (1996:12).

1766. Asmal, Hadland and Levy (2011:227).

The membership of the team included people outside the department as well as senior officials from within.

Chief directorate of community water supplies

Because of the urgent need, a chief directorate of community water supply was created with immediate effect. The responsibilities of this directorate included:

- ensuring the effective ongoing operations of the department's supply of potable water services
- planning the expansion of services, in collaboration with provincial governments and in line with new policies (outlined in the White Paper)
- promoting the expansion of services
- developing the necessary organisations to deal with water-related matters at the local and regional level, in line with the goals of the government of national unity and the RDP
- monitoring, as well as regulating, water supply and sanitation in accordance with the interim constitution of the country.[1767]

The community water supply and sanitation services branch of the department began operations in 1994 with actions focused on the development of a programme to address the needs of the almost 12 million South Africans without access to basic water supplies. This branch of the DWAF was directed by Mike Muller. One of the outstanding features of the operation was finding new ways of working. The presidential lead projects, although finalised by mid-1994, only reached maturity in the planning phase by 1996. The branch's planners started well in advance of this, with the preparation of plans so that the system could start running smoothly without delay. Apart from the issue of drinking water, there were ongoing concerns about the estimated 17 million South Africans in rural areas who did not have access to proper sanitation.[1768]

The new department's focus was on service delivery to all.[1769] In the process of integrating the water and forestry functions of the former homelands, the department was faced with the amalgamation of the employees of these structures into a national establishment. The water law review, starting in 1994, laid the foundation for the matters of supply, use and management of water resources into the next millennium. The process presented several problems. There was a lack of technical, human and financial capacity. The department's report suggested that employees had learnt to resolve problems, and aspired to finding solutions through current and future programmes. The bigger

1767. Department of Water Affairs and Forestry (1994a:1–2).

1768. RP134/1996 (1996:19, 22).

1769. Department of Water Affairs and Forestry (1997a:4).

headache for management was DWAF's budget, which rose from R470m in 1994 to R2142m in 1997.[1770]

The enlarged department meant that a significant portion of the budget was absorbed by salaries. Employment equity was a cornerstone of the transformation process in DWAF. In this respect the department performed ground-breaking work and became one of the first in the country's civil service to publish an employment equity policy in 1995, giving substance to the stipulations of the interim constitution and working towards meeting the RDP aims of transforming the public service into a representative democratic institution.[1771] A government employment equity policy document, circulated in all departments in 1995, provided useful guidelines. The department made a point of conforming to the guidelines in the appointment of new management staff. The appointments followed of F.L. Ramagwede (from 01 June 1995); C. Triebel (01 October 1995), A.M.M. (Mike) Muller (01 November 1995); and M.T.M. Sokutu (01 November 1995).[1772] In 1996–1997, T.L. Ramaema was appointed as chief director of community water supply and sanitation and A.M. Matukane took over as chief director of the Northern Province.[1773]

By 1996, for the most part the structure of the department still resembled a near-traditional system with the DG, M. Erasmus, supported by three deputy directors-general (DDGs). They were respectively responsible for:

- development (Dr C.P.R. Roberts)
- utilisation (C. Triebel)
- regions (M. Muller)
- corporate services (F.L. Ramagwede).

They formed the top executive. The post of the strategic chief directorate for community water supply and sanitation of the regions, was still not filled in 1996. In the regions, the DDG, Mike Muller, formerly of the DBSA and SCOWSAS, as well as Trevor Balzer (formerly of the Department of Public Works), served the central regions of the country and the Eastern Cape, respectively. Other chief directorates included those of the managing engineers for, development (H.J. Best), planning (vacant), and international projects (W.S. Croucamp). Water resources came under P.F. Pretorius and scientific services was under M.T.M. Sokutu. The forestry division also had a manager (H.B. Coetzee) who served on the department's management committee.[1774]

1770. Department of Water Affairs and Forestry (1997a:5).

1771. Department of Water Affairs and Forestry (1997a:6).

1772. RP134/1996 (1996:10).

1773. RP134/1996 (1996:10).

1774. RP134/1996 (1996:7).

Rationalisation

As part of management's plans to reinvent the DWAF, consultants were appointed, on the advice of the transformation management committee. The process started in August 1995 and involved at least 70% of the department's staff. The sub-directorate for services spent most of 1995 to 1996 on the reincorporation of the homelands and the TBVC states. Many members of staff were retrained in the process, which was scheduled to carry on in the year to come.[1775] Once the various regions' officials had been incorporated, the department had about 33 000 posts. These had to be reduced to 27 000. What had, in fact, happened was that the DWAF's staff component, with the incorporation of the former homeland officials, had increased from about 7200 to 26 500 in the face of ongoing civil service downsizing. A matter of grave concern was the serious skills shortages in some areas of departmental operations. In 1997, 5000 vacant posts were listed.[1776]

The more comprehensive work of rationalisation began in January 1996, when a committee of 13 members was formed to drive the implementation of the transformation process. At the top of the hierarchical system was the transformation coordination committee, responsible for overseeing the process. The committee reported directly to the minister. Below the management committee was the transformation programme coordination committee, set up in September 1996, to drive the national goal-setting, coordination and monitoring of the process throughout the department.

This committee reported to the transformation management committee through the department's management committee. At the same time the transformation programme coordination committee interacted with the regional structures by means of constant dialogue and regional visits. From the outset, the focus was on aligning the department with the democratic principles of the new government (please see Figure 12.3). This led up to a 'national future search' conference in April 1996. At this event the objective was to agree on a new mission, identity and culture for the DWAF. The vision outlined for the department at the time was to:

> [*S*]trive to be a competent, innovative and developmental team, to ensure both the integrated sustainable development and management of water and forestry resources and the provision of basic community water supply, sanitation and forestry needs, thus providing a fair service to all users […] A committed, people-driven, participative approach through excellence in leadership, will support Reconstruction and Development towards economic growth, prosperity and harmony of our nation.[1777]

1775. RP134/1996 (1996:11, 14).

1776. Green (1997:6).

1777. Green (1997:6).

Source: Green (1997:5).
FIGURE 12.3: DWAF's 1995–1996 roadshow familiarised staff with the new, progressive era.

It was also at this conference that the slogan 'Ensuring some for all forever' was used.[1778] This vision for the future originated in the New Delhi Statement, issued in September 1990 by some 6000 participants representing 115 countries who attended the Global Consultation on Safe Water and Sanitation for the 1990s – a summit organised by the UNDP. The objective was to review the successes and failures of the water and sanitation decade and then to set new goals and targets for the realisation of these goals.[1779] In their work for SCOWSAS in 1993, the PDG at the University of Cape Town used the same slogan.[1780] By 1996 the key consensus that arose from these deliberations in DWAF was the principle of '[s]ome for all, rather than more for some.'[1781]

This juggling of the emphasis in DWAF's slogan was based on the universal human rights principle of championing equality of all people regardless of race, gender, creed or culture. At the 1996 conference, 10 building blocks were identified on which the department had to focus in the process of assuming its new identity. These were:

- creating a vision
- managing water resources

1778. RP134/1996 (1996:2).

1779. Palmer Development Group (1993:Section 2.3).

1780. Palmer Development Group and the University of Cape Town (1993:50–51).

1781. Palmer Development Group (1993:Section 2.3).

- delivery of community water supplies
- delivery of sanitation services
- forestry development
- organisational structure development
- developing administrative support systems
- human resource development
- ensuring employment equity
- developing partnerships, democratic practices and communication.[1782]

From 1996 to 1997 the transformation programme coordination committee was hard at work. It moved into the regions and grouped various regions and directorates together. The new entities set their respective goals by working towards specific objectives. Soon the process became part of a standard approach to strategic planning procedures in the department. Two specific transformation goals for 1997 were to integrate transformation into much greater public participation than ever before in the department, and to 'put in place stakeholder forums to place transformation in a formal and structural setting'.[1783] In an effort to accelerate the transformation process in the department, a case was made for the appointment of a human resources director, with the specific objective of ensuring opportunities for each member of staff to reach their full potential. Attention was given to previously disadvantaged and previously underprivileged persons in the department.

The transformation management committee's first annual report, published in February 1997, mentioned a number of achievements. Many workshops were held, involving various directorates and provincial offices, to promote an awareness and understanding of equity within the department. The committee also ensured that all equity-related information was circulated to members of staff. The workshops were opportunities to have discussions and debates on equity matters with employees at grassroots level. There was significant progress in the process of transformation, and between April 1995 and April 1997 nine black men and two white women were appointed to top management positions. At the same time 11 more people of colour were appointed as deputy directors, and two women were recruited as assistant directors.[1784]

Management was aware that the employment equity policy lacked measurable goals and targets. This issue received attention, and a system was set in place to monitor the transformation process in the department. Transformation at the top management of DWAF remained slow, largely because top management was wary of abrupt changes. They preferred to implement representivity with delivery. The department 'trusted that natural

1782. Green (1997:5).

1783. Green (1997:6).

1784. Green (1997:6).

attrition would create vacancies'. However, this did not happen, although severance packages worked well in the lower rungs and junior posts. There was also a shortage of female engineers and related officials, especially in the construction field. This made it difficult for the department to promote representivity across the board. The net result was that change in top management was negligible.[1785]

Procurement practices

In respect of procurement practices, the employment equity committee helped to draft new procedures for the appointment of consultants. In the early period of transformation the strategy was to enable officials with certain specialised skills to leave the service of the department and become private consultants rendering the same services as before.[1786] This was an interim measure until the state tender board's rules and regulations had been changed. From April to November 1996 only 21% of consultants appointed were from previously disadvantaged backgrounds. In time to come there would be significant changes. Gender initiatives also received attention. A committee was formed to draw up guidelines for addressing matters of sexual harassment in the workplace. The employment equity office promoted gender initiatives such as workshops and enjoyed some support from a UK-based gender organisation, which provided two consultants to assist in the framing of the department's gender policy framework. Finally, in the field of language usage, there was also a move towards promoting multilingualism in the department.[1787]

A new approach to water governance and administration

By 03 May 1997, when the DWAF celebrated the provision of water to the one millionth person, with the completion of the Modderspruit supply scheme in North West Province, distinct traits of the RDP were evident. The DWAF projects meant that thousands of people could be employed in construction work; women could be accommodated in the projects; and RDP projects, as a rule, were in the rural areas of the country where poverty and inferior administrative services were proving to be major obstacles to development. These projects were far more than merely laying pipelines. It was all about empowerment and mobilisation. The projects tended to build capacity at the level of local government. Because of a lack of departmental capacity, management resorted to using experts in the private sector for performing

1785. Green (1997:7).

1786. Parliamentary Monitoring Committee (1999).

1787. Green (1997:7).

some essential services.[1788] There were also the sombre voices of warning that somewhere in the future, attention would have to be given to a long-standing legacy of boycotting payment for services, and limited resources.[1789]

In its first annual report the new department's management let it be known that it had proceeded on the road of institutional reform with a new approach to operations and service delivery. For the department, there were essentially two groups of people, namely, those who had to deliver and those at the receiving end. DWAF now boasted:

> In the past these two groups, namely the decision makers and the silent majority, were largely kept apart. It is not so anymore. The Department is now not only looking seriously after the interests of both partners, but, equally important, is bringing the two parties together, in collaborative decision-making, planning and execution of projects. Principles in this process are consultation, transparency and democracy.[1790]

These were noble ideals in a young democracy. The process of consultation across a broad spectrum in the formulation of strategies, policies and legislation, received critical acclaim in the field of water policy studies.[1791] The values were correct and commendable, but in the years to follow it would become evident how difficult it was to maintain high standards of dedicated support and participation.

In the labour sector, the department showed it was determined to set aside the labour practices of former times and in an employment equity document of November 1995 they concluded a tripartite agreement between the department, the ministry, management and labour formations. The employment equity committee formed under these circumstances was then scheduled to spend a year in negotiations informing and educating all the DWAF employees on the aims, aspirations and goals of the employment equity policy. At the same time, the principles of the policy were entrenched into DWAF's employment procedures.[1792] Once the department had reached a satisfactory level of staff reduction, a phase of normalisation followed. In 1997, the human resources division revived the department's bargaining council. The department once again recognised employee organisations, and steps were taken to enhance labour stability through building trust.[1793]

1788. Green (1997:11).

1789. Goldblatt (1996:21–26).

1790. RP134/1996 (1996:1).

1791. De Coning and Sherwill (2003:30).

1792. RP134/1996 (1996:2).

1793. Green (1997:7).

MINMEC forums: Department and provinces

Then followed the first Ministers and Members of Executive Council (MINMEC) meetings. Initiated by DWAF, the forum meetings consisted of the minister and members of the executive committees of all the provinces responsible for water affairs. It soon became a comprehensive and effective platform for interaction between political role players to deliberate on implementation strategies and find consensus on matters of mutual interest and benefit.[1794] DWAF's MINMEC forum was said to have been the most representative of its kind among all the government departments at the time.[1795] In its interactions with the public at large, the department made a point of establishing opportunities to engage in public consultative processes. For example, a scoping document developed in the department garnered public comments towards a national groundwater management strategy for South Africa. The same procedure was followed in the development of guidelines for groundwater protection as well as the community water and sanitation programme – but not without problems.[1796]

National strategy on sanitation

In November 1995, one year after the release of the White Paper on water supply and sanitation, the DWAF set up an interdepartmental national task team. The team had to organise a national strategy and a sanitation policy, with a view to providing the whole country with adequate sanitation. Senior officials of the departments of health, housing, education, constitutional development, and environmental affairs and tourism, participated in the deliberations.[1797]

The draft policy on national sanitation embraced the objectives of raising awareness of diseases caused by unhealthy behaviour and practices, supporting and providing health and hygiene education, and encouraging an increased demand for appropriate sanitation facilities and willingness to pay for them.[1798] The first draft of the White Paper was published in November 1995 and pointed to government's commitment to the improvement of health and the quality of life by means of household sanitation and protection of the environment in the country as a whole.[1799]

1794. Department of Water and Sanitation (2016a). Cf. Republic of South Africa (1998b)

1795. RP134/1996 (1996:2).

1796. Hemson (2000:4–50); Braune, Adams and Fourie (2014:4, 8, 76).

1797. RP134/1996 (1996:2).

1798. Green (1997:10).

1799. South African Government (1995).

The DWAF was eager to promote sanitation in the household environment. Again, there was an awareness of the need to provide affordable services. The department realised that waterborne sanitation was expensive and potentially beyond the reach of households with low income levels. In terms of a system that had evolved the year before, the understanding was that local authorities would be responsible for the upgrade of sanitation to existing households in their areas of jurisdiction. These were all interim arrangements before the new water laws were passed in 1997 to 1998 by the legislative assembly.

There was a possibility of making grant funds available from the government where local governments were unable to pay for the services. In some cases, the White Paper suggested, the national Department of Housing could contribute. In the case of rural sanitation, there was the potential of interdepartmental grant collaboration to subsidise the running costs of services, as well as the systems. However, this line of funding was anticipated to reduce significantly in the long-term. The foundations of the new sanitation strategy dated back to 1990, when the Water and Sanitation 2000 (WS2000) workgroup started up at the DBSA. Along with the WRC, the relevant SCOWSAS sub-committee, with funding from The Mvula Trust, began its deliberations on a viable policy framework. In the course of 1995, the National Sanitation Task Team (NSTT) became an interdepartmental team to frame the draft paper. The authors of the document let it be known that it was merely a draft document and was open to recommendations.[1800]

Subsequently, in 1996 the DWAF established the national sanitation programme, with the objective of eradicating the country's sanitation backlog by 2010.[1801] By the time the final White Paper was published in April 1997, it was evident that the department had explored the policy field extensively. The White Paper drove home the message that sanitation was all about health; that communities had to be involved; and that there had to be an awareness of the environmental impact of sanitation. At the same time the document laid down strategies for affording sanitation improvements; which systems were the most suitable for local circumstances; and the departmental initiatives aimed at providing support with the implementation of the policy.[1802]

Water law review

In 1996 the department reported that the existing water law was in the process of review. Mike Muller, the DG of the DWAF, later observed that the time was ripe for making changes in policies and legislation.[1803] At the start of 1995 *You and your*

1800. South African Government (1995).

1801. Tissington (2011:8).

1802. NSTTeam (1996).

1803. De Coning and Sherwill (2003:30–32).

water rights! a booklet of about 30 pages, was issued by the department to inform the public on matters of water legislation in South Africa. The information booklet proved successful and underwent a fresh reprint by May 1995,[1804] being dubbed a DWAF 'bestseller'.[1805] The message conveyed in this booklet was wrapped up in words and phrases on the way water should be used in society and how we can all, through our use of water, interact with the environment. It secured for Asmal the coveted Stockholm Water Prize in 2000.[1806]

In legal terms, from 1995 the DWAF operated within the framework of the *Water Amendment Act*, No. 51 of 1995 and the *Forestry Amendment Act*, No. 63 of 1995 respectively. In terms of the revision of the existing water legislation, a water law review monitoring panel was set up, comprising members representing all water sectors, including experts in several disciplines relevant to the management of the country's water resources. The panel then formulated a set of principles; in effect, these were guidelines with which any new water legislation for the country had to comply.[1807]

There were many reasons for supporting the move towards change. The existing water law no longer reflected the needs of society. In the department there were views that rural water users and environmental conservation did not benefit sufficiently. The legislation was outdated and reflected on practical requirements dating back to the 19th century. In a nutshell, the existing legislation was no longer viable in the new South Africa. There was a need for a water management system that reflected the value of water in African contexts. The existing legislation did not meet this need. It was against this backdrop that for the greater part of 1996 the water law review group engaged with stakeholder groups such as industry, farmers, traditional authorities, urban and rural grassroots communities, and other interest groups in many parts of the country.[1808] In March 1997, the department announced in its annual report that the Water Services Bill was to be tabled in parliament later that year. In the second half of 1997, it was anticipated the drafting of the National Water Bill would receive attention.[1809]

During 1996 a discussion document was circulated on some of the fundamental principles of the proposed new water legislation. Nine workshops were held in the provinces; these provided opportunities for people to make direct inputs on the proposals. The process culminated in a national consultative conference

1804. Department of Water Affairs and Forestry (1995).

1805. RP134/1996 (1996:3).

1806. Asmal, Hadland, and Levy (2011:242); RP101/2000 (2000:6).

1807. RP134/1996 (1996:15).

1808. Green (1997:9).

1809. RP186/1997 (1997:15); Green (1997:10).

held in East London in October 1996. Based on the comments received, the fundamental principles of the document were revised, specifically with the objective of reflecting the provisions of the 1996 constitution. The document was submitted to cabinet in November 1996. After the government had given its approval, work began on a White Paper focusing on a national water policy for South Africa. It outlined how the country's water would be managed in future, to meet the constitutional requirements of equity and access to natural resources and their sustainable use. Much of the technical content of the White Paper had been contributed by technical task teams working on practical options for implementing the water law principles. The White Paper was approved by cabinet and then formed the groundwork for a national Water Bill that would give substance to the legal expression of the policy.[1810]

The National Water Services Bill had meanwhile also been distributed to all relevant stakeholders in the water sector, with local government being particularly articulate. Many of the matters that arose from comments were addressed with the support of the South African Local Government Association (SALGA). After this round of discussion, the bill was once again submitted to cabinet and was also circulated for comprehensive comment before being submitted in the format of a bill to parliament. To take the proposed water legislation through all the processes of review and coordination a new team, appointed by Kader Asmal, succeeded the previous steering committee. Appointed in December 1996, this policy and strategy team consisted of the departmental staff members and external experts in policy and legal matters. Legal drafting experts were brought in and several experts were appointed to manage the communications aspects of the process.[1811]

The *Water Services Act*

The *Water Services Act*, No. 108 of 1997, provided a regulatory framework for developing water services. The legislation defined water services institutions and detailed their roles and responsibilities, which included taking care of sanitation, as well as wastewater disposal, at the local government level. The responsibility lay with the national government to see to it that the municipalities strengthened their capacity to manage their own affairs in respect of Sections 4 and 5 of the Constitution, by regulating municipalities' exercise of their authority.[1812] The *Water Services Act* preceded the *National Water Act* for the obvious reason that government's prime responsibility was to ensure, in terms of the constitution of 1996, that all the country's people had access to clean drinking water and an environment that was not potentially harmful

1810. Republic of South Africa (1997).

1811. RP186/1997 (1997:23–24).

1812. RP88/2001 (2001:13).

to their health.[1813] It was a matter of getting the nuts and bolts of operations in place, such as securing a basic blueprint for service delivery strategies, and the affirmation of the right to water and sanitation for everyone,[1814] before outlining the bigger plan with water.

Deliberations prior to the political transition in 1994 pointed to the need for collaboration in the governance departments responsible for housing, water, sanitation and energy services to work on strategies for effective local government.[1815] In line with the policy guidelines of the RDP, water services authorities became responsible for ensuring access to bulk water supply services, while water services providers had the responsibility of delivering the service.

It was the responsibility of local authorities to ensure that water reached the consumers. Some local authorities had the status of water services authorities, but in areas where comprehensive regional service providers, such as water boards, were operating, local authorities merely had to ensure service delivery to consumers. Furthermore, local authorities were required to have integrated development plans (IDPs) and water services development plans (WSDPs), which were an integral part of their standard IDPs. While the water services legislation was being written, the minister gazetted a set of national standards for water services, norms and standards and guidelines for the governance of water services at various levels of local governance throughout the country.[1816] Government was aware that there would be a significant funding shortfall if the department were to provide water and sanitation services to all parts of the country.

There was interdepartmental consensus that a consolidated municipal infrastructure programme (CMIP) should be introduced to provide essential services where provincial and local government authorities and the housing department did not have any capacity to do so. Following an interdepartmental conference held at a venue on South Africa's Wild Coast in June 1997, cabinet approved an agreement between the various departments that provided for infrastructure development. Between 1997 and 2003, approximately 2300 municipal infrastructure projects were initiated. Of the R8bn spent on the project, more than half (R4.9bn) was invested in urban and peri-urban water and sanitation service infrastructure.[1817]

By 1997, as the bigger picture of the new era of governance started sinking in, the department's managers and the authors of the annual report saw the input of the department in the water sector as playing a major role in the

1813. Republic of South Africa (1996).

1814. Earle, Goldin and Kgomotso (2005:11).

1815. Palmer Development Group (1994a:4–5, 1994b:5–7).

1816. Department of Water Affairs and Forestry (*c.* 2006:8).

1817. Department of Water Affairs and Forestry (*c.* 2006:10).

unfolding of a democratic South Africa. Historically, the department had been the custodian and manager of the nation's water resources. In the new dispensation it began to see itself as the national regulator of water supply and sanitation services. The department was in a maturing phase, as the formulator of policy development in the fields of water resource management, complementing the water supply and sanitation policy that had been announced in 1994.[1818]

The *National Water Act*

DWAF in the 'new' South Africa was at the forefront of initiatives aimed at sharing information – especially with the public of South Africa – on what was being done to realise the objective of securing proper water supplies and sanitation. At the nucleus of the process was the formulation of legislation compliant with the objectives the department's management had set for itself. It was a process that would take four years.[1819]

In the foreword to the 1997 *White Paper on a National Water Policy for South Africa*, the minister, Kader Asmal, mentioned that it had taken two years of hard work and extensive consultation to reach the point where it was possible to list a number of fundamental principles and objectives for a new water law for South Africa. Key members of the law drafting team included a number of legal luminaries and water sector specialists. In their number were Antonie Gildenhuys, Robyn Stein, Francois Junod, Hadley Kavin, Chris Audie, Hubert Thompson, Rayleen Knightley, Jo-Ann Ferreira, K. Mphosho, Heinz Klug and Ronald Roberts.[1820] Because he had been so intricately involved in the process of writing the law, Asmal pointed to the critical components required for the realisation of what can be singled out as a social ecological hydraulic mission, when he stated:

> We are not getting the social, economic or environmental benefits from our water use that we could, or should be getting, indeed, that we need to get.[1821]

In the department, the White Paper was one of the high points in the 1996–1997 financial year. Management described the role of the paper as being:

> [*To*] guide the development and management of South Africa's water resources in the next century and to ensure that the goals of economic and social development are achieved in an environmentally sustainable manner. It is also an important step in the continuing Water Law Review Process.[1822]

1818. RP186/1997 (1997:1–2).

1819. Asmal, Hadland, and Levy (2011:243).

1820. De Coning and Sherwill (2003:23).

1821. Department of Water Affairs and Forestry (1997a).

1822. RP186/1997 (1997:2).

The *National Water Act* repealed 104 statutes related to water in South Africa, replacing a large corpus of the country's legislation dating back to colonial times and the era of apartheid, when the allocation of water use was determined on racial grounds.[1823] The redefinition of South Africa's premier water legislation was the epitome of transition in a society haunted by racial bias and discrimination. The *National Water Act*, No. 36 of 1998, marked a distinct South African breakthrough.

The legislation was greeted with international acclaim for its progressive nature, the innovative measures introduced and its stylish absorption of the latest international trends in water governance.[1824] The NWA was aligned perfectly with South Africa's constitution of 1996 and interfaced in strategic areas with the legislation of other government departments. The ubiquity of water, carefully described by the poet Antjie Krog in a preamble to the White Paper of 1997,[1825] resounded like a refrain in the NWA. Access to water for everyone was interpreted as a human right, and the concept of an ecological reserve acknowledged the importance of human respect for a natural resource, in the spaces where its fluidity was under threat. Above all, the objective was to create a sense of redress for past injustices. From a management perspective, the legislation provided for a decentralised system that sought to provide for the needs of its users.[1826]

Later, when Asmal reflected on the NWA, he accentuated four principles underpinning the legislation. The water reserve, he explained, was a world first in legislation. Secondly, there was the principle of equity and sharing water with neighbouring states. Thirdly, he saw the shift from water user rights to water use rights, which implied that bulk water consumers were bound to pay more for their water supplies. Finally, Asmal prided himself on the fact that the legislation made provision for water catchment areas.[1827]

It was also evident that based on the research findings emerging since the early 1990s, women played a key role in the management of domestic water. In his memoirs, looking back on his time as Minister of Water Affairs, Asmal stressed the importance of safeguarding women's rights and making their lives easier by procuring water supplies within reasonable reach for domestic consumers.[1828] In fact, Barbara Schreiner's appointment in

1823. Stein (2005:2168).

1824. Asmal, Hadland, and Levy (2011:13).

1825. Krog (1997).

1826. Movik (2012:8).

1827. Asmal, Hadland, and Levy (2011:243).

1828. Asmal, Hadland, and Levy (2011:225).

1995 as consultant to the Minister of Water Affairs and her subsequent rise to chief director for water, were among the first steps taken by Asmal to address gender inequality in the top management of the department. From 2002 to 2007, she served as deputy DG of policy and regulation in the department.[1829]

From a technical viewpoint, the *National Water Act* was ground-breaking. Of particular significance was the ecological reserve. Since the mid-1990s, when South Africa became part of the international community after years of exclusion, there was a growing awareness of the implications of global climate change. This being so, water policy planners and managers came up with innovative recommendations for the creation of an ecological reserve, that is, conserving the quantity and quality of water required to protect the aquatic ecosystems of the country's water resources.[1830]

Research on the reserve had begun in the 1980s, with the first measures to safeguard the riverine water supplies of South Africa's Kruger National Park from excessive irrigation and urban consumption.[1831] At the time when the legal experts sat down to write South Africa's *National Water Act* there was sufficient evidence available to work on a scientific calculation of the ecological reserve. Ultimately, roughly 20% of the available water supply was earmarked for this purpose.[1832]

In July 1998, media in the international water sector noted that South Africa's National Water Bill had run into problems in parliament, with the opposition parties criticising the new proposed legislation on the grounds that it seemed to imply the nationalisation of water. In the farming sector in particular there appeared to be widespread discontent. One opposition party, the Freedom Front, representative of most of the farming interests in the country, suggested that the proposed legislation would have an effect on irrigation and the value of farming land.[1833] However, in the international water sector, the legislation was praised as being representative of ground-breaking and innovative thinking in water legislation. The Act was promulgated after its publication the *Government Gazette* on 26 August 1998.[1834]

1829. Schreiner (n.d.).

1830. See Chapter 3, Part 3, The Reserve, sections 15-18, in Republic of South Africa (1998a); King, Tharme and De Villiers (2000:26); King and Brown (2006); Department of Water Affairs and Forestry (n.d.d).

1831. Van Vuuren (2017).

1832. Van Wyk et al. (2006:403–409); Muller (2009:175).

1833. World Water and Environmental Engineering (1998:1).

1834. Republic of South Africa (1998a:1–200); Thompson (2006:198–199).

Evolving views of water resources management

Community water supply and sanitation

In terms of DWAF's organisational structure there were significant changes. By 1997 it had evolved from a reactive to an anticipating institution, one that was ready to meet whatever challenges that came its way. In the process a new streamlined community water supply and sanitation (CWSS) structure was created. It separated the chief director, regions and the chief director, CWSS. Meanwhile, because of the cross-cutting nature of the work done in the sanitation branch, this section was transferred to the institutional and social development directorate. According to management, CWSS was a building block for the transformation process itself; it kept DWAF on track in maintaining its objective of working towards 'some for all forever'. The process of recruitment since 1996 had changed the face of the chief directorate, which was now much more representative of all racial groups in the comprehensive directorate of institutional and social development. The directorate in itself was responsible for a people-driven approach to all projects, and the building of institutional frameworks in which all role players were empowered to strive towards the realisation of their constitutional rights and obligations.[1835]

In respect of the process of sanitation in the institutional social development directorate, the NSTT, managed by the DWAF, was responsible for the comprehensive national sanitation policy and the implementation strategy that they followed. The NSTT was formed in 1995, and its members included representatives of DWAF, as well as the departments of provincial and local government, health, education, housing, environmental affairs, public works and the National Treasury.[1836] Part of the activities of the task team and the members of the department were to promote health and hygiene information distribution and education in community development.[1837]

Chief directorate regions 1997

The regions that had previously formed part of the branches of water resources and CWSS, experienced comprehensive transformation processes in 1996 to 1997. Firstly, the regions had to be demarcated. They had increased, meanwhile, from the original six, to nine. The classification was almost in perfect synchronisation with the new classification of the provinces of the country. There were minor managerial changes. Some regions, such as the Northern Cape,

1835. RP186/1997 (1997:26–27).

1836. Green (1997:12); Tissington (2011:8).

1837. RP186/1997 (1997:28–29).

had to be managed on an agency basis. The Northern Cape was one of the new provinces of the country and the DWAF had to redevelop a regional management system for the province in 1996 to 1997.

The second phase of the transformation was the creation of new middle management posts. Over an extended period many of the posts had not been filled, so a considerable amount of time went into planning. On 02 January 1997 the directors-general of Water Affairs and the minister gave their approval for the upgrading of the Northern Cape to a directorship, with the regional head office in Kimberley. In addition there was a new CWSS directorate in the KwaZulu-Natal region. These regions were later placed under the newly created branch responsible for the regions and had the task of implementing all water services and water resources management functions there.[1838] The responsibilities in this sector were comprehensive.

In the Northern Province (now Limpopo), the regional office had to deal with severe floods in February 1996,[1839] while the KwaZulu-Natal region experienced good rains. Two of the 44 irrigation boards in the region were involved in major developments. The Umlazi irrigation board appointed a full-time environmental officer to engage actively in integrated catchment management, with a view to improving the water in the Umlazi catchment. The Impala irrigation board commenced with the construction of the R108m Paris Dam project on the Bivane River. The dam was under construction to secure water for 14 700 ha of mainly sugar cane and for 250 000 people in the Simdlangentsha district. KwaZulu-Natal had 78 business plans for water services to communities, to be completed in rounds two and three of the RDP. In the Gauteng region, although there had been good rains by 1997, there were concerns about the Sterkfontein Dam. Over a period of seven weeks there had been a stoppage when no water was transferred to the massive reservoir that functioned as the emergency back-up to the Vaal Dam in times of water scarcity. The department reported that they were keeping an eye on the matter and that funds had been earmarked for the new financial year to see to the upgrading of the most critical sections of the system. In Mpumalanga two water boards were in the process of being formed. The greater Bushbuckridge water board was expected to start operations later in 1997, and the Highveld water board was scheduled to follow soon afterwards.[1840]

In the Western Cape, Phase 1 of the Palmiet pump storage scheme to augment the water supply to greater Cape Town was set for completion by 1998. The department was in the process of creating a management system for

1838. RP186/1997 (1997:87).

1839. RP186/1997 (1997:88).

1840. RP186/1997 (1997:88–89).

the Palmiet scheme by June 1998.[1841] The regional office in the Western Cape had started working through the provincial and municipal structures to get to communities in the Northern Cape and the Western Cape. The communities they had contacted by the end of the 1996–1997 financial year were:

- Klipheuwel near Stellenbosch
- Wupperthal near Clanwilliam
- Kalbaskraal and Abbotsdale near Malmesbury
- Elandsbaai and Teslaarsdal near Caledon
- Riverland and Chatsworth
- Khayalitsha informal settlement near Clanwilliam
- Sellington informal housing, Witterwater near Piketberg
- Kayamandi near Stellenbosch
- Kliprand near Van Rhynsdorp
- Klein Karoo Farm School near Oudtshoorn.[1842]

By 1997 the Northern Cape region was effectively without management. It was managed by both the Western Cape and Free State region. Then the Free State office became significantly larger, after the Northern Free State region, formerly under the control of Gauteng, was transferred to the Free State region. The enlarged Free State region received R7m for the year, as the first instalment of a five-year period for phasing out subsidies. In North West, the regional office, with the support of the Danish International Development Agency, could finish developments in five existing water boards or authorities in the province. These developments led to the need for personnel to take charge of the new offices. By 1997, the province had made a substantial contribution towards the upliftment of previously disadvantaged communities, in terms of water supply. Via various RDP programmes and other departmental projects it had been possible to secure a sum of R140.7m for procuring potable water supplies to about 360 000 people. In another project, of R91m, the Mmabatho water supply augmentation scheme in North West Province started operations to provide water to 90 000 people living adjacent to the municipal boundaries.[1843]

In the Eastern Cape, considerable planning went into setting up regional offices. There were subdivisions of the systems into eastern and western sections, with the main centres in Cradock, Umtata and King William's Town. There was significant progress in collaboration when district councils became implementing agents for RDP projects. In the final quarter of 1996, the European Union provided support to the tune of R90m for a project over three years to establish a sustainable water supply to previously disadvantaged communities. In addition, funds were set aside for other areas to secure the services of

1841. RP186/1997 (1997:99).

1842. RP186/1997 (1997:90).

1843. RP186/1997 (1997:91–92).

specialists for environmental impact assessments and information systems technology, as well as for monitoring and evaluation of the regional water systems.[1844]

Water boards

From 1995 to 1996, South Africa's 17 water boards were transferred to become the responsibility of the deputy DG of the regions, while the 283 irrigation boards received R9m in government subsidies.[1845] However, in 1997 the department launched a programme to reconstitute the existing 17 water boards, making them representative of the consumers they served in a democratic South Africa.[1846] Water boards functioned in terms of the stipulations of Chapter 6 of the *Water Services Act*, 108 of 1997. Their primary activity was to provide water services to other service institutions within their service areas.

The boards had the responsibility of entering into agreements with water service authorities (typically municipalities) in their areas of supply. Boards could undertake other services as well, providing these did not impede their essential service of providing water to their customers. Not all water boards functioned optimally. It was not always easy to situate them squarely in the existing structure of water boards. Consequently, in 2002 some of the water boards in South Africa applied to be reconstituted as water user associations in terms of the *Water Act*.[1847]

International relations

In the international arena, South Africa secured considerable publicity in the 1990s, and accolades for the 'miracle' of the transition to a non-racial democratic society. The DWAF was the beneficiary of a great deal of international interest. The DWAF participated in the UN Convention to Combat Desertification; made an assessment of the implications of the implementation of Agenda 21's Chapter 18 on Freshwater Resources; and participated in influential discussion forums such as the Southern African Regional Water Sector Assessment of the USAID; and the World Bank's Water Resources Technical Workshop for sub-Saharan Africa. The department even attended to water matters as key sectoral institution in the larger Southern African Development Community (SADC).[1848]

1844. RP186/1997 (1997:92–93).

1845. RP134/1996 (1996:12).

1846. RP186/1997 (1997:12).

1847. RP73/2002 (2002:15).

1848. RP134/1996 (1996:28).

Source: Green (1997:19).
FIGURE 12.4: Deliberations on 11 December 1996 between South Africa and Swaziland on the development of the Komati River Project.

There was a sense of optimism and confidence in the country. The Japanese government made available R180m in the form of a concessionary loan for the development of CWSS initiatives. This funding was used for the KwaNdebele–Mautse augmentation project in 1996.[1849] The Norwegian government sponsored a conference on 'The Greening of South Africa'. There was a strong partnership between the department and The Mvula Trust. The NGO became well-known for work to promote water supply and sanitation in many of the country's rural areas, and this good publicity prompted the British government to contribute R5.5m towards the project.[1850]

Apart from reaffirming South Africa's commitment to the construction of the LHWP and the Komati River Basin development project (Figure 12.4), by 1995 the country's government and officials had begun active engagement with the SADC to establish the DWAF as custodian of the country's water supply. South Africa's water sector was equipped with appropriate diplomatic skills in complex transboundary water relations on the subcontinent. Gone were the years of semi-isolation and non-acceptance in the region.

In August 1995, South Africa and leading members of SADC signed a protocol on shared watercourse systems. This was an instrument for the appropriate, sustainable and efficient use of the shared watercourse systems in the region. Furthermore, in November 1995 South Africa entered an official agreement with Botswana on the establishment of a Joint Water Commission.[1851]

Phase 1B of the Komati Basin project began in 1996 to 1997 on the construction site of the Maguga Dam in Swaziland. This dam was an addition to the Driekoppies Dam construction project close to the border between Swaziland and

1849. RP186/1997 (1997:5).

1850. RP134/1996 (1996:5).

1851. RP134/1996 (1996).

South Africa. In Phase 1B, as the project started getting under way, there were special arrangements made for the humane resettlement of farmers in terms of an acceptable compensation policy. Another of the objectives of the planning phase of the project was to secure more water for previously neglected small-scale farmers in the Nkomazi district of Mpumalanga in South Africa.[1852]

The Lesotho Highlands Water Project

The era of President Nelson Mandela (1994–1999) coincided with the completion of the first phase in the development of the LHWP. The project, which had been ongoing since the treaty was signed between Lesotho and South Africa in 1986, was a significant breakthrough for both South Africa and the 'mountain kingdom' of Lesotho. In the early years of the project it was difficult to secure funding for the construction of the dam. South Africa experienced economic sanctions and then negotiated for Lesotho to take the responsibility of securing a loan that was to be paid for by South Africa, for the completion of Phase 1A of the project. In the process, it was possible to bypass economic sanctions. Following South Africa's change of regime in 1994, the situation changed and suitable arrangements were made through international monetary markets. In terms of the agreement, South Africa was responsible for all the costs related to transferring water, estimated to be about US$26bn in 1998. Lesotho had the responsibility of securing US$23m to pay for the Muela hydroelectric scheme that the country required to provide electricity to its people.[1853]

There was significant private sector involvement in the project from the outset, with international contracting consultancies and South African groups working side by side. However, South Africa's Department of Water Affairs played an important role in several strategic areas.[1854]

The LHWP was marred by problems. The construction project per se was not an issue. However, what were originally considered to be peripheral complications, became more pronounced. For example, in 1995, before the construction of the dam began, the process of resettlement of residents from the site was problematic. In addition to claims of inadequate compensation paid to displaced communities, there were reports of negative health conditions, such as HIV/AIDS, being introduced by foreign workers on the project.[1855]

The South African authorities and their Lesotho counterparts made a concerted effort to address and mitigate these problems. The LHWP project was a long-term project for South Africa's water resource planners. They were intent on operating

1852. RP186/1997 (1997:5).

1853. Gleick (1998:95–96).

1854. Conley (1988:225).

1855. Gleick (1998:97).

with a view to maintaining sound relations and good neighbourliness, which they saw as moral investment for future collective development.[1856]

In 1998, projections suggested that the future Phase 1B of the project would see even more local people displaced than was originally planned. There were also fears of extensive seismic events because of the dam construction project.[1857] These issues were thoroughly investigated and reported on.[1858] In respect of community displacements, the DWAF minister, Kader Asmal took a firm stand on social equity and ensured that people who had to be relocated received adequate compensation and assistance. Senior representatives of the World Bank, such as John Roome and the sociologist, Ted Scudder, worked on the project as part of a review panel to ensure that affected communities received fair treatment.[1859] There were also ongoing investigations by scientists, technology experts and social scientists, to find solutions to address other glitches in the execution of the project.[1860]

In their investigation into the LHWP, Meissner and Turton found that 'international interest groups' were highly critical of the project. Some of these groups engaged with the authorities to query the terms of the treaty between South Africa and Lesotho. Subsequently the LHDA entered into a memorandum of understanding on cooperation with interest groups. More compromises were made when international groups who had originally been excluded, were later accommodated in the deliberations on developments. One of the mechanisms created in the memorandum of understanding was an arbitration facility. Arbitrators would be used if there were disputes that could not be resolved between the relevant parties.[1861]

The complex nature and size of the LHWP created opportunities for corruption involving international consulting and contracting groups, as well as officials responsible for overseeing the project. These were picked up by enforcement officials. In the aftermath of public exposures, the South African and Lesotho authorities took special measures, under the scrutiny of Transparency International, as well as international funding institutions, to introduce state-of-the-art management strategies to mitigate these issues.[1862]

At the time of its construction and implementation, the LHWP was the largest project of its kind ever undertaken in Africa. Ultimately, the lessons

1856. Conley and Van Niekerk (2000:137); Turton (2001:18).

1857. Gleick (1998:97–98).

1858. World Bank (n.d.).

1859. Roberts pers. comm., 28 March 2017.

1860. Hartnady (1998).

1861. Meissner and Turton (2003:124–126).

1862. Roberts pers. comm., 28 March 2017; European Investment Bank (2002).

learnt in southern Africa would inform similar water project developments in many parts of the developing world.[1863]

The ORDP of the 1960s relied largely on water from Lesotho. At the time the objective was to secure water for the Eastern Cape, the OFS and the arid western parts of South Africa. The LHWP of the 1990s changed the objective. The water of Lesotho was now necessary to supply water to the province of Gauteng – home to the most populous urban communities in South Africa and much of the country's industrial activity. The measure was vital for the economy of South Africa.

The Vaal River system's operational development plans (for the energy sector Escom and Sasol, as well as regional domestic and industrial consumers) had been structured for the existing system to reach capacity by 1997.[1864] Therefore it was important to tap into the Lesotho water supply. At the same time, Lesotho became the beneficiary of a comprehensive hydroelectric system to make the country more self-reliant as far as electricity was concerned.

Part of the LHWP was a strategy for contributing to modernisation and development in some of the most rural communities in Lesotho. Before the completion of Phase 1A, at a time when there was growing NGO criticism of large dam schemes, the LHWP incorporated strategies aimed at promoting tourism and ensuring that closer collaboration with South Africa could benefit development in the mountain kingdom.[1865]

Then, in 1998, as the LHWP was in its final stage for releasing water to South Africa, armed South African National Defence Force troops entered Lesotho, at a time when there was escalating political conflict caused by discontent over the outcome of a countrywide election. The South African troops were assisted by Botswana. The two countries were acting to restore stability, it was said, under the banner of SADC.

South Africa declared it had earlier committed itself to the maintenance of political stability in the SADC region. But there were observers who were highly critical of the claim that South Africa was acting on behalf of the SADC. It was argued that the country that had become a multiracial democracy in 1994, now appeared to be pursuing its own interests, in an aggressive act that was suggestive of an evolving path towards hard line measures to extend its influence on the subcontinent.[1866]

This claim was vociferously denied on the South African side.[1867] Conditions in South Africa had changed since 1994. The demand for migrant labour from

1863. Hitchcock (2015:526–538).

1864. Goldblatt (1998:24).

1865. Conley and Van Niekerk (2000:137).

1866. Hadebe (2011–2012).

1867. Turton (2001:11–26); Meissner (1998).

Lesotho was no longer influenced by formal mining sector demands. By implication it meant that despite the close partnership on the LHWP, South Africa was unable to extend a privileged status to Lesotho in terms of economic support. Water consumers in South Africa were liable to pay more for strategic supplies from Lesotho.[1868]

Much of the income from increased water rates to consumers in South Africa was used to pay for the water from Lesotho. In governance quarters all the talk was about water security. That could not be compromised. South Africa and Lesotho maintained very close ties of friendship and there had been a mutual understanding, since the signing of the agreement in 1986, that the water supply service to South Africa would not be jeopardised.

Since the late 1990s there was growing consensus that large dams were not desirable. Ecologically and economically these massive projects no longer made sense. In 2000, the World Commission on Dams published a report with a comprehensive exposition on the downside of large dams. The LHWP was one of three large schemes singled out as an example of a project where corruption was rife. International corporations involved in the construction of the LHWP were accused of having bribed, for their own benefit, some managers responsible for the execution of the LHWP.[1869]

Shortly before, Lesotho's government introduced judicial and enforcement measures to combat corruption, with the passing of the *Prevention of Corruption and Economic Offences Act*, No. 5 of 1999. It also established a directorate responsible for dealing with corruption and economic offences.[1870] The authorities of Lesotho, in collaboration with their South African counterparts, subsequently prosecuted a number of persons and companies and secured convictions.[1871] The LHWP was a resounding success story from the outset. At the official opening of the LHWP on 22 January 1998, the South African president, Nelson Mandela, touched on the intrinsic value of the scheme:

> This project is more than a bi-national venture between two governments. It has international significance. The success of our combined endeavour should stimulate more than a passing interest [...] We have built a spectacular vehicle to create a more sharply focused development environment, a contribution to the reconstruction of Southern Africa.[1872]

South Africa and its neighbour had to deal with changing circumstances. The landscape of water governance was bound to change. The LHWP received the nod of approval in the mid-1980s as apartheid reached its use-by date. Lesotho

1868. Weisfelder (1997:38–41).

1869. International Rivers (2002); World Commission on Dams (2000:187).

1870. Comparative and International Law Journal of Southern Africa (2000:1–2).

1871. Roberts pers. comm., 10 October 2017; Transparency International (2003:251, 252, 256).

1872. South African History Online (1998).

had relied extensively on South Africa in the apartheid era, particularly as far as its economy was concerned. Although Lesotho had been independent since 1965, it still required substantial support from the British Commonwealth in its collaboration with South Africa.

Economic realities were destined to become increasingly important in the new millennium. Both states were in a phase of maturation. The way the partners engaged on the LHWP determined the status of their respective levels of international diplomatic maturity.

The LHWP received accolades. In 1999 it was noted that the project was one of the largest and most ambitious of its kind in the world at the time. The 22 km northern delivery tunnel, with its outfall about 8 km from Clarens in the eastern Free State, came online in 1997 to 1998 transferring 18 m^3/s into the Ash River and then further downstream into the Liebenbersgvlei River to the Vaal Dam. The project represented a major tunnelling accomplishment. In 1999 SAICE awarded the project an excellence award for the year's most outstanding international civil engineering project.[1873]

South Africa's new Minister of Water Affairs and Forestry, Ronnie Kasrils, in an acceptance speech when the award was handed over, stated that the project was a prime example of South Africa's role in African development. It was in line with the New Partnership for Africa's Development (NEPAD) initiative, part of President Thabo Mbeki's drive for an African renaissance.[1874]

Conclusion: Progress in the Mandela era

In 1998, as the era of Mandela's government came to an end, Mike Muller, the DG of DWAF, was a keynote speaker at a World Bank event in Annapolis in the US. Reflecting on what had been accomplished in South Africa in the new government's first term, he explained that it had been an era in which a clear statement was made on the goals of water resource management.

The value of water was recognised in a management approach that aspired to introduce a strategy for the environmental protection of water resources, to transform the concept of water rights, and to ensure that the allocation of water rights was guided by overall goals. South Africa had moved beyond merely developing water resources and had begun to focus on the conservation and effective management of water, engaging in transboundary relations on water with the country's neighbours.[1875]

1873. Civil Engineering = Siviele Ingenieurswese (1999:13, 15–17).

1874. IMIESA (2004:5).

1875. Muller (1998:4).

Muller was frank about the challenges that had been created in terms of the political framework and the policies of water governance and service delivery. There were substantial challenges in the management and administration to meet the demands of the new democratic South Africa. At the same time, he was mindful of the limits of change that could be introduced without compromising the functionality of the (metaphorical) organism the department had to manage. The government's economic policy had also been shaped by the realities of everyday life in South Africa. Looking at the unfolding economic landscape, Muller explained, there was a pragmatic resolve to accept the principle that both privatisation and nationalisation were acceptable instruments to realise the overall social and economic goals of the government. By the second half of the 1990s, the farming sector's role in the country's economy had dropped to less than 5% of the country's GDP. According to Muller, this meant that the supply of water to the country's urban domestic and industrial consumers was assured. Acknowledging the decline in employment opportunities in the agricultural sector and forestry, he saw signs of growth and development in the country's tourism sector.[1876]

In hindsight, the 1990s was a period of comprehensive change in South Africa. Yet the country's people were remarkably resilient in their adaptation to living in a non-racial democratic society. The DWAF was at the forefront in the transitional process that continued well into the 2000s. Government held in high regard the constitutional principles of the basic right to clean drinking water and an environment that is not harmful to human health. The ground-breaking legislation introduced in the water sector was representative of excellent work done in Africa's youngest democracy. The department's engagement with water sector partners in southern Africa and the rest of the world was exemplary.

Little wonder then that the highly coveted Stockholm Water Prize was awarded in 2000 to the former minister, Kader Asmal. Apart from the work he had done in South Africa's water sector, he also received recognition for his chairmanship of the World Commission on Dams, at the time when the ethics and environmental implications of large dam construction came under extensive scrutiny.[1877] However, the Stockholm Prize being awarded to an African water sector pioneer was, in many ways, also in recognition of what had been accomplished by South Africa's water sector under circumstances of creative destruction and reconstruction in one of the most diverse societies on the continent.

1876. Muller (1998:1–2, 6).

1877. Stockholm International Water Institute (n.d.).

Chapter 13

Departmental developments (1999–2008)

Introduction: The Mbeki strategy of planning and doing

Upon assuming power, Thabo Mbeki called for an integrated approach to governance. DWAF's DG, Mike Muller, was aware that the new president of South Africa was keen to start *doing*, instead of merely making plans. The civil service was still in a phase of organising itself, but Muller and his staff gave all their support.[1878] Mbeki wanted to strengthen free market entrepreneurialism and neo-liberal principles – an approach that did not find favour with sections of the ruling ANC alliance leadership that were more leftist.[1879] Moreover, Mbeki's Growth Employment and Redistribution programme was scheduled to replace the RDP of the Mandela era.[1880]

The leadership of the DWAF, in line with officials who had worked under the previous government, as well as those appointed since 1994, set about

How to cite: Tempelhoff, J.W.N., 2018, 'Departmental developments (1999–2008)', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 483-522, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.13

1878. Muller (1998:2).

1879. Robins (2008:5); Habib (2003:234–235).

1880. Bakker and Hemson (2000:5).

implementing an array of strategies that had been planned since the early 1990s. Essentially the department's activities were focused on two fields, namely, securing water and sanitation services in poverty-stricken urban and rural communities, and keeping an eye on the management and oversight of the country's water resources.[1881]

The first priority was the implementation of the social hydraulic mission – the planning of the country's local and regional water resources so that previously disadvantaged people gained access to water and sanitation. The second focus was to maintain the large infrastructure components of the existing water resources management system. At the same time attention had to be given to innovations, with an accent on catchment-based systems of IWRM.

The new Minister of Water Affairs and Forestry, Ronnie Kasrils, had served in the Mandela administration as deputy minister of defence. His approach to the ministry differed from that of his predecessor. Whereas Asmal was more focused on operations in legal and constitutional contexts and had a determined approach to assert influence in the management of the department, Kasrils was more geared towards working at the political level, giving substance to the objectives of the presidency. He did not try to 'take charge' of the DWAF. On his appointment, Kasrils launched a strategic review of the focus and programmes of the department and its operations.

The DWAF's vision, mission and slogan were changed and aligned to Mbeki's policies. A notable feature was that service delivery had to be associated with a service rendered to the 'customer' – underlining an effective businesslike approach to state administration. The principles of Batho Pele (that the people themselves should be consulted on the level and quality of service delivery)[1882] formed part of the department's values, while the slogan 'Viva water, pure and clean! Viva forests, rich and green' had a more distinct grassroots South African flavour than the etymologically foreign 'water for all forever' (Figure 13.1).[1883]

The department was comfortable with Mbeki's focus on the international sphere of political action. DWAF had been active in foreign affairs dealings in southern Africa since the mid-1980s. The LHWP and sharing the Inkomati Basin with Swaziland and Mozambique were prime examples of sound transboundary relations. In the case of the latter project, the KOBWA, created in 1992, was a positive step in the completion of the Driekoppies Dam (1998) and the second collaborative project, the construction of the Maguga Dam by 2000, made good progress.[1884]

1881. RP101/2000 (2000:6).

1882. Republic of South Africa (1997:13–14).

1883. RP101/2000 (2000:2–4).

1884. RP101/2000 (2000:34).

Source: RP101/2000 (2000:5).

FIGURE 13.1: In March 2000 DWAF minister, Ronnie Kasrils and President Thabo Mbeki appeared together at the launch of the annual Water Week celebrations, held that year at Vygieskraal in the Western Cape.

Moreover, the department's engagement in the SADC on shared watercourses in the region, was important. The cooperation in water management contributed to the realisation of the goals of Mbeki's 'African Renaissance'.[1885] Beyond building sound ties of friendship with neighbouring states, the department was able to introduce several functional services. In 2000, a directorate for international liaison was established in the department, and by incorporating the DWAF's dam safety office, more than two decades of experience and expertise became available to neighbouring states.[1886]

In 2003, the DWAF maintained a high profile in the SADC in promoting the effective use of water, and this tied in well with the NEPAD – Mbeki's prime economic strategy for Africa. Meanwhile, the final work on the Mohale Dam was completed, ending the LHWP's Phase 1B.[1887]

1885. RP101/2000 (2000:6).

1886. RP101/2000 (2000:35).

1887. Department of Water Affairs and Forestry (n.d.a:1).

DWAF reporting from 2000

In 2000 the DWAF began submitting annual reports, as stipulated in the constitution (1996), the *Public Finance Management Act* (1999), Treasury Regulations, and Public Service Regulations (1999).[1888] The objective was to make the operations of the department more transparent, as was the case with all government departments. As will become evident, making the transition to a new system of reporting created numerous problems for the department's management. As one of the largest government departments in the country, with very specialised responsibilities, the DWAF experienced difficulty in being fully compliant with a rigid system – an almost businesslike reporting on its activities. However, from the outset, the department was fully committed to complying with the new system.

The department became more transparent and readily engaged with the public by 2000. For one, the DWAF's website became an outstanding platform for public engagement. Its first corporate business plan was developed in this era and maintained a high, open access public profile.[1889] Another notable feature was the correspondence between budget allocations made by parliament and the department's business plan. There were minor adjustments in the early plans and structures were changed where necessary; restructuring enabled the department to distinguish clearly between policy, planning, regulation and monitoring on the one hand, and extensive operational and trading activities on the other.

By 2002, programmes featured prominently in the DWAF annual report. It was now possible to determine performance, expenditure and operations in several areas. The primary fields were:

- corporate services (administration)
- water sources (assessment, integrated planning, and development)
- regions (operational and implementation plans)
- integrated water resources management
- water services
- forestry.[1890]

In the early years of the new reporting style the auditor general frequently issued negative reports. In 2003 it was evident that operations in the department, probably as a result of the complexity and the integrated management required across governmental departments and various levels of governance, were not yet up to standard.[1891] The report of the auditor general's

1888. RP88/2001 (2001:7).

1889. RP101/2000 (2000:6–7); Department of Water Affairs and Forestry (2000a).

1890. RP73/2002 (2002).

1891. Muller (2003).

office pointed out that by 2003 the DWAF's regional implementation programme had underspent by R56.9m. In other programmes such as water resources assessment, and water resources planning and development, underspending was well below R10m.[1892]

Although the DWAF maintained basic oversight of the water boards in South Africa, this did not constitute a vast expense. However, in 2003, as a result of difficulties experienced in setting up the water boards of Ikangala and Bushbuckridge, the department made seed funding available to get operations under way.[1893] The DG, Mike Muller, explained to the department's parliamentary portfolio committee in Cape Town that the DWAF was still grappling with remnants of an old, rudimentary, financial management system. As a result of the need to make savings, the department did not invest in costly new accounting software. Instead it chose to wait before aligning with the new accounting system when Treasury introduced it in all government departments. The DWAF would then follow the example, he said.[1894]

In 2004 the department developed its own internal accounting system based on the Systems, Applications and Products in data processing software, to comply with the treasury's requirements. However, the system could not be completed by the end of the financial year 2004–2005 because staff in the regional offices were unable to undergo special training in its use. Problems of this nature stymied the planning and use of the department's annual budget to the extent that by 2005 management reported it had used 99% of its budget.[1895]

The DWAF's expenditure was an indication that its financial management, in terms of treasury oversight, was sound. For some time to come the accounting system remained a problem. Only in 2009 did the acting DG, Ms N. Ngele, report that for the first time the department had been awarded an unqualified nod of approval by the auditors. This was the result of four long years of systematic preparation.[1896]

Contemplated in retrospect, it is evident that the DWAF, like Public Works, had always had a comprehensive institutional structure with many employees and numerous operational sections. Incorporating all the activities and developments on an annual spreadsheet – engineered for governance uniformity – was a complex operation. Although the system had been structured to pick up irregularities, and first-class accounting practices were applied, the DWAF's complex structure of operations tended to hamper effective economic reporting.

1892. Department of Water Affairs and Forestry (n.d.a:75–76).

1893. Department of Water Affairs and Forestry (n.d.a:82).

1894. Parliamentary Monitoring Group (2003a).

1895. RP130/2005 (2005:6, 8).

1896. RP163/2009 (2009b:9).

TABLE 13.1: DWAF expenditure and accomplishments of water services projects 1994–2000.

Province	Expenditure (June 1994 to March 2000)	People served (June 1994 to March 2000)	Projects completed (June 1994 to March 2000)	Jobs created (June 1994 to March 2000)
Eastern Cape	R476 293 000	1 008 611	42	39 652
Free State	R107 960 000	196 686	23	10 796
KwaZulu-Natal	R771 469 000	894 230	53	70 240
Mpumalanga	R412 469 000	611 530	23	39 892
North West	R574 360 000	764 202	19	60 560
Northern Cape	R55 850 000	24 932	35	5680
Northern Province	R1 136 462 000	1 253 436	30	94 380
Western Cape	R25 640 000	96 824	11	2564
TOTAL	**R3 561 940 000**	**4 847 451**	**236**	**323 764**

Source: RP101/2000 (2000:17).

Services: Taking resources to the people

In 1999 the operational structures of the DWAF were still organised in terms of directorates. These were remnants of the pre-1994 era and reminiscent of a time when DWAF's prime preoccupation was to provide abundant water supplies to bulk consumers; it was all about resource management. However, at the same time there was growing evidence of a strong social component in the hydraulic mission of water governance in South Africa. The bottom line was now to provide services. In all directorates, there was a commitment to rendering service at the local levels of governance in both the urban and rural contexts. For example, the chief directorate of water services, formed in 1994, had the primary responsibility of implementing rural infrastructure development in terms of the RDP. After the introduction of the *Water Services Act* of 1997, there was an emphasis on appropriate governance and departmental bodies that functioned efficiently. An additional responsibility was to maintain the rural infrastructure support of the RDP. For a comprehensive overview of the DWAF's expenditure and accomplishments of water services projects between 1994 and 2000, please see Table 13.1.

According to a report of April 2000, the capital infrastructure programme of the chief directorate of water services had provided 4.8 million people with water, thanks to 236 projects; in the process 323 764 job opportunities had been created. The DWAF's water services programme had provided water to 1.6 million people in the country, spending R735m in the process.[1897]

DWAF's ability to deliver services and provide infrastructure was a major accomplishment, not only for the government, but also for the communities concerned, the officials, and the NGOs and consultants who had collaborated on a project of great magnitude.

1897. RP101/2000 (2000:15).

Supporting local human resources development and infrastructure

One obstacle experienced from the outset was insufficient capacity to take on the responsibility for the physical construction and operationalisation of infrastructure. Consequently, DWAF entered into agreements with private sector partners in the build–operate–train–transfer (BoTT) strategy. This meant that contractors would take responsibility for the construction. They would then oversee the initial operation, and undertake the training of local officials, before finally handing over the system to the responsible authority. The implementation of this strategy saw the department in collaboration with consortia of bidders operating in the Eastern Cape, KwaZulu-Natal, Mpumalanga and Limpopo – the provinces where most problems were experienced in delivering water and sanitation services. The first contracts were awarded in 1997.[1898]

The creation of new local authorities – a process that began when the new constitution came into effect in December 1996 – guided the DWAF's focus. The department was responsible for preparing transitional structures of water governance to fit in with the new evolving municipal system. The former Department of Constitutional Development made way for the Department of Provincial and Local Government. In March 1998, the latter submitted a White Paper on local government, preparing the way for the *Municipal Structures Act* of 1998 and the Fluid Rights: Water Allocation Reform in South Africa of 2000.[1899]

Both the *Water Services Act* of 1997 and the *National Water Act* of 1998, were compatible with the new legislation. According to Eales, what was presented to South Africa in terms of local government in the post-1994 years was a reconception of local government as the primary driver and enabler, as well as the implementer of programmes. This new leading role for local government was aimed at replacing apartheid era disparities in the water sector.[1900] All that was required was to create conditions for local and regional officials to implement new services.

The first national local elections were held for the new municipal dispensation in 2000.[1901] Prior to 1990 there were about 1000 local authorities in South Africa. The number dropped progressively to 284 local authorities by 2000. The revamped municipal structure had three categories of local authorities:

1. Category A: metropolitan municipalities
2. Category B: local municipalities
3. Category C: district municipalities.

1898. Department of Water Affairs and Forestry (*C*. 2006:11).

1899. Department of Provincial and Local Government (1998).

1900. Eales (2011:35).

1901. Powell (2012:16).

The outcome of the new system saw the establishment of six single-tier metropolitan municipalities, 232 local municipalities and 46 district municipalities.[1902]

Government's objective was to consolidate and integrate poor communities into a functional framework of local governance where there was sufficient capacity to afford paying for service delivery. This meant that there would be a common revenue base to make a meaningful contribution towards improving the lives of all people, and thereby eradicate poverty.[1903] Local government was in a phase of intrinsic change. In terms of implementation the new system was scheduled for consolidation in a sustainability phase by 2005.

However, the system became increasingly complex. For example, in 2001 to 2002 government adopted the policy of free basic services to provide water, sanitation, electricity and waste removal for impoverished communities. In the process, there had been no finalisation whether district and/or local municipal authorities would provide such services. The system required major restructuring to secure the transfer of staff and water schemes to appropriate authorities.[1904] In terms of the new free basic water services programme, there was a marked improvement in the lives of the country's previously disadvantaged communities. The DWAF engaged with the Department of Provincial and Local Government on strategies aimed at developing the capacity of the new local government institutions. Muller's point of departure was that the improvement of local administration services was just as important as the construction of water works and sanitation infrastructure.[1905] With this in mind the department devised a regulatory system to determine the requirements for the establishment of water services authorities and water services providers.

The DWAF then worked towards implementing a sustainable water services institution programme (ISWIP), following the example of a pilot project in what was still the conventional regional services councils of KwaZulu-Natal, dating back to the 1980s.[1906] The ISWIP strategy focused on preparing municipalities for the decentralisation of DWAF's water services infrastructure. Earlier, a variant of the build–operate–transfer–train (BoTT) programme, then dubbed operate–train–transfer was devised to facilitate infrastructure takeover by new water services authorities. However, serious shortcomings persisted in the development of urban water and sanitation service delivery. By 2000, once the ISWIP programme had been launched in the provinces of Limpopo and Mpumalanga, DWAF started working on a more ambitious programme.[1907]

1902. Eales (2011:42).

1903. Ndletanya and Muzondidya (2009:24).

1904. Powell (2012:16–17).

1905. Muller (2001:58).

1906. Department of Water Affairs and Forestry (*C*. 2006:12).

1907. Department of Water Affairs and Forestry (n.d.b:n.p.).

The new programme, Masimbambane, was funded by member states of the European Union.[1908] It aimed to address the water and sanitation services backlog, improve services levels and contribute to sustainable development. In the Western Cape, the DWAF worked with consulting engineers to study the quality of treated municipal water, pointing to a number of issues that required the special attention of local and regional authorities to improve WQM.[1909] However, the department was critical of the programme, arguing that Masimbambane had proved unable to take the country's complex macro environment into consideration.[1910] Although some problems could be resolved at the local level, there was not yet a uniform system in place to deal with the same problems in other parts of the country.

A public–public partnership strategy was also put to the test. This meant that water-oriented bodies (such as water boards), should collaborate with local authorities and the Department of Water Affairs to provide water services.[1911] One such scheme was initiated in 2001 in the local municipality of Harrismith in the eastern Free State, where the Gauteng-based water utility, Rand Water, took the responsibility of providing local water services in a community with relatively high unemployment and poverty rates.[1912] When it started in 2001 the operation tended to function well,[1913] but in the longer term it did not succeed.

Despite the problems of introducing the technologies and technical staff to operate the infrastructure, the DWAF performed well. For the period 1999 to 2000 the department's water services programme had spent R735m for water provided to 1.6 million people in the country.[1914] By 2005, 95% of all municipalities were providing free basic water to their residential populations – representing 69% of the country's population. A total of 23 million of the 29 million impoverished South Africans were receiving water services free of charge. In areas where the service had not yet been introduced, the DWAF's provincial support unit made it possible to extend these services.[1915]

However, the service delivery problems continued and were central to a swathe of countrywide service delivery protests by 2004. Powell is of the opinion that there were contradictions in the local government policy and the

1908. Department of Water Affairs and Forestry (*C*. 2006:12; *C.* 2002/2003:1–27).

1909. Van der Merwe (2004:6–11).

1910. Department of Water Affairs and Forestry (*C*. 2002/2003:1116–1117).

1911. Sjölander-Holland (2005:177–194); Boag and McDonald (2010:1–25).

1912. Van Rooyen and Hall (2007).

1913. Smith (2005); cf. This book was consulted on the internet in March-April 2010. A revised edition was subsequently published electronically, but was no long accessible on the web by April 2011.

1914. RP101/2000 (2000:15).

1915. RP130/2005 (2005:58).

national policy that evolved in the first term of the Mbeki presidency.[1916] The African majority was restless, and the post-1994 national policy had heightened expectations that government would be making a substantial contribution to poverty relief, with fixed dates set for universal access to basic services. Such expectations were unrealistic before the proper establishment of local authorities and the setting of fiscal frameworks for regulating municipal systems had been accomplished.

In Mbeki's second term, from 2004 to 2008, the situation did not improve. His opponents in the ruling alliance government still opposed his privatisation objectives – although many measures had been watered down. More important was Mbeki's loss of control as president of the ruling ANC to his major opponent, Jacob Zuma, in December 2006 at the Polokwane general meeting of the ANC. The president was dealt a fatal blow. To all intents and purposes, the presidency had become a lame duck in its inability to execute strategies in line with policy guidelines that had been expressed in the annual state of the nation speech in 2007 and 2008.

In some respects, the failure of service delivery in the 2000s can be ascribed to government, through departmental agencies like the DWAF trying to do too much too soon. They tended to lose focus on the essential tasks at hand. For example, in 2000, all district municipalities were registered as water services authorities (WSAs). Because of the apparent confusion and non-responsiveness of some WSAs, a select group of 183 municipalities were classified as WSAs.[1917]

The system showed certain weaknesses that did not augur well for the future of local water governance. The case of small-scale irrigation schemes proves the point. In 2004, government made funding available for historically disadvantaged communities, especially in the rural areas of the country. In the case of Limpopo, the provincial government initiated a project to rehabilitate and expand over 100 irrigation schemes.[1918] Government saw the small-scale irrigation operations as capable of making a substantial contribution towards food security and potential income for participating families.

Van Averbeke and Mnkeni outlined the conundrum by explaining that the area under irrigation in South Africa increased from 0.23×10^6 ha in 1909, to 1.2×10^6 ha in 1991. At the time, 30% of irrigation was conducted at state irrigation schemes, 30% was controlled by irrigation boards, and 40% was conducted on private farms.[1919] The lion's share of the irrigation funding from the state was intended for whites. They were also advantaged in terms of the

1916. Powell (2012:17).

1917. Eales (2011:43).

1918. RP130/2005 (2005:7).

1919. Van Averbeke, Denison and Mnkeni (2011:797).

size of their farmland. The irrigated holdings of whites, as a rule, ranged between 8 ha and 20 ha, which on average was 10 times larger than the 1.5 ha plots allocated to Africans. Averbeke and Mnkeni, argue that:

> The relatively small size of the irrigation plots allocated to Black farmers explains why in South Africa, the term 'smallholder irrigation scheme' is commonly used to refer to irrigation schemes on which the land is held by Black people.[1920]

For this reason, they argue, 'smallholder irrigation schemes' should be understood in terms of the context of being intended primarily for Africans. The project posed a number of challenges, dating back to the dawn of the new South Africa. For one, it was difficult to turn these operations into instant profit-making entities. The apartheid era and the years of exclusion had led to a loss of continuity and a dearth of local knowledge on how to manage and operate irrigation systems. In former times government heavily subsidised these schemes to create local income opportunities and make migration to the white urban areas less attractive. The new government did not have the same priorities.

From 1994, the state started closing down parastatal operations responsible for irrigation farming activities in many of the former homelands areas. In line with global trends, irrigation schemes were increasingly transferred to farmers; they were no longer state-owned. South Africa's irrigation management system was in line with global trends, but at the same time there was consensus among experts that the situation in the case of South Africa had been too rushed, and that a less sudden process would have yielded better results in the longer term.[1921]

It was against the backdrop of tumultuous political change and a completely new focus on water governance, that micro-irrigation projects had to be transformed. It was a mammoth task for a small section with a small number of officials in the department's existing work programme. The programme required dedicated attention, expertise and experience at a time when knowledgeable human resources in the field were in short supply.

Despite an awareness of the potential obstacles the project presented, the DWAF gave its full support.[1922] The parliamentary portfolio committee on water and forestry met with a delegation of the DWAF on 02 June 2005. The officials explained the implementation of the department's new NWRS[1923] and how the water allocation reform strategy fitted into it.[1924] At the time about 500 emerging farmers in new farming areas received an annual amount in support from the department, operating in collaboration with the Department of Agriculture.

1920. Van Averbeke, Denison and Mnkeni (2011:797).

1921. Van Averbeke, Denison and Mnkeni (2011:798).

1922. RP130/2005 (2005:7).

1923. Department of Water Affairs and Forestry (2004a:47–47, 80, 86).

1924. Parliamentary Monitoring Group (2005b:n.p.).

From countrywide experience DWAF's officials knew that only a small proportion of the farmers made use of irrigation technologies.[1925]

In 2005, the water allocation reform (WAR) programme was launched by Water Affairs and Forestry minister, Buyelwa Sonjica. There had been an extensive preliminary investigation and the findings were presented in a position paper, entitled *Towards a framework for water allocation planning.*[1926] The use of the acronym 'WAR' was seen as controversial by advisers, who pointed out that the use of the term and the phrase used by the minister, 'WAR on poverty' at the time of the 2005 annual Water Summit, was not in the spirit of reconciliation.[1927] The programme was subsequently also linked with the departments of agriculture and land affairs.[1928] In the established, predominantly white-controlled farming sector, the proposed strategy did not go down well. Farmers were subject to more scrutiny and monitoring to ensure they did not overuse water allocations. Moreover, they were required to pay for whatever was used.

In respect of the historically disadvantaged farmers, by 2008 WAR had made significant strides forward in securing greater equity along gender and racial lines to give more water users access to irrigation water services.[1929] However, this was a slow and arduous task that required ongoing skills transfers, support and funding. Because the policy was intricately linked to the process of land reform in South Africa, researchers emphasised the need for an accurate and reliable system of monitoring WAR to determine how successful it was.[1930] There were concerns about the slow progress being made with the land reform process.[1931]

A significant change that had taken place in the irrigation sector was that the *National Water Act* (1998) abolished the system of irrigation boards, and all commercial farmers who had previously been members of these boards became members of water user associations (WUAs). This strategy enabled previously disadvantaged South Africans in the farming sector to gain participation in the governance of the local water resource. In 2008 the department participated with smallholder water users in the country. These were primarily farmers in the former homelands who did not own any land but, subject to securing permission from the local tribal authority, could occupy

1925. Parliamentary Monitoring Group (2005a:n.p.).

1926. Ashton, Turton and Roux (2006:29).

1927. Movik (2012:62–63).

1928. Jonker (2007:1258–1259); RP130/2005 (2005:12); RP166/2006 (2006:28).

1929. RP246/2008 (2008:372).

1930. Anderson et al. (2008:731–737).

1931. Movik (2012:72–73).

land to conduct their farming operations. Because these farmers did not have ready access to credit facilities their operations were jeopardised.[1932] The existing legislation enabled the department to use the WUAs to facilitate collaboration among farmers and make the available water resources work to the benefit of local farming communities.

From 2007 to 2008, 13 new WUAs were established, most of which focused on serving previously disadvantaged farmers in areas such as Tulbagh, Kabous River, Northern Sandveld, Krom Antonies, Wolseley, Onrus, Duivenhoks, Kweekvallei, Sekhukhune, Tubatse, Ilanga and Tshiping.[1933] Accommodating small irrigation farmers remained a problem; more comprehensive solutions were clearly needed to address their economic woes. Of the 1 675 822 ha of land registered in 2008 as irrigation land, a total of 1 399 221 ha was under irrigation in 2010. And, of that land, 47 667 ha formed part of the smallholder irrigation land in South Africa. By comparison the number of smallholder irrigation operations, totalling 34 158 plot-holders on smallholder irrigation schemes, was relatively low in comparison with the 1.3 million households that had access to land for the purpose of cultivation.[1934]

Macro planning on water services

Within the DWAF there were still working systems operating free of political interference. It was in these sectors that operational fault lines were identified and strategies developed to find solutions. DWAF's directorate for macro planning and information services was responsible for WSDP and supported the regional offices and WSAs. They had to help all nine provinces that had WSDP regional coordinators. Their main task was to help WSAs develop a planning culture and prepare water services plans.[1935]

The *Water Services Act* (1997) made provision for water services development programmes that were integrated with municipalities' institutional development plans. These plans laid the foundations for whatever expansion and development local authorities had for improving or upgrading their water services infrastructure.[1936] Meanwhile the department started setting up a consolidated national business plan for water services. The final document outlined the methodology for ensuring water services projects in the framework of DWAF's existing services projects and evolving legislation.[1937] The system

1932. RP246/2008 (2008:9).

1933. RP246/2008 (2008:10).

1934. Van Averbeke, Denison and Mnkeni (2011:797–798).

1935. SAWHAR AHCA9/031 (2000:1–107); RP101/2000 (2000:16).

1936. Department of Water Affairs and Forestry (*c.* 2006:9).

1937. Department of Water Affairs and Forestry (*c.* 2006:1–48).

incorporated the government's policy on strategy for local institutional development, operations, macro planning, and the strategy for local institutional development. In addition, water quality and groundwater management strategies had been added to the planning system.[1938] The project development support directorate of DWAF was compliant with the national business plan. In addition, the directorate supported DWAF's regional staff. Importantly the directorate saw to it that that sanitation interventions were supported in the implementation process. There were skills training, conflict management and community mediation processes.

The DWAF White Paper of 2002, entitled 'Towards a water services White Paper' that emerged from these plans, was focused on the role of local authorities in water supply and sanitation and the way they could be of service to consumers in urban and rural, as well as domestic and non-domestic contexts.[1939] A monitoring and evaluation system, introduced in 1998, was operational for the capital infrastructure programme. The system provided information to those local and provincial authorities participating in the programme. By 2000, monitoring and evaluation units had been established at the head office of DWAF in Pretoria and in the regional offices of Mpumalanga, North West and KwaZulu-Natal.[1940]

DWAF's directorate for local institutional development supported the initiative to build the capacity of WSAs operating in local government. Staff in this directorate provided methodological support and tool development to enrich WSDP. The directorate was also responsible for water boards and worked out a set of guidelines for drafting and appraising their policy statements. It also collaborated with the Department of Provincial and Local Government in evaluating business plans for the CMIP. The directorate helped the Department of Housing in preparing the *Red Book: Guidelines of engineering services and amenities in human settlements*.[1941] This informative and ground-breaking set of guidelines in two volumes, was compiled by the CSIR's Building and Construction Technology division under the patronage of the Department of Housing. The first edition appeared in 2000 and a reprint followed in 2005.[1942]

The *Red Book*, which from the outset had been used as a living document, was subject to change and adjustments as society changed. The second volume dealt with the water-related themes of stormwater management, water supply, sanitation and issues of solid waste.[1943] In 1999 to 2000 the sub-directorate for

1938. RP101/2000 (2000:18).

1939. Department of Water Affairs and Forestry (*c*. 2006:7).

1940. RP101/2000 (2000:18).

1941. RP101/2000 (2000:19).

1942. CSIR ([2000] 2005:n.p.).

1943. CSIR ([2000] 2005:Vol. II, Chs 6, 8, 9, 11).

sanitation provided support in sanitation development. It helped define the role and interlinkages between various departments, the national task team and the national sanitation coordinating office. Overall, the processes in which the sub-directorate participated made for a good working relationship between all the agencies.[1944]

The directorate for intervention and operations support focused on ensuring that service delivery was efficient and sustainable. It investigated operations and maintenance while promoting a businesslike approach to water services, cost recovery and the transfer of schemes to WSAs. In addition, the directorate had to see to it that plans were executed. In the various regions there was support for developing performance in local activities, helping in developing policies and guidelines. It was also responsible for the development of national standards for water services, as well as norms and standards for tariffs. In performing its constitutional function of securing equitable access to water resources, the directorate was responsible for developing model by-laws and contracts, in terms of Sections 9, 10 and 73 of the 1997 *Water Services Act*, along with guidelines to support WSAs. In the process of executing their responsibilities the officials of the directorate looked at international best practice on regulatory models. Subsequently they completed a discussion document on making basic water more affordable to the poor.[1945]

In 2004 the Department of Provincial and Local Government launched what they called 'Project Consolidate'. It followed a critical assessment of the 284 municipalities of South Africa in terms of their service delivery capacity. In the process, 136 municipalities were singled out for special support in the development of service delivery.[1946]

The DWAF participated actively in this project, scheduled to run over 2 years, in an effort to provide specialised support in improving standards of water supply and sanitation service delivery. The department's participation was shaped by the strategic framework for water services that had been approved by cabinet in September 2003. Part of the programme implied the detailed specification of the areas in which local authorities required support in service delivery. Part of DWAF's support was the development of a toolbox of services for WSAs and water services providers to step in and provide support to local authorities. The department's partners in the initiative included the DBSA and SAICE.[1947] It was evident there was a place for private sector skills in the operations of DWAF. In some cases, it was evident that there had been a

1944. RP101/2000 (2000:19).

1945. RP101/2000 (2000:19–20).

1946. South African Government (2007:n.p.).

1947. RP166/2006 (2006:4, 47); Institute of Municipal Engineering of Southern Africa (2005:79–81).

significant deterioration in local services. What was required was a more direct and ongoing form of support to restore services.

In October 2005, following the outbreak of what was thought to be cholera in the Mpumalanga town of Delmas, experts warned that municipal services in South Africa needed special support. In the water sector there had not been sufficient reporting on critical issues of WQM. The concern was that it could jeopardise the high standing that the country's water sector enjoyed in the international arena.[1948] It also posed a threat to basic conditions of sound community health.

In February 2008, the country's 2001 census statistics were updated and it was established that the South African population had reached 49.5 million people. The DWAF's annual report indicated that in terms of water supply 95% of the population had access to drinking water – up from 59% in 1994. At the same time, 75% of the population now had access to sanitation – up 49% from in 1994.[1949] The water services programme of the DWAF had R18bn at its disposal. The department's management worked in collaboration with the departments of provincial and local government and education to ensure that services reached the population.[1950]

Regional implementation developments

The DWAF's chief directorate for regional implementation's so-called 'Programme 5' was formidable. The programme had three main aims. It had to see to it that the management of water in the various catchment areas was effective and efficient. There had to be sufficient financial resources and support. In addition, there had to be functional, direct support to promote and manage the implementation of efficient water services infrastructure. The directorate supported local government to promote equitable and sustainable water supply and sanitation for all people in South Africa. The responsibility lay with the regional offices to establish effective relations between provincial and local government, as well as stakeholders in other regions.

In 2000, Programme 5 was responsible for 69% of the department's approved posts and 67% of its allocated budget.[1951] It supported and coordinated the regional offices, and its officials engaged with the provincial governments and coordinated activities. The directorate was responsible for the regular meetings of the minister and the provincial MECs (MINMEC), as well as the

1948. Venter (2005:n.p.).

1949. RP246/2008 (2008:54–56); Tissington (2011:14).

1950. RP246/2008 (2008:54).

1951. RP101/2000 (2000:49).

MINMEC technical committee. Bilateral provincial liaison committees addressed local coordination issues and in turn fed that information into the MINMEC.

By 2002 it became clear that the regional offices were not making progress in the field of water supply and sanitation infrastructure. Technically, they were supposed to interact at grassroots level with the CWSS programme. The main problem was a lack of cooperation from stakeholders and this hampered the process of securing revenue for maintaining the services. It caused endless delays, and eventually the matter was discussed at the ministerial level. Subsequently, a special intervention programme was introduced. In some cases, the full allocations of departmental funds had been used to ensure service delivery. Given the fact that in the northern areas of South Africa there was a growing problem of cholera because of open borders, several initiatives were taken to address the issue of sanitation in 2001 to 2002. The regional offices were instrumental in lifting the profile of sanitation within the programme for CWSS. Several management plans were tabled on speeding up toilet construction, and many were successful in the implementation phase.[1952]

By 2003, the team responsible for the transfer of water and sanitation infrastructure from DWAF to the local authorities comprised representatives of the DWAF, National Treasury, the Department of Provincial and Local Government (DPLG) and the SALGA. The delays had significant financial ramifications. Infrastructure could not be maintained and the accumulated backlog on work to be done was estimated at R710m.[1953]

In 2004, much of the funding for the regional offices was transferred to the municipal infrastructure grant (MIG) funding, operated by the DPLG. This meant that the DWAF's regional offices only had a small capital budget and some donor funding for institutional support to WSAs and providers. Among the beneficiaries of departmental support was Emfuleni local municipality in southern Gauteng, which received R130m for the improvement of water and sanitation infrastructure. For the rest, DWAF collaborated with SALGA, DPLG and the National Treasury to transfer funding and service to the regional levels of local government.[1954]

One of the major breakthroughs at DWAF's regional level was the implementation of the Water Use and Authorisation Management System (WARMS) and the Systems, Application and Products software in data processing.[1955] In 2001 to 2002 the regional offices were responsible for capturing

1952. RP73/2002 (2002:62).

1953. Department of Water Affairs and Forestry (n.d.a:8); Parliamentary Monitoring Group (2003b:n.p.).

1954. RP130/2005 (2005:59).

1955. The project's first terms of reference report was completed in 1998; cf. SAWHAR AHCA9/001 (1998:732–733).

data for more than 4600 water users in all nine provinces. The accomplishment of registering and incorporating about 80% of the country's water consumption in this manner made South Africa one of the first countries in the world to secure information on water use by consumers at the property level.[1956]

It was possible by the end of the financial year 2002–2003 to send out 52 000 invoices and secure revenue totalling R46.4m from service delivery for the department's water resources.[1957] By 2008, WARMS made it possible to report that in 14 of the country's 19 water management areas there had been an increase in water consumption, with the highest increase registered in the Crocodile–Marico (2.9%), Luvuvhu–Letaba (2.6%), Usutu–Mhlatuze (7.7%) and Tugela (2%). There were indications that in the Berg and Inkomati areas, domestic and industrial water consumption had decreased by 34.6% and 24.6% respectively, while water consumption had increased in Limpopo (37.7%), Luvuvhu–Letaba (19%), Tugela (18%), and Usuthu–Mhlatuze (121%). Irrigation consumption had gone up overall by 20%, specifically in the Usutu–Mhlatuze region.[1958]

Meanwhile, the DWAF's provincial sector was engaged in a regional implementation programme to coordinate all activities in the regions. Head office provided guidance and support to coordinate all trading accounts in the regions. At the same time, there was overall guidance in the planning, management, support and control of the implementation of policy and water resources management, corporate services and monitoring programmes.

The programme made it possible to coordinate survey services by collecting data and distributing the information for processing. Included were topographical surveys; hydrological surveys of dams; setting up flood, silt and servitude beacons; and surveying and monitoring developments in catchments. In the field of hydrometry, regional offices were responsible for determining the quality and quantity of surface and groundwater available in the catchment. This involved capturing hydrological data at gauging stations and then processing and storing the data on an information data system that reported on the quantity and the quality of both surface and groundwater.

Water drilling services, a technological innovation that had been fashionable in the first half of the 20th century, made a comeback in the 21st century. It now acquired a new meaning in the department's efforts to make use of groundwater to meet the ever-growing demand for more water supplies, especially in the rural and arid regions of the country. The geotechnical drilling services continued to collect data for planning and the design of water infrastructure in terms of dam safety and geological mapping. Geotechnical experts in the regional offices made assessments of groundwater resources.

1956. RP73/2002 (2002:62).

1957. Department of Water Affairs and Forestry (n.d.a:57).

1958. RP246/2008 (2008:30–31).

In addition, they provided important information on monitoring groundwater resources for traces of solid waste disposal in some areas.[1959]

From 2003 to 2005 the department's water resources planners, in collaboration with a consortium of consultants, completed a quantification of groundwater resources at quaternary catchment level. Advanced investigations by the mid-2000s suggested that South Africa had the potential for as much as 10 300 MCM/a. Given the increasing demand for more water, the country's groundwater was bound to become an even more valued source of supply.[1960] The regional offices continued their advisory services, making contributions to regional water services planning, driving RDP projects in the various regions and overseeing sustainable development management in terms of community development, capacity building, and training communities for water supply and sanitation projects.[1961]

By 2000, the Northern Cape region, which had started from scratch, had conducted pilot studies on water services planning for 14 local authorities and six district councils. The department funded these to the sum of R1.2m. Complete status quo and five-year plans had been developed for six district municipalities and 17 local municipalities. A further 13 status quo plans were received, bringing the total completed to 36.[1962] In one of the most populous regions, Gauteng, by 2000 there was an abundance of water supplies after good rains.[1963] In addition, the Lesotho Highlands scheme delivered as much as 540 MCM annually to the regional bulk utility Rand Water, supplying water to local authorities, industries, as well as the strategic energy sector's Sasol and Eskom (re-branded from 'Escom' in 1987).[1964]

As it was situated in one of the more underdeveloped regions of South Africa, the Eastern Cape office was engaged in completing 10 projects in 1999 to 2000 to secure water supplies for 1.2 million people.[1965] In the space of a year the staff completed inspections of 60 state dams. Meanwhile, in Mpumalanga, the regional office was instrumental in securing 90 MCM of water supplies for 2.4 million people and about 1.28 MCM from boreholes and small electrical pump stations to people in rural areas. The Free State regional office spent R18.2m on 17 water services projects. The office also began the registration of water users in the Orange–Riet, Sand–Vet and Gariep Dam government water schemes. In the case of KwaZulu-Natal, the regional office worked primarily in the rural areas. By 2000 they were busy with 96 potable water projects and 31

1959. RP73/2002 (2002:63).

1960. Braune, Adams and Fourie (2014:9–11).

1961. RP73/2002 (2002:64).

1962. RP101/2000 (2000:51).

1963. SAWHAR AHCA5/022 (2000:54).

1964. RP101/2000 (2000:54).

1965. RP101/2000 (2000:56, 58).

for sanitation purposes. The staff consulted with stakeholders in at least 30 liaison forums in the province.[1966]

In North West, the regional office had plans to spend R18m on three new rural water supply projects at Magalies Water, North West Water and Goudveld Water. There was also a concerted drive to promote DWAF's '2020 Vision' water education initiative at schools in the province, in respect of water conservation.[1967] In the Western Cape region, by 2000 a number of new forums had been created while some older forums were re-established with a view to the establishment of catchment management agencies (CMAs).[1968] In Limpopo (previously Northern Province) initiatives were launched to start water services planning towards the establishment of a number of multi-purpose community services.[1969]

Regional consolidation into four clusters

Significant institutional changes took place in the regions. In 2003, the nine regions of the DWAF were subdivided into four clusters. The southern cluster comprised the Eastern and Western Cape; the eastern cluster included KwaZulu-Natal and Mpumalanga; while the central cluster comprised the Free State, Northern Cape, Gauteng and North West provinces. Limpopo was on its own in the northern cluster. In justifying these changes the annual report merely disclosed that the key requirement for the regional offices was to establish effective relations with provincial and local authorities and other stakeholders. It added that there was a good relationship in most regions between stakeholders. Provincial liaison committees operated as official forums in provinces where matters of mutual interest were discussed. Officials of the DWAF's national office participated in many of these meetings and in some cases, MECs participated in provincial legislature committees.[1970]

By 2008, the water services programme included the sub-programmes of provisioning policies; water and sanitation services; water sector policies; water and sanitation services; water sector support; the transfer of functions; African initiatives; African participation; the operations of water services; and water services administration.[1971] By this time 97% of the targeted schemes scheduled for water services at the local level had already been transferred, and the remaining 3% were awaiting imminent transfer.

1966. RP101/2000 (2000:62–65).

1967. RP101/2000 (2000:66–67).

1968. RP101/2000 (2000:69).

1969. RP101/2000 (2000:72).

1970. Department of Water Affairs and Forestry (n.d.a:55).

1971. RP246/2008 (2008:54).

In 2008, the DWAF acquired the new responsibility of implementing the regional bulk infrastructure programme. A dedicated fund was to be used to make bulk water and sanitation services available. The role of the department was to facilitate integrated planning and the implementation of multi-institutional regional bulk services; all stakeholders were to be encouraged to participate. An amount of R1.4bn had been set aside for use over a three-year period, and R300m was made available to start up the programme in 2007 to 2008. In the course of the year the department began interacting with the DPLG, the treasury and SALGA by initiating 31 projects, while 50 other projects were identified for feasibility studies.[1972]

In 2008 the Masimbambane project, supported by EU funding, was revived again. There was now a third phase of development, with the theme 'Water for growth and development', focusing on water for services and resources. This shifted the emphasis from basic services in an effort to promote economic development. However, by the end of the 2007–2008 financial year no money had yet been received from the European Union, while more than R280m had been spent, so the amount had to be earmarked as over-expenditure.[1973]

There were a number of challenges in the programme, including the alignment of service delivery plans between government departments. Furthermore, there was a shortfall of essential data required for planning development, and fragmented and misaligned reporting on monitoring programmes sent out contradictory messages on service delivery. Nor did the problems end there. Starting up the 'Water for growth' programme was suspended because there were no stakeholders to engage. However, close collaboration remained in place between the water service providers and the responsible coordinating departmental unit.[1974]

Water resources governance

In 2000 the chief directorate of planning's primary functions included:

- planning water resources management and development options to sustain the socio-economic wellbeing of the country's people
- providing guidelines for regional water resources management and development
- assessing the need to adapt or change departmental strategies and policies in the context of the dynamic environment in which the department operated
- helping the department to develop and maintain information systems and supply IT infrastructure.[1975]

1972. RP246/2008 (2008:65).

1973. RP246/2008 (2008:122).

1974. RP246/2008 (2008:69).

1975. RP101/2000 (2000:23).

The information systems division was later removed from the directorate. It was outsourced in 1999 because of difficulties experienced in retaining IT specialists in the service of the department. In terms of its business plan for 2000 to 2001 the department made use of 'a cadre of contractors, supervised and overseen by a small number of departmental staff members.[1976]

Catchment Management Agency developments

As early as 1996, expert groups of legal, engineering and management specialists were hard at work in preparing for South Africa's new water legislation. There were several reports, one of which dealt with integrated catchment management and how it coincided with sustainable development and water resource management.[1977] The *National Water Act* of 1998 provided for a new dispensation, in which all aspects related to the management of the country's water resources would be done in consultation with water users and interested parties. The *Water Act* provided for the fundamental transformation in all institutional management systems, specifically in matters related to service delivery and representivity.[1978]

In the spirit of one of the internationally most advanced pieces of water legislation, the understanding was that the DWAF would progressively transfer authority and powers to regional and local water management institutions, such as water user CMAs, WUAs, advisory committees, and institutions for infrastructure development and management.[1979] The new legislation started to move away from command and control management strategies. Instead, the ideal was to seek strategies for integrated catchment management. The environmental science understanding of sustainability was foremost in the minds of the planners of the new legislation.[1980]

The department would also stand in for international relations on matters related to the country's role in the southern African transboundary water management system, until such time as appropriate regional authorities were established to take care of the governance and management of the water governance and management responsibilities. The ideal was the establishment of river basin commissions that would foster dialogue between countries in the southern African region for the cohesive and effective cooperative management and utilisation of shared water resources.

1976. Department of Water Affairs and Foresty (2000b:19).

1977. Department of Water Affairs and Forestry and Water Research Commission (1996:8).

1978. Department of Water Affairs and Forestry (2004a:91).

1979. Department of Water Affairs and Forestry (2004a:92–98).

1980. Department of Water Affairs and Forestry and Water Research Commission (1996:8–10).

Source: Department of Water and Sanitation (*c.* 2014).

FIGURE 13.2: The 19 future regions of the catchment management agencies envisaged for South Africa in 1999.

In October 1999 the government gave notice in the Government Gazette that it would establish 19 water management areas (please see Figure 13.2). Their boundaries would be along the lines of the scientifically determined water catchment systems.

The first response to the proposed classification system came from the scientific fraternity, where environmental scientists, working in the field of catchments and river systems, warned that governance authorities should be careful not to repeat a command and control system of water governance.[1981] It would not be in the interests of adaptive resource management. Instead, attention should be given to learning from doing. In addition, the environmental scientists accentuated the need for greater knowledge on the variety of catchments that had been demarcated, and argued that priority should be given to an adaptive and generative management system, with strategic adaptive management as the desired system.

1981. Rogers, Roux and Biggs (2000)

By 2006 it was evident that the complexity of a broad spectrum of potential stakeholders could complicate the establishment of CMAs. Apart from the CMA functioning in concert with traditional leadership, the catchment forum and the water users' authority, there were numerous stakeholders at the level of local government who had to be incorporated into the system.[1982]

The Inkomati catchment management agency was the first to be established, in 2005.[1983] The following year the governing board and chief executive officer were appointed, and the minister received the first business plan for the CMA in 2006. The CMA's stakeholders were a comprehensive array of people and institutions, and included representatives from the established commercial farming sector, new farmers, the mining sector, the power generation industry, civil society and SALGA, as well as the offices of the premiers of Mpumalanga and Limpopo.[1984] This wide range of stakeholders was compliant with the recommendations of leading thinkers on CMAs at the time.[1985]

At the time there were plans to start a CMA for the Crocodile West–Marico catchment, in conjunction with North West Province. It transpired that the establishment of CMAs in the Vaal River system would take somewhat longer. The river had been divided into Upper, Middle and Lower CMA regions. Nine of the envisaged 13 forums of the proposed CMA had been established. A structure was also in the process of coordinating the forums and management activities in the three sub-catchments to facilitate the creation of a single CMA. The annual report from Gauteng region stated, 'Because this catchment is so complex, this will take longer than the process envisaged for the Crocodile/Marico water management area.'[1986]

Up to 2007 there was a cavalier initiative in the Western Cape for the establishment of what was considered to be the crucially important Berg River CMA. A proposal was submitted to the DWAF, which was accepted by the responsible cabinet minister in October 2007.[1987] However, in the corridors of political power and environmental science, the process appears to have been stalled. Almost a decade later, in February 2016, a *Government Gazette* gave notice that a proposal for the establishment of

1982. Mazibuko and Pegram (2006)

1983. RP130/2005 (2005:6).

1984. RP130/2005 (2005:6, 12); RP166/2006 (2006:30).

1985. Pollard and Du Toit (2008:671–679).

1986. Pollard and Du Toit (2008:671–679).

1987. Department Water Affairs and Forestry (2007).

the Berg–Olifants CMA was open for public scrutiny.[1988] That was a year before plans were afoot in the DWS for scrapping all plans for a multitude of CMAs. Instead, by the end of 2017 government was intent on establishment of a single CMA in South Africa![1989]

In a 2009 philosophical treatise aimed at creating an enabling learning environment, three water sector experts pointed to some of the problems experienced in the establishment of CMAs. These included:

- an exponential growth of information, its availability and an increasing interdependence among the community of practice working on the management, science and technology of CMAs
- limited local resources and scientific development
- indications of a decline of science and engineering expertise in the department, along with the lack of a cohesive interface between science and government.

There was also a shortage of graduates equipped to work in the field. Environmental attitudes and ethics were not focused on the natural environment in which the CMAs had to operate. In addition, there were problems with the practical implementation of the NWA. Internally, both in the existing institutions and in those that were still in the process of being established, there appeared to be a lack of history. The managers still relied on the DWAF for guidance. There was a lack of inspirational leadership, and operating systems were not yet in place.[1990] It was against this backdrop that the treatise aimed to promote principles of adaptability, informed action, receptiveness and responsiveness.

The inability of the department to start the cumbersome, but vitally important process of establishing catchment-based regional water governance in South Africa, did not augur well for planning strategies aimed at introducing adaptive management for the country's scarce water resources in the era of climate change.

National Water Resource Strategy 2004

Because of the introduction of the new *National Water Act* in 1998, the strategic planning directorate worked on plans for the new NWRS. A policy implementation task team (PITT) was established shortly after the passing of the *Water Act,* to provide the detail of what had been broadly outlined in the legislation. The core members of the team were, Piet Pretorius, James Perkins, Willie Enright, Henk van Vliet, Heather MacKay and Alison Howman.[1991]

1988. Department of Water and Sanitation (2016b).

1989. Department of Water and Sanitation (2017).

1990. Roux, Murray and Van Wyk (2009:2–3).

1991. De Coning and Sherwill (2003:27–28); Department of Water Affairs and Forestry (2002).

The PITT's membership varied. Depending on the type of expertise required, consultants or researchers would be brought into the group. But the core members were mostly in management positions in the department, or at the WRC, as was the case with Heather MacKay. Some had many years of experience in the department, while there were also members who moved into management in the 1990s.

A first draft issue of the NWRS appeared in 2002,[1992] followed by the final edition in 2004. This was scheduled to become a formal document outlining how the Minister of Water Affairs intended to manage the country's water resources over the next five years.[1993] The NWRS 2004 was a comprehensive document, which required extensive assessment.[1994] More than 800 meetings were held and the process of participatory activities generated almost 2000 formal written comments.[1995] The final document was in line with government policy planning, based on extensive participatory activities and stakeholder consultations. It outlined how the DWAF would protect, use, develop, conserve, manage and control water resources. In the process of its compilation it was necessary to use a variety of strategies for securing information from stakeholders.[1996] The NWRS's projections were aimed at extending over a period of 20 years.[1997]

The NWRS 2004, compiled in five chapters, outlined:

- water policy, water law and the management of the country's water resources
- the available water supply and some anticipated water demand issues in the various catchment areas in the country
- strategies for water resources management to make the management system compliant with the existing legislation
- complementary strategies that could be used for building capacity in the water sector
- the need for national and international planning and coordination at various levels of government.

The 2004 edition of the NWRS focused on the progressive decentralisation of the responsibility and the authority for water resources management at the catchment level. The understanding was that the department would loosen itself increasingly from operating, developing and regulating the resources.

1992. De Coning and Sherwill (2003:29).

1993. The first version of the NWRS was published in 2004.

1994. PMG (2003a).

1995. Department of Water Affairs and Forestry (n.d.a:7).

1996. Maharaj and Pietersen (2004:125–132).

1997. RP130/2005 (2005:6).

In the process, the DWAF was scheduled to become a locality for policy making, a regulator of the country's water resources and also a monitor.[1998]

Within the department per se, the DWAF was playing by the book, but there were concerns about the location of control in decentralised systems. In their 2003 article, Galvin and Habib examine the local water sector at the level of governance and discuss the need for decentralisation. It was evident that government and the donor community favoured decentralisation at the level of local governance. In reality, the authors contend, decentralisation was more relevant at a central state (departmental) level, which, they allege, had little concern for the local needs of communities, and focused instead on the state.[1999] The NWRS only tended to give marginal attention to the issue, in the interest of securing support in rural areas where local authorities were weak.

Behind the scenes a great deal of work had gone into the NWRS 2004. Well before the first draft issue of 2002, work had started on several national studies. These included an economic study of assessing each management area and arriving at indicators of economic growth, and the development of computer-based models to assess the balance between water needs and available resources throughout the country.[2000]

Some key studies began at the catchment level. These included an analysis using the updated Vaal River system which showed that the system yielded far less than was previously estimated, and a study to form an understanding of the current irrigation water used throughout the Vaal River catchment.[2001]

The management of the Vaal River system soon had more up to date data at its disposal. In view of the new statistical information at the managers' disposal for the period (1920–1989) they predicted a significant undersupply of water in the Vaal River. Water affairs minister, Ronnie Kasrils, issued a sombre message to the media. He warned that it might be necessary to take precautionary measures to prevent a repeat of lapses in the Vaal River system's water supply, reminiscent of the 1980s drought period. The department's strategic managers recommended a further augmentation of the Vaal River system's water supply by 2005 – instead of the original 2016 date set for the LHWP update.[2002]

The concerns of the ministry proved to be premature. Preparations for Phase 2 of the LHWP gained momentum on the originally scheduled time.

1998. Department of Water Affairs and Forestry (2004b:i–iii).

1999. Galvin and Habib (2003:865–884).

2000. RP101/2000 (2000:25).

2001. It appears as if the preliminary findings of a more comprehensive report of 2002 sparked off the concerns. See Directorate of Water Resources Planning (2002b).

2002. Department of Water Affairs and Forestry (2000a:1–2).

In the case of the Breede River in the Western Cape, a study of 2002 reported on one of the few river systems in the province that had not yet been fully developed.[2003] Part of the study included a strategy to determine what part of the existing catchment's supply could be transferred to the Cape Metropolitan area. In the Eastern Cape there was an investigation into the Umtata River to see how existing facilities would ensure that water be provided to the city of Umtata (Mthatha) in the face of an increasing demand for water from upstream forestry operations. In Pondoland there was a study of the coastal catchments, particularly at Lusikisiki and the surrounding areas.[2004]

On the international front, a transboundary Limpopo monitoring study, conducted in conjunction with Botswana, Zimbabwe and Mozambique, featured a mathematical rainfall run-off model which included alluvial aquifer and river loss models. [2005] There was consensus that the Limpopo River was better understood than before and the Limpopo Basin Permanent Technical Committee approved the results of the comprehensive study.

Furthermore, there were ongoing deliberations between South Africa and Swaziland about using the water catchments shared by the two countries. South Africa also entered negotiations with Mozambique on the way the Maputo basin could be used. Some of the preparatory work had been completed on the project, paving the way for further deliberations between the two states.[2006]

River health programme studies

In the field of ecological research, several studies were launched to determine how the country's water resources could be used in a sustainable manner. Between 1998 and 2005, as many as 13 river systems in South Africa had been assessed in terms of the department's river health programme.[2007] In the case of the Nyl River floodplain a hydrological model was developed to determine how the flow conditions operated. The rainfall model was calibrated further while the hydraulic model was still under development. In the case of the Olifants River, a project was launched to determine the quality and quantity of the supply in the system. A comprehensive public participation project was set up to ensure that all stakeholders could participate and help determine the present ecological state of the river.

Work began on an evaluation of the Agricultural Catchments' Research Unit (ACRU) model to determine the reserve. The model was originally developed

2003. Directorate of Water Resources Planning (2002a).

2004. RP101/2000 (2000:25).

2005. Directorate of Water Resources Planning (2003a:1-1–1-2).

2006. RP101/2000 (2000:26).

2007. RP130/2005 (2005:28).

in KwaZulu-Natal in the 1970s by the University of Natal.[2008] In the new millennium, the ACRU model was put to the test to see if it could be used to simulate natural or pristine flow conditions from basic inputs, or even simulate the effects of land use changes and hydrology.[2009]

The Sabie River catchment was under investigation to determine the real-time rules for the operation of the Inyaka Dam. The data generated was intended to prepare the way for all sectors that relied on the water supply to deliberate on the way it would be used in future. In a research article by leading water scientists on water monitoring in the Sabie River catchment, it was evident that there was a new focus in the field of water catchment studies and biophysical phenomena. What was required, the authors argued, was to combine existing knowledge with new data and then start filling up gaps in the evolving field of catchment knowledge.[2010]

By 2000 there had also been good progress in determining how the ecological reserve extrapolation method would operate in all the rivers of South Africa. The objective was to determine the first order appropriation of the quantity components at the desktop estimate level (Level 1) and the rapid determination level (Level 2).[2011]

DWAF data systems and security

The NWRS 2004 required reliable data and also the certainty of sound designs in the system. The first thorough investigation into the department's datasets started in 1999 when the department took steps to safeguard the country's entire water sector against anticipated Year 2000 (Y2K) computer failures. In the process, the DWAF maintained a scrutiny of 834 identified local authorities, 18 water boards and several sewage companies.[2012] The government, well in advance, set up a national year 2000 decision support centre and all departments were expected to participate in regular meetings and send monthly reports to the support centre. The DWAF's participation was exemplary.[2013] The argument was that if the department stepped out of line, it could be held responsible in the event of something going wrong.[2014] Ultimately, the Y2K was an 'uneventful millennium roll-over,' according to the IT experts.

2008. SA Water Bulletin (1997:25–27). Centre for Water Resources Research (n.d.).

2009. RP101/2000 (2000:26).

2010. Van Wyk, Van Wilgen and Roux (2001:349–356).

2011. RP101/2000 (2000:26).

2012. RP101/2000 (2000:29).

2013. SAWHAR AHCA2/0149 (1999).

2014. Three comprehensive files in the Alan Conley Collection of SAWHAR, testifies to the meticulous manner in which the department had taken steps to be proactive on a potential Y2K network crash.

The DWAF's integrated water quality information system was enhanced by 2000. The system had been extended to the Western Cape regional office in the previous year, and was expanded to include all water sample analyses on a downsized database at a substantially lower cost. One of the findings of the investigation was that the water quality data could be placed on both the intranet and internet, making it possible for the public to have access to information. The system was developed to conform with sound standards for the architecture of a durable database. Meanwhile, the water management system of the department was also put to the test, and was found to be of a sound quality. DWAF's service operators developed the WARMS, which was scheduled to play a key role in the licensing of water users under the new *Water Act*.[2015]

At the time GIS became mainstream and its use was evident in engineering and scientific procedures. It made new methods possible for creating hydrologically correct digital elevation models. These were put to the test on a 1:50 000 mapping system and a preliminary model was developed of the Vaal Dam catchment area. Associated programmes were developed to a stage where they could generate the geographic and flow information for the calibration of a new river forecast model, developed jointly with the United States weather bureau and DWAF's hydrology directorate. With the new technologies it was becoming far easier to work efficiently and with greater accuracy, and the DWAF mentioned in its annual report for 2000–2001 that soon the national water balance model would be ready.[2016]

In that same year (2000) the DWAF's chief directorate comprised the directorates of civil design, design services, mechanical and electrical engineering and construction. In 1999 to 2000 the chief directorate worked at giving substance to the RDP, specifically in the promotion of labour-intensive methods for the construction of bulk water supply schemes, and in promoting small to medium enterprises and micro-enterprises in the implementation of bulk water schemes. The directorate designed, built and/or supervised 12 projects, of which the Qedusizi Dam was perhaps the most significant, having won accolades from SAICE, which described the project as one of 'technical excellence'. A unique feature of the dam was that it was supposed to remain empty for the greater part of every year and then, at a time of high rainfall would be able to store sufficient water to prevent flooding in the town of Ladysmith in KwaZulu-Natal.[2017] In the longer term (about 30 years) the planners were of the view that it would become a water storage dam in the Tugela system.[2018] But then, the

2015. RP101/2000 (2000:29).

2016. RP101/2000 (2000:30).

2017. RP101/2000 (2000:31–32); SAWHAR ITC/DWS(d) (n.d.a); Construction World (1996); The Civil Engineering and Building Contractor (1998:91).

2018. SAWHAR AHCA7/003 (1996:40).

directorate had also excelled in maintaining dam safety, having visited 33 dams and executed inspections and advanced hydraulic studies on these facilities.[2019]

International projects and infrastructure planning

Apart from dealing with the water projects South Africa had with Lesotho and Swaziland, the chief directorate also created a directorate for international liaison in 1999 to 2000. This directorate was active in the context of the SADC and secured assistance from the dam safety directorate. In this committee, plans were made to coordinate the activities of the department internationally. It was also responsible for the coordination of assistance for the department from donors and coordinating the policies of those donors. Furthermore, the committee facilitated a donor assistance and coordinating committee and arranged for annual meetings where donors could meet the minister. The directorate facilitated the responsibility for the department's financial commitments to the Komati Basin project (KOBWA) and monitored and advised on the formulation of a resettlement development plan for the Maguga Dam in Swaziland.[2020]

In time, the dam project became a noteworthy symbol of cooperation between South Africa and Swaziland. The construction project, which in 2002 was estimated at R1bn, became a dam with a gross storage capacity of 332 MCM, extending over a surface area of 1042 ha. Apart from securing irrigation opportunities for rural farmers, the scheme created opportunities for sophisticated water transfer management in the Inkomati catchment in South Africa, Swaziland and Mozambique.[2021]

Changing role of the Trans-Caledon Tunnel Authority

The activities of the TCTA, the body responsible for the management of funding and engaging with the Lesotho authorities on the LHWP, were somewhat redirected by government under the *National Water Act* of 1998, when, in terms of Government Notice No. 27 of 2000, the Minister of Water Affairs and Forestry directed the TCTA to perform services outside the scope of the LHWP's jurisdiction.

However, in 2001 the TCTA took over the treasury functions of Umgeni Water and the following year it stood at the helm of the Berg Water Project, scheduled for augmenting the water supply system of the Western Cape. In terms of an agreement signed between the DWAF, the City of Cape Town and the TCTA, raw water was to be provided for Cape Town. The planning of the project began in 1989, with a view to providing solutions to the increasing

2019. RP101/2000 (2000:31).

2020. RP101/2000 (2000:35).

2021. The Civil Engineering Contractor (2002:34–36).

scarcity of water resources experienced by the city and water consumers in the Cape Peninsula.

The Berg River Dam, the pinnacle of a comprehensive project, was scheduled to provide 18% of the water needs (523 MCM/a) of the Western Cape by the year 2007. In 2002, the TCTA received instructions from government to fund and implement the project as the agent of DWAF.[2022]

Furthermore, in 2004 the TCTA was granted a mandate to perform treasury and financial services for the Umgeni Water Board. This meant that the TCTA's role had changed from an interventionist strategy under instructions of the government, to a formalised process of capacity building and strategic oversight.[2023]

The TCTA was versatile, being in a perfect position to provide similar services to other water boards, water management institutions and the DWAF. On 26 November 2004, the TCTA received the mandate to implement the Vaal River eastern sub-system augmentation scheme supporting the operations of Eskom and Sasol in Mpumalanga. The project featured a water pipeline of about 120 km, from the Vaal Dam to Secunda, and was estimated to cost in the vicinity of R2.2bn upon completion.[2024]

In the same year the cabinet appointed the TCTA to advise it on funding options for Phase 2 of the Olifants River Water Resource Development Project. The project included the construction of the De Hoop Dam on the Steelpoort River and a comprehensive bulk raw water distribution system.[2025] Developments of this nature positioned the TCTA to become an important part of the emergent infrastructure development branch of DWAF.[2026] It had built up a reputation as a highly respected organisation with substantial international credibility.

Scientific services

The DWAF's chief directorate of scientific services proved its worth at the time of the severe Domoina-related floods of 06 February to 09 February 2000, which were said to have caused damage of more than R30m. The chief directorate, working through the flood office, was instrumental in the management of water, avoiding further damage to property and human lives by opening and closing sluices in time. It also provided daily hydrological reports to the Mozambican authorities. However, the impact of the floods

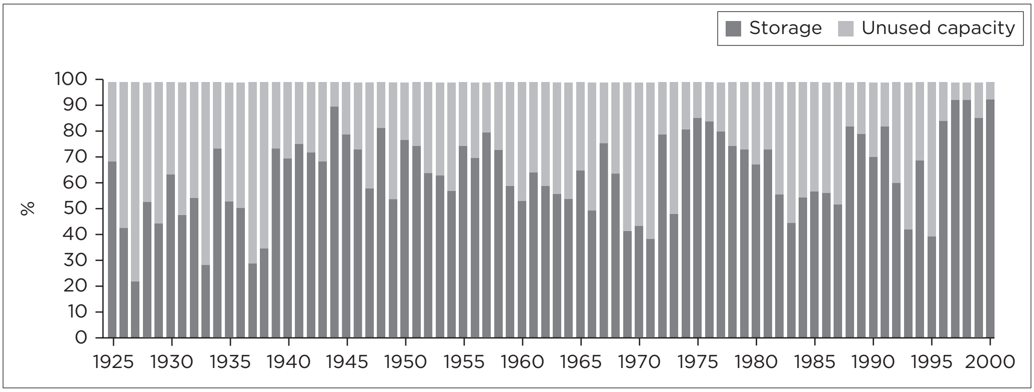
2022. TCTA (2006:55).

2023. TCTA (2004:77).

2024. TCTA (2005:9–10, 88–95).

2025. TCTA (2005:10).

2026. SAWHAR ITC/DWS(d) (n.d.b:1–8); RP130/2005 (2005:12); RP166/2006 (2006:12).



Source: RP101/2000 (2000:39).

FIGURE 13.3: The historical storage of South Africa reservoirs confirmed that 2000 was a year of sufficient water supplies in the country.

remained vast; many of the department's monitoring stations had been damaged and the researchers foresaw that it would take several years for the system to be restored.[2027]

One of the valuable research outcomes was an impressive and accessible web-based report on the flood damage of 2000 in the province of Mpumalanga and parts of Limpopo.[2028] By 2002 there was still post-flood repair work to do and in the case of Mpumalanga, the regional office formed part of the repair team responsible for water services infrastructure. A sum of R176m was spent on repairing damaged water infrastructure and it was estimated that ultimately at least R129m was required to pay for repairs.[2029]

The flood event created greater collaboration on data sharing. One such platform was the Southern African Development Community Hydrological Cycle Observing System (SADC/HYCOS). DWAF's flood management system, which previously only worked on the comprehensive Orange River system, now also included smaller catchments.[2030] The shift from a macro to micro-focus was beneficial. In the process SADC/HYCOS was able to help Zimbabwe, Malawi, Swaziland, and Lesotho to install, operate, and maintain data collection platforms in various catchments. The new system added at least 50 data collection points from which researchers could monitor the hydrology of southern Africa.

Scientific services helped in the formulation of the system for managing water authorisations (licences) and registration (Figure 13.3). The final system for administration, the scientists foresaw, would be like a water use 'ATM', enabling

2027. RP101/2000 (2000:37).

2028. Department of Water Affairs and Forestry (n.d.c).

2029. RP73/2002 (2002:63).

2030. RP101/2000 (2000:38).

water users to pay their accounts, apply for water use, register and de-register water, transfer water from one property to another and secure statements for outstanding charges. The system entailed developing a database with the necessary security and validation controls that conformed to departmental standards and incorporated an audit trail on all data fields. System users would be tracked and they could also control transactions. Overall, the system was intended to be user-friendly and accessible online. A guide for using the system was available in several official languages and was supported by the computer systems in the regional offices of the department.[2031]

In the field of geohydrology, in 2000 the scientists of the department were still busy with the national groundwater information system.[2032] Two of the nine regions had implemented a pilot version of the system developed with the Tegnologie Navorsings Organisatie of the Netherlands. Pilot working groups were established in four areas. Guidelines were set up for establishing regional and local networks for groundwater monitoring. Nine of 23 maps, as well as the first four accompanying brochures, were printed in the period 1999 to 2000.[2033]

At a November 2000 workshop, the geohydrology directorate's researchers and officials reflected on progress made since 1995. There was consensus that the management objectives for groundwater had changed significantly from bulk water supply, to using groundwater as a significant component of IWRM.[2034]

In the field of social ecological services, it was evident that the environment was beginning to be accorded the appropriate attention in terms of developing dam sites for recreational use. There were details of a priority list of South African estuaries, with a health index that measured their importance and sensitivity. A draft standard environmental management and rehabilitation specification manual had been completed. There was a further draft rehabilitation action plan, as well as a draft consolidated environmental implementation and management plan prepared for the department.[2035]

Another exemplary project was the research conducted on the Nandoni Dam near Thohoyandou in Limpopo before construction work began in the 2004 to 2005 period.[2036] Scientific services worked on the site, making contributions to:

- the methodologies for determining the ecological reserve
- the establishment of national priorities for scheduling activities

2031. RP101/2000 (2000:38).

2032. SAWHAR AHCA9/014 (1999).

2033. RP101/2000 (2000:40).

2034. Braune (2000:1–8).

2035. RP101/2000 (2000:40).

2036. Van Riet and Louw Landscape Architects (2003:6); Directorate of Water Resources Planning (2003b); RP130/2005 (2005:6).

- the creation of structures to coordinate and allocate limited resources
- the strengthening the institutions responsible for maintaining and observing the ecological reserve.[2037]

Partly as a result of the cholera outbreak of 2000 to 2001, the DWAF's section for WQM completed inorganic, organic, toxicity bio-assay and microbiological analyses on 35 000 water samples in 1999 to 2000.[2038] In the same period, the DWAF, in collaboration with the Danish government's environmental aid agency (DANCED),[2039] funded an important first report on local government, especially in informal and new settlements in an era of rapid urban development. The first study reported on the links between pollution, community perceptions and local government capacity in dealing with issues of WQM.[2040]

Working for Water

The chief directorate for water use and conservation had under its supervision the directorates for water conservation, WQM, water utilisation, and catchment management. One of its main responsibilities was to take overall responsibility for the Working for Water (WfW) project.[2041] WfW was established in September 1995 with RDP funds, as a water conservation measure in water catchment areas with exotic forests. It had a strong research focus, aiming to determine how to deal with plantations in sensitive catchments. WfW also focused closely on the problem of rural unemployment in South Africa. With this in mind, it used the services of unemployed people in the country's rural areas,[2042] and by 2002, an impressive 226 400 ha of land had reportedly been cleared of exotic growth. The WfW also revisited the 285 000 ha that had been cleared of alien vegetation previously. In 2001 to 2002 the initiative created temporary job opportunities for about 17 000 people.[2043]

A cost-benefit analysis of the WfW programme in the Eastern Cape in 2004, suggested that some parts were ineffective. More work had to be done on non-water benefits and, at lower discount rates, the project could be run more efficiently. However, by 2006 WfW had had cleared more than 674 000 ha of land by removing alien invasive species. In the course of the year the project had spent R416.743m and 29 470 people had benefited directly from the creation of 11150 job opportunities.[2044]

2037. RP101/2000 (2000:38).

2038. RP101/2000 (2000:41).

2039. SAWHAR WLC C2316d (1998:3).

2040. Department of Water Affairs and Forestry (2001:1); SA Water Bulletin (2001:1).

2041. RP101/2000 (2000:42).

2042. SAWHAR AHCA16/136 (1996).

2043. RP73/2002 (2002:7).

2044. RP130/2005 (2005:12); RP166/2006 (2006:31).

Human resources and operational aspects of empowerment

By the end of the financial year 2002–2003, the staff complement of DWAF had declined to 18 606. This was almost a third less than the staff complement of more than 26 000 in 1997.[2045] In 2005, the DG noted in the annual report that the corporate services programme was falling victim to the rationalisation that had been ongoing in the department. The department was the third largest in South Africa's civil service, but it was troublesome that there was an emergent paucity of appropriate leadership. A number of key senior officials accepted posts outside the department, and it became increasingly difficult to manage more than 17 000 staff in a large and complex department.[2046]

An assessment of change management showed that the turnover of staff was small. There was a 10% annual change, of which 7.3% was as a result of retirement and death, while a mere 2% was due to resignation. There were indications that a younger generation of officials was becoming more frustrated and negative about the department. With this in mind, DWAF's management started working on team building and management development. Initially the programme focused on the management committee of DWAF, but by 2005 it was extended to middle management.[2047]

Women in water

In the new millennium, empowerment became a prominent feature of equity in the DWAF. At the beginning start of the second term of the Mbeki presidency, in April 2004, Buyelwa Sonjica became the first female minister of the DWAF. She served twice in the portfolio (2004–2006) and (2009–2010).[2048] As a leader she had risen to prominence in the 1980s as member of the UDF, the MDM and, as a qualified teacher, in the South African Democratic Teachers' Union. In 1994, she served as whip of the ANC, before being appointed in 2003 as deputy minister of arts, culture and technology.[2049]

As the first female DWAF minister, Sonjica gave more prominence to the role of women in the water sector. The first Women in Water award was made in 2002 by the minister, Ronnie Kasrils, with Ms M. van Rensburg (CEO of the TCTA) as recipient.[2050] By March 2004, the annual Women in Water award

2045. Department of Water Affairs and Forestry (n.d.a:10).

2046. RP130/2005 (2005:8).

2047. RP130/2005 (2005:9).

2048. SAWHAR DWSA/Alumni2 (2017).

2049. Staff Reporter (2009).

2050. Dr Paul Roberts [Pretoria] pers. comm., 16 March 2017; cf. Information based on Dr Roberts' personal documentation as CEO of the TCTA.

ceremony coincided with the annual national Water Week. The award was fully sponsored by Eskom.[2051] By 2009, the DWAF launched a women's organisation in the Department of Water Affairs and Forestry, with a view to encouraging women's development in the organisation and in the water sector.[2052]

Skills promotion

From 2005 to 2006 the DWAF entered into partnerships with a number of South African universities, including the Tshwane University of Technology, the University of the Western Cape and the University of Cape Town, to develop learning interventions for skills development in the department. In 2005 the department also entered into an agreement with the Peoples' Republic of China to assist with developing skills in the water sector. In addition there was an agreement with Cuba for engineers from there to be seconded to South Africa, where they were scheduled to help facilitating effective service delivery in the water sector.[2053]

Black empowerment

In respect of black empowerment in the workplace, since the 1990s Mike Muller had been sensitive to race relations, and had worked hard at maintaining the services of key officials. Although black South Africans were soon promoted to the senior management positions in DWAF, their appointments were determined by proven skills and expertise in the fields where they had played a leadership role. At the same time the DG had to be sensitive to the views of the cabinet minister responsible for the department.

In the era of Asmal, the minister wanted to make an affirmative action appointment to replace Muller, but an intervention from higher up in government ranks had prevented the change.[2054] At least until 2004 there was consensus on the need for consistent leadership in DWAF. There were phases of significant rationalisation and then the swelling of numbers to incorporate people of designated orientations in the departmental staff component. Muller was capable of maintaining the institutional memory of senior specialised staff in specific strategic areas of the DWAF system.

In retrospect, Muller (1997–2004), among the longest serving heads of department (eight years), played a pivotal role.[2055] He came into the department as an outsider. However, he chose to start working first as a manager and gain

2051. Isaacs (2004:n.p.).

2052. RP163/2009 (2009b:1).

2053. RP163/2009 (2009a:12); RP166/2006 (2006:20).

2054. Muller pers. comm., 29 September 2016.

2055. SAWHAR DH DWSa/Alumni1 (2017).

insight into the operational system. As engineer he knew how to communicate with peers at the helm of a technical government department. Only three years after the new government came to power, did he take charge. As a hard worker, with new ideas representative of a new democratic dispensation, he managed the department in a complex transitional period.

From 2004, with the appointment of Buyelwa Sonjica as minister, the institutional ecology in the department changed. In August 2005, Jabulani Sindane was appointed as DWAF's first African DG. Prior to his appointment in the department he had been a law enforcement official. Once in DWAF he was placed at the helm of the NSTT before being appointed as DG.[2056] There were also indications of a greater preference for the economic empowerment of previously disadvantaged black South Africans in the water sector.[2057] As more graduates joined the department, many black South Africans took up senior posts, with the promise of a good standard of living.

A notable feature of the post of the DG was a high frequency rate of succession. Over a period of 93 years (1910–2004) the department had 14 departmental heads, serving on average for a term of 6.6 years. From 2005, after the appointment of Sindane (who served for two years) until 2009 the tendency was for directors-general to serve for terms of little more than a year. P.R. Rampede, for example, who served as an acting DG, started his term on 01 September 2007 and served in the post for a mere six months, until February 2008.[2058] Another trend to emerge was that in the new era (post-1994) directors-general did not have a long career in the water sector. There are similarities in the relative short terms of DG in the first decade after the NP came to power in 1948 and the first decade of the new millennium

The permanent appointment of Pam Yako as DG in March 2008 lasted little more than a year. Yako did not have a long history in the water sector. She was a graduate of Rhodes University and was appointed as CEO of the Amatola District Council in 1997, before being appointed as municipal manager of the same municipality in 2001. The following year she was appointed as an executive manager in the Department of Environmental Affairs before taking up the post of chief operating officer. In this post, she was responsible for standing at the helm of a number of events, *inter alia* the WSSD in 2002. She served as DG of DWAF from 01 March 2008 to 23 July 2009.[2059] After 2009, the tendency for a high turnover rate in one of the key position in the department persisted.

2056. Parliamentary Monitoring Group (2005c:n.p.).

2057. RP163/2009 (2009:1); Tempelhoff and All Rand Water Portfolios (2015:n.p.).

2058. SAWHAR DH DWSA/Alumni1 (2017).

2059. Staff Reporter (2008).

Conclusion

In the era of Thabo Mbeki, the DWAF grew at a steady rate. Notable accomplishments included giving substance to the legislation passed in 1997 to 1998 and simultaneously working in strategies for its implementation. South Africa's major test was the transition between 2000 and 2002 to a new system of local and regional municipal governance. In terms of the resilience of the emergent social ecological hydraulic mission, it is clear that the governance system was put to the test in a phase of creative destruction.

The creation of new local authorities by randomly grouping together urban communities that in some cases, had followed separate development paths for more than a century, was catastrophic.

Urban areas, as Geoffrey West asserts, are organic entities that emerged at the start of the Holocene some 11 000 yBP. In what he describes as the transition from the Anthropocene to the Urbanocene, the nature of urban space can be scaled to mathematical standards. At a time when it is increasingly possible to use algorithms to determine future livelihoods,[2060] the transformation of South African urban areas from a postcolonial to an African space was notable for simultaneous rapid decline and growth in a number of key areas. In the context of panarchy, it was a rapid succession of processes of creative destruction and recovery, determined by the desire to use the city and its environs for a rapidly growing urban population. Under dynamic and ever-changing processes, the critically important infrastructure systems of water and sanitation, as well as energy supply, formed a nexus. Its notable feature was the inability to adapt resiliently to the changing social ecology. The leap in scale from a conventional urban space to a post-apartheid landscape had a profound impact on urban livelihoods in the country's rapidly growing metropolitan areas. Similar processes also occurred in small conurbations in the country's rural areas, but on a much smaller scale.

Departmental development until 2004 was relatively predictable, with significant innovative changes and management strategies that augured well for the future. By 2006, when the country's economy was growing, there was the promise of a sustainable development trajectory, until significant changes started taking place in the ruling ANC. The pro-free market economy was subject to change when Jacob Zuma became president of the ANC in 2007.

What is undeniable is that the politics of the day had, and continue to have, a marked effect on the water sector, where there appear to be traces of uncertainty.

Internationally, South Africa maintained a high profile. Many of the country's innovative water governance strategies continue to draw international attention.

2060. West (2017:Chs 5–7).

In southern Africa, the completion of the LHWP marked a phase of water conservation growth in what began to take shape as the social ecological hydraulic mission. The TCTA, an institution of DWAF that made its mark in the Lesotho project, was destined to play an important role in transboundary water governance strategies on the subcontinent. It would also play a role of growing importance in the confines of South Africa, where the TCTA's skills and experience were of substantial value to the DWAF.

Chapter 14

Civil society and the legacy of the free market in the water sector

Introduction

In the new millennium, South Africa continued to enjoy considerable status in international affairs. At the same time, as part of the general trend in most liberal democracies, the state was subject to consistent scrutiny from civil society, especially NGOs with local and international ties. In the water sector, there were a number of academics and NGOs that made their voices heard. Apart from a focus on water, they worked in the fields of human rights, the environment, and the economic development of countries in Africa, and elsewhere in the Global South. Many had close ties with the UN and operated in agencies of global governance. In the new millennium, a completely different situation presented itself. South Africa, as a prominent state on the African continent enjoyed considerable international exposure through the agencies of the UN.

From 06 September to 08 September 2000, representatives of all 189 member states of the UN, as well as 22 international organisations (including the World Bank, the African Development Bank and the International Monetary Fund)

How to cite: Tempelhoff, J.W.N., 2018, 'Civil society and the legacy of the free market in the water sector', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 523-544, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.14

attended a summit in New York to discuss plans for the upliftment of the poorest countries of the world. The deliberations were informed by a document of the UN secretary-general, Kofi Annan, in which he outlined the role the UN foresaw for the organisation at the beginning of the 21st century.[2061]

After an ambitious UN Development Declaration had met with collective approval, a strategy was formulated to embark on the Millennium Development Goals (MDGs) in terms of Agenda 21 – a strategy that first emerged at the time of the UN's Rio de Janeiro conference in 1992. The goals, a comprehensive theory on development, emanated from a number of UN summits since the 1990s where issues of poverty and the upliftment of underdeveloped countries of the world featured prominently.[2062] The MDGs included eight basic objectives, namely to:

- eradicate extreme poverty
- achieve universal education
- promote gender equality
- reduce child mortality
- improve maternal health
- combat HIV/AIDS, malaria and other diseases
- ensure environmental sustainability
- develop a global partnership for development.[2063]

In 2000, the water sector of the WHO and the United Nations Children's Fund published an assessment report on the status of global water and sanitation.[2064] This initiative contributed significantly to the formulation of the MDGs. It provided the monitoring platform for water and sanitation which came under the MDGs' Target 10 of 'halving by 2015, the proportion of people without sustainable access to safe drinking water'.[2065] The initiative dovetailed well with South Africa's DWAF and its operations, taking water and sanitation to the country's previously disadvantaged communities.

At the continental political level, the African Union's 2001 NEPAD, an initiative driven by South Africa's president, Thabo Mbeki, and his counterparts Olesegun Obasanjo of Nigeria and Abdelaziz Bouteflika of Algeria, created a sense of continental cohesion on the MDGs, with substantial support from the UN for its implementation in the African Union framework.[2066]

2061. Annan (2000).

2062. United Nations (2000:n.p.)

2063. United Nations (2001:55–58); cf. Secretary-General (2001).

2064. Joint Monitoring Programme for Water Supply and Sanitation (2000:87).

2065. The Right to Water and Sanitation (n.d.).

2066. African Union (2016:n.p.).

The fact that South Africa hosted the 2002 WSSD, also known as Rio+10, highlighted the MDGs. South Africa increasingly acquired more status in the international arena. Along with the plaudits came more responsibilities. By 2008, South Africa was prominent in extensive collaboration in the SADC and NEPAD for the mobilisation of private sector funding to make the UN's MDGs succeed.[2067]

In some African quarters there was a recognition of the fact that the South African 'miracle' was bound to become over-mythologised. In the international community and in global events, South Africa was a shining star in the firmament. The country was famous, largely as a result of the leadership figure, Nelson Mandela, and his role in the political transition to non-racial democracy. One role player that had not always been prominent in the governance sector was the voice of civil society.

■ The civil society factor

In the era of the struggle against apartheid, civil society at large opposed government in many critical areas. After 1994 there was a new and different role for civil society. Since 1994 the new government had had to contend with issues that went against the grain of its policy thinking at grassroots. In the water sector the new government was soon stereotyped in much the same way as the former white minority government. It was in this space that civil society, through the NGOs, made a significant contribution towards developments in the water sector in the Mbeki era.

Researchers and activists had expressed an interest in the development of civil society since 1994.[2068] In water sector research there was a lively interest in water privatisation and commodification;[2069] the growing critique of large dams;[2070] pro-poor activities; and indigenous approaches to secure access to and manage water supply and sanitation.[2071] Local NGOs proliferated and linked up to many discourses and campaigns promoted by activists in the international water sector.[2072]

One of the foremost critics of government's planning in terms of the municipal infrastructure policy was Patrick Bond, a KwaZulu-Natal academic who, in 1999, maintained that there were serious shortcomings in the

2067. RP 246/2008 (2008:4).

2068. Hyden (1996:96–102); Swilling (1990:151–160).

2069. Bond (2002:14–17); Debbané and Keil (2004:209–225).

2070. Reisner (1994:1–12); World Commission on Dams (2000:n.p.); Braun (2007:231–238).

2071. Binns and Nel (1999:398–408); Perret (2002:287–288).

2072. Robins (2008:Ch. 1).

government's municipal infrastructure policy. In his view, there had to be larger infrastructure and service subsidies in the form of redistributive tariffs. It was all about ensuring that the previously disadvantaged and impoverished people of the country enjoyed greater services as part of a 'public good' in one of the countries of the world with the greatest disparity between the rich and the poor.[2073]

In the late 1990s, reports in the media hinted that DWAF was beginning to run out of steam because of a funding shortfall. The department had set aside R1bn for additional capital projects across the country, but analysts questioned the sustainability of these projects. It had all been done with the understanding that consumers would eventually pay on a cost recovery basis. The major problem, it transpired, was that communities were either 'unable' or 'unaccustomed' to paying for the service. The first signs of crisis were evident in KwaZulu-Natal where poor people in the rural areas, living in survival mode well below the average international baseline, were unable to pay R50 per month for their water supply. Further north, in Limpopo, residents resorted to vandalising taps when they were forced by debt collectors to pay their arrears for water services.[2074] There was evidence that as early as 1994, in Limpopo, with an estimated five million previously disadvantaged rural residents, the per capita consumption of water dropped from 1000 L to 150 L/d – 300 L/d once metering was introduced.[2075]

Just how tenable the state of affairs was, could not be predicted at the time. Once water cut-offs became endemic, anger ensued.[2076] The DWAF's Mike Muller explained at the time that it was possible for the department, in collaboration with the Department of Constitutional Development, to secure state funding to pay some expenses on the principle of an equitable share. This meant that communities would be responsible for paying as much as they could afford towards service provision. The state would pay the rest. The proposed subsidy system meant that the service would continue despite non-payment in conditions of extreme poverty.

The problem of affording water infrastructure upgrades was not confined to the country's poor. Water sector specialists had grave concerns about the issue of raising funds to pay for DWAF's Skuifraam–Berg River project augmentation scheme to provide sufficient water for Cape Town. The cost of the project, scheduled to come on line by 2003, was estimated at R760m. The problem was that the dam was essentially a back-up for times when the demand for water in Cape Town exceeded the existing water storage capacity.

2073. Bond (1999:43–59).

2074. Engineering News (14 May 1999a:n.p.)

2075. SAWHAR WLC C1464h (1994:108).

2076. Engineering News (14 May 1999b:n.p.)

DWAF indicated it would not be able to secure state funding for the project, which was situated on the Berg River in the La Motte forest near Franschhoek. The water was scheduled to pass through a 1500 mm diameter Dasbos tunnel pipeline over 8.7 km to the Cape Peninsula.[2077]

In the case of the LHWP, from the outset Gauteng's water users were obliged to pay the higher rate that was decided upon when the LHWP construction began.[2078] Furthermore, the stream of payment for the project started when the first water flowed into the Vaal Dam.

Water privatisation

The South African government's ties with the international water sector brought it into the ambit of the principle that the cost of water infrastructure had to be paid for by the consumer. Privatisation of water services was a hot topic. Since the early 1990s this mindset, based on the successful privatisation of public utilities in the era of British premier Margaret Thatcher, implied that private enterprise – mostly multinational corporations in the water sector – should take over public water services. International financing institutions favoured the strategy, in that it was considered a successful measure to combat dysfunctional water services and corruption.

At a September 1999 week of Britain–South Africa partnership talks, DWAF's minister, Ronnie Kasrils, extended an invitation to the private sector to become involved in South Africa's water sector. The department was interested in establishing ties in both public–public and public–private partnerships that worked for the benefit of client communities. The British minister of trade, Richard Caborn, explained that privatisation had strengthened water companies in England and Wales, with private sector funding making it possible for infrastructure to be upgraded. The English and Welsh water industry had been privatised in 1989 with 10 regional water boards – created in 1973 – from a multitude of municipal water utilities that had been sold off. Caborn went on to say that Britain was making significant headway on improving the old and outdated water infrastructure in the United Kingdom.[2079]

At more or less the same time, a major turning point was reached in the international discourse on water privatisation when, in 1999 to 2000, in the Bolivian city of Cochabamba in South America, thousands of residents protested successfully against privatisation, after their rates for water had increased by as much as 200%. The Bolivian government ultimately had to

2077. Engineering News (14 May 1999b:n.p.)

2078. Dr Paul Roberts [Pretoria] pers. comm., 12 March 2017.

2079. Engineering News (14 May 1999b:n.p.)

step in and terminate the contract.[2080] In South Africa, the discourse on privatisation did not change immediately.

In April 2000 the DG, Mike Muller, addressed a conference of SAICE. He touched on the global water crisis, explaining that South Africa's key challenge was the inequality of its population, and he hinted at the need for South Africa's water to be managed in a way that reflected its value. Water management had to be sensitive to the environment. However, it did not mean that polluting factories, operating in an unlawful manner, should be summarily closed. Instead, there had to be a sense of responsibility; South Africans had to realise that the underdevelopment of the economy had had a worse effect on the environment than development.[2081]

In the same month, the DPLG issued a White Paper on municipal services partnerships (MSPs). Local authorities were running up a significant backlog on municipal infrastructure and service delivery, estimated at R10.6bn p/a. After extensive investigations over a period of three years, the government addressed the problem by promoting its municipal service partnership policy. Municipal service partners were to be appointed by local authorities to improve service standards and ensure service delivery to consumers.[2082]

At a meeting of the parliamentary committee on Water Affairs and Forestry on 04 October 2000, the South African Municipal Workers Union and COSATU expressed their opposition to the system. Earlier in the year the two unions had almost brought services to a standstill in the Johannesburg metropolitan municipality. Their members feared job losses if certain municipal services were privatised.[2083]

The alternative voice was that of the Municipal Infrastructure Investment Unit (MIIU), a non-profit Section 21 Company, with government as sole shareholder, that argued in favour of privatisation. Representatives of the MIIU explained there had been extensive work on the system of municipal service providers. For more than two years they had participated in drawing up regulations in terms of Section 19(5) of the *Water Services Act* of 1997 to implement MSPs. It was a proven way of ensuring proper water and sanitation service delivery. The MIIU had been monitoring progress with municipal service providers who had concessions in the Dolphin Coast region and Nelspruit. The programmes were said to run effectively and plans were in preparation for 15 water services to be run by MSPs.[2084]

2080. Hall and Lobina (2002:15–16); Olivera and Lewis (2004); Hall, Lobina and De la Motte (2005:281–305); Bakker (2007:430–455).

2081. Engineering News (28 April 2000:n.p.).

2082. Department of Provincial and Local Government (2000:5–6).

2083. SAWHAR AHCA5/022a (2000); SAWHAR AHCA5/044 (2008).

2084. Parliamentary Monitoring Group (2000).

The public debate on water privatisation and effective water governance deepened. By 2000 the parliamentary portfolio committee on water heard evidence to the effect the 1990s public–private partnership system of build–operate–train–transfer (BoTT) was not working well. Civil society no longer favoured the strategy. NGOs argued that it made private sector exploitation of the system possible. It meant that charges for services would escalate by as much as 2.7 times more than the charge for the same service under pre-BoTT conditions. The only operator working well was the NGO, Mvula Trust, which provided BoTT services that were considered reasonable. However, it worked primarily in the Eastern Cape, and as a rule its operations were small.[2085]

Furthermore, at the coalface of water operations there were ructions. There were reports of attempts to seize DWAF documents that identified problems that needed attention. When this was made public and allegations followed that the department was not doing its work, Muller explained that much of the criticism levelled against the department was because of a lack of understanding of the framework in which DWAF operated.[2086]

The problem appeared to arise from the fact that local authorities, especially those in the rural areas of the country, needed significant water and sanitation infrastructure development. However, whereas in the populous urban areas, where many rates and tax payers could pay more for services, it might have been possible to pay for much of the infrastructure, this was not the case in the rural areas.

World Summit on Sustainable Development 2002

In 2002, South Africa hosted the UN' World Summit on Sustainable Development (WSSD 2002) in Johannesburg from 24 August to 04 September. One of the major features of the summit was the special attention given to water-related matters. Prince Willem-Alexander of the Netherlands, the host of the UN's World Water Summit in 2000,[2087] was asked by the UN secretary-general, Kofi Annan, to serve on the panel that dealt with water issues at the WSSD 2002.

In April 2002 the Dutch prince met with more than 200 African water stakeholders in Accra, in preparation for the summit. They discussed critical issues experienced on the continent in the water sector. In a report after the West African deliberations, Prince Willem-Alexander explained to Annan that in essence there could be no development opportunities without water.

2085. Parliamentary Monitoring Group (2000).

2086. Muller (2001:60).

2087. SA Water Bulletin (2000:4–5).

The reality was that despite their varied cultures, it was water that remained a binding factor, bringing people of the world together.

In continuation of the efforts towards the MDGs of 2000, the group underscored the need to halve the number of people in the world without access to proper safe drinking water, to halve the number of people worldwide without proper sanitation by 2015, and to promote water productivity in agricultural practices. Although the discourse on water privatisation was still ongoing in civil society, the collective view held by leaders in the political and the water sector was that privatisation did not mean that water resources would become privatised.[2088]

When the impressive UN summit began in Johannesburg in August 2002 the programme ran like clockwork, calm and according to schedule, until the day of the main water event when the Minister of Water Affairs and Forestry, Ronnie Kasrils, addressed the delegates. A group of 70 members of NGOs who had been meeting in Soweto, interrupted Kasrils' speech – despite having been warned in advance that protests would not be tolerated. The protesters gave their support to the World Coalition Against Water Privatisation and demanded the government cancel its privatisation plans.[2089]

In a subsequent report to the summit by the Water, Energy, Health, Agriculture and Biodiversity (WEHAB) working group, there was consensus that water resources in many countries of the world were fragile, with as many as 1.2bn people globally lacking access to safe drinking water, while 2.4bn did not have proper sanitation. Financial resources, the report stressed, remained the most limiting constraint on developing water and sanitation infrastructure. Many developing countries were cash strapped, and financial assistance from the rich countries for developing water infrastructure was often meagre and slow to materialise. WEHAB's working group suggested nine areas for action in the water sector, including:

- providing and expanding safe drinking water supplies
- preparing and implementing water management action plans
- improving water productivity in agriculture
- safeguarding human health
- strengthening disaster preparedness planning
- strengthening the institutional and technical capacities
- protecting aquatic ecosystems, as well as estuarine and marine systems.[2090]

The WSSD 2002 was one of the highlights of the Mbeki era. The event cemented the status of the country as a leading partner for international engagements on the African continent. For the international water sector, it was an

2088. Alexander (2002:1–19).

2089. Tempelhoff (2009a:30–53).

2090. United Nations (2002:3–5).

opportunity to form an impression of some of the problems experienced on the African continent, which were similar to those in many parts of the developing world. A message that did register with delegates of many of the leading countries of the world was that financial constraints prevented water and sanitation infrastructure from reaching the people most in need. There was also an awareness that thanks to the unconventional message of activists at the summit, water could not be privatised for personal profit and gain.

Free basic water

In 2001, temporarily at least, the department was morally exonerated from allegations against its water privatisation strategy. When in 2000 there was a cholera outbreak in KwaZulu-Natal – claimed to be the worst of its kind in the country's history[2091] – it was ascribed to inferior water infrastructure.[2092] Within the space of less than two years there had been 239 cholera-related deaths, with 106 389 people being treated for the disease. Most of those affected lived in the rural areas of the provinces of KwaZulu-Natal (105 389 cumulative cases), Limpopo (793 cases), Mpumalanga (125 cases), Gauteng (65 cases) and North West (6 cases).[2093] Experts stressed that the government had to address the issue of poor water services if it wanted to halt the spread of cholera.[2094]

As early as 2000 the minister, Kasrils, observed that poor people in the rural areas of South Africa were resorting to using sources of water that were potentially polluted, because they were unable to afford to pay for local water supplies. At the time of the run-up to the 2000 municipal elections he announced that every household would soon be entitled to 6 kL of free water per month – basically 25 L/c/d. The system was based on a strategy that had been put to the test in Durban.[2095]

In 2001, Kasrils formally introduced the policy of a free, basic water supply for all the country's residents. The scheme, launched on 14 February 2001 at a cost of R2.2bn, provided 27 million South Africans with a free monthly supply of 6 kL of potable water.[2096] The first phase of the project's implementation was in parts of the provinces of KwaZulu-Natal, the Eastern Cape and Limpopo – the poorest regions of the country. In practice, the free water policy was a resounding success. It removed an onerous responsibility from the shoulders

2091. Deedat (2010:16).

2092. National Department of Health (2001); Hemson (2000:48–53).

2093. Mudzanani et al. (2003/2004:260).

2094. Van Vuuren (2006:16–18).

2095. Department of Water Affairs and Forestry (*c.* 2006:15).

2096. Kasrils (2001:n.p.).

of the government to demand payment for water services in communities that were clearly unable to afford it.

In 2008, Muller, from a management perspective, defended the government's free basic water policy. At the time of its introduction, he explained, the measure was a flexible approach to ensure access to water for people most in need of proper supplies. Despite the fact that local water and sanitation service delivery protests were on the increase, he explained that free basic water was one way for water supply organisations to recover their costs and achieve financial sustainability, by not asserting rates pressure on the poor.[2097]

Sanitation services

In the field of sanitation, the fear of outbreaks of diarrhoea, cholera and the spread of HIV/AIDS deepened after 2001. By 2005 a national health and hygiene education strategy had been introduced to provide appropriate education on health and hygiene.[2098]

At the local level, sanitation infrastructure planning received a boost when government announced that a special MIG system would be introduced to work towards eliminating 200 000 bucket toilets by 2008.[2099] The MIG, functioning under the auspices of the DPLG, was introduced, with the objective of working towards at least basic levels of services by the year 2013. This meant that grants under the MIG system would form part of municipalities' IDPs, creating job opportunities and boosting decentralised service delivery, as well as local economic development.[2100]

The following year, Jabu Sindane, managing the NSTT, briefed the parliamentary portfolio committee on the department's sanitation initiative. DWAF had a budget of R200m for 2005 to 2006 to roll out the sanitation programme. One major problem was the persistent preference of communities for water-based sanitation. In some municipalities sanitation was considered to be a low infrastructure priority. Furthermore, although they were working in the appropriate manner, the local authorities appeared to be unable to procure the necessary funds for infrastructure development. This had a marked impact on sanitation services.[2101]

The demand for water-based sanitation in a water-stressed country was a tall order. The available water resources were jeopardised as a result of

2097. Muller (2008:67–68); Gumede (2005:116).

2098. Tissington (2011:55).

2099. RP130/2005 (2005:7).

2100. Department of Provincial and Local Government (2004).

2101. Parliamentary Monitoring Group (2005b).

promises made by politicians, and the expectations of people who were not in a position to pay for services, and who did not appear to be sensitive to the need for using water in a careful manner. In the months to come there were protests in many parts of the country; indeed, they became commonplace.

Service delivery protests

Since early 2001 there had been several problems in local government. The transfer of authority from transitional local authorities to responsible municipal government with demarcated authorities in the fields of planning, performance management and the management of resources, in terms of the *Municipal Systems Act*, 32 of 2000, posed many challenges. Part of it was the overzealous implementation of certain government policies, such as employment equity and black economic empowerment. One result was that white officials who had been working in the municipal water sector for many years, opted for early retirement. Alternatively, they chose to start working in the private sector. The loss of skills, experience and especially institutional knowledge of water purification and treatment plants – a field in which the country was an industry leader – was significant. In some cases, the former officials became private contractors to the same local authorities.

By May 2005, a total of 78 of the 284 local authorities in South Africa had no engineers, technologists or technicians. A further 49 only had the services of a single civil engineering technician.[2102] Local authorities had to rely increasingly on private service providers to perform crucial tasks in the municipal sector. The shortage of skilled labour had a direct effect on the water services of local authorities – especially in the rural regions of the country.[2103]

Furthermore, municipalities did not always have the necessary funds to pay for services. Most households did not pay rates and taxes. It was part of a continuing culture of non-payment that had taken root in the country's African townships in the 1980s. This created substantial financial problems for local authorities.

By 2005, 81% of the country's 284 municipalities provided free basic water to domestic consumers; 64% provided free basic electricity; and 44% were in the process of providing free basic sanitation.[2104] The lack of revenue left local authorities hamstrung and unable to develop, upgrade, or even maintain, local wastewater treatment works, water purifications plants, pipelines and drainage systems.

2102. Ndletanya and Muzondidya (2009:23).

2103. Day and Van der Merwe-Botha (2010:9–10, 13–14).

2104. Roefs and Atkinson (2010:58).

Although the wave of service delivery protest that began in 2004 was primarily rural, there were also protests in informal settlements in highly urbanised regions, such as Gauteng's Diepsloot informal settlement, north of Midrand, Ekurhuleni Metropolitan Municipality, the town of Secunda in Mpumalanga, Ocean View in the Western Cape, and hostels in the Port Elizabeth area.[2105] However, in contrast to the Soweto uprising of 1976, which manifested as an urban phenomenon, the outbreak of violent water service delivery protests in 2004 had its origins in the rural parts of South Africa.

The first was in the Free State Province town of Harrismith where, at the local township of Intabazwe, there had been little progress in terms of service delivery since the first wave of local services provided in the town in the 1990s. According to dissatisfied local residents, the only project that had been completed since the local RDP housing project was the 'water meter project'. For the rest, the government concentrated on the former homeland of QuaQua because, according to locals, most of its electoral support came from south of Harrismith. Out of sheer desperation and in an effort to attract the maximum attention, a group of local residents blockaded the N3 highway between Johannesburg and Durban, before resorting to widespread destructive activity and damaging public property.[2106]

The Harrismith protest soon spread throughout the eastern Free State, especially in rural communities where local water and sanitation services were far from satisfactory.[2107] At first, when active protests began in 2004, it appeared to be a benign governance problem, with residents of some of the country's former apartheid townships and informal settlements coming out in protest against what they considered to be inferior municipal service delivery.[2108] The protests soon became malignant.

From 2006 to 2007, Atkinson identified a number of institutional problems responsible for the wave of protests. In the water sector the discontent was related to organisational difficulties at the municipal level, the lack of response from the local authorities to residents' queries, which amounted to an absence of communication, and difficulties of intergovernmental communication.[2109]

It was evident that the engagement of the local governance system in the community was too close and too direct; the desired outcomes of good relations between local government and the citizenry were simply not realised. At the time when the Johannesburg municipal water supply authority began

2105. Atkinson (2007:54–56).

2106. Gouws et al. (2011).

2107. Motloung (2011).

2108. Ndletanya and Muzondidya (2009:23).

2109. Atkinson (2007:60–72).

a privatisation programme, this lack of proper communication had the effect that protests flared up in Diepkloof when residents were not properly informed of the reasons for the municipality cutting off their water supplies.[2110]

By 2009, partially as a result of the economic downturn, with increasingly high rates of unemployment, protests more than doubled, and clearly posed what has been termed a 'wicked' problem for government.[2111] As research at grassroots targeted specific areas of popular attitudes towards local government and issues of service delivery, it was evident that people in the rural areas did not necessarily always engage with local authorities.

Residents were frequently ignorant of the IDPs of local authorities. There were breakdowns in the activities of ward committees, in which political representatives were supposed to engage with local residents to determine how problems related to, *inter alia*, water and sanitation service delivery could be addressed. Participation in matters of governance did not always extend to the people at grassroots level.[2112]

Discontent had meanwhile also spread to middle class South Africa – primarily previously advantaged urban residents. A National Taxpayers' Union, founded in the 1990s,[2113] gained considerable support among suburban residents. People of all races seemed to be increasingly dissatisfied with paying high rates and taxes to local authorities that they felt were inefficient, unresponsive and that furthermore chose to stoically ignore residents' complaints.

Service delivery protests, especially events culminating in violence, reflected negatively on the national government. Reports in the international media hinted that the unrest was reminiscent of the political violence in the country's African townships in the 1980s, during the apartheid era.[2114] But this was an oversimplification of a complex state of affairs. In their assessment of public perceptions and local election results since 1995, political analysts pointed out that although there was a lack of confidence in the authorities who were running local government, the majority of South Africans were still firmly behind the new ANC-ruled national government.[2115]

The government's performance scorecard since 1994, in terms of delivery to the country's previously disadvantaged, showed that there was a strong focus on working towards the elimination of poverty. Service delivery protests were

2110. May (2006:148).

2111. Rittel and Weber (1973:155–169); Coyne (2005:5–17).

2112. Reitzes (2009:25–27).

2113. Kelder, pers. comm., 13 September 2009.

2114. Bearak (2009); Smith (2009a); Smith (2009b); Clayton (2009); Pearce (2008:27).

2115. Roefs and Atkinson (2010:43–67).

seldom exclusively in reaction to inferior water services. A lack of housing, absence of electricity, unemployment and the apparent inability of the government to live up to its pre-2009 national election promises, featured prominently among the major triggers of protest.[2116] Water was also high on the list of service delivery complaints. A case study on discontent with water service delivery in the North West Province town of Sannieshof in 2009, suggested that water-related issues accounted for as much as 60% of residents' frustrations with municipal service delivery.[2117]

Peripheral issues, sometimes hardly relevant to the actual reasons for protest and violence, acted as the spark that started the fire. Indeed, eliminating municipal water service delivery backlogs were described as a 'pressing priority for the country' in a report by researchers at the University of the Witwatersrand's Centre for Applied Legal Studies, the Centre for Housing Rights and Evictions and the Norwegian Centre for Human Rights at the University of Oslo.[2118] There was also reason to believe that South Africa's water services, specifically at the level of local government, faced serious challenges. However, towards the end of 2010, problems with local water service delivery started to decline.

■ Large dams under scrutiny

Ever since the late 1990s, the chances were highly unlikely that the DWAF would be compliant with civil society's demands on the question of large dams. In a water-stressed country like South Africa, it had become a standard principle of planning procedure that dams, irrespective of size, were essential to ensure water security. The resource simply had to be sufficient to meet the growing demand. Civil society's discontent with large dams emerged for the first time on the international scene in the 1980s. An NGO, the International Commission against Large Dams, participated for the first time in a 1988 ICOLD conference in the United States, where its members listed a number of complaints against large dams, on the grounds that these facilities were responsible, *inter alia*, for the resettlement of people (especially the poor); the loss of land and forests; the loss of fauna and flora; the loss of fertilisation in the form of silt downstream; the reduction of water quality; the decrease of water evaporation; the decrease in fish stocks; the tendency to induce earthquakes; and the loss of cultural heritage.[2119]

The bigger picture was that since 1987, environmental NGOs were concerned about steps taken by the World Bank to provide loans that had almost doubled

2116. SABC News (2009a, 2009b); Seleka (2009); Hlongwane, Laganparsad and George (2009); Dlamini (2009); Gumede (2009); Smith (2009c); Smit (2009); Heese and Allen (2009).

2117. Gouws et al. (2009:19).

2118. Tissington et al. (2008:3).

2119. Van Robbroeck (1996:12).

to US$75bn because of dam construction. The NGOs' major concern was that that based on evidence from disasters in Brazil, India and Indonesia, the World Bank had funded projects that promoted ecological disasters. There appeared to be insufficient planning on mitigating threats to safety. In particular NGOs singled out the bank's tropical forest development plan and the forced resettlement of people in the case of large dam construction projects.[2120]

In South Africa, where major dam schemes had proliferated since the 1960s, the issue of large dams was a fertile hunting ground for NGOs. In 2003, Bill Rowlston, DWAF's strategy coordination manager, told the parliamentary committee on water affairs that in the department, dam construction was still firmly on the agenda. At the time, an investigation by the Environmental Monitoring Group in association with the World Commission on Large Dams was busy with a South African assessment of the WSSD's global report on large dams, and how South Africa measured up to international trends.[2121] While a strong case could be made for smaller dam structures, the department's management, supported by substantial environmental experts, supported large schemes. Rowlston considered it unwise to halt these resource reservoirs.

The department had made extensive dam construction plans to meet the future demand for more water. Between 2005 and 2015 it was scheduled to embark on 18 'large scale water resource developments', of which the Skuifraam Dam in the Western Cape formed part. However, significant delays arose in undertaking the project, primarily as a result of political factors. The minister, Kader Asmal, held back on his approval – a fact he acknowledged in parliament. At the time he served as chairperson of the World Commission on Large Dams and yet he admitted that he was not fully in favour of major dam projects. He also insisted that Cape Town introduce a water conservation–water demand management programme.[2122] The local authority complied with the arrangement in a subsequent agreement between Cape Town, the DWAF, the TCTA and Ninham Shand Consulting engineers.

After the release in 2000 of the World Commission on Dams report on large dams,[2123] a new minister, Ronnie Kasrils, was at the helm of the ministry. The commission's report on the construction of large dams was critical. Once again, trends in the international water sector held up the construction of the dam because Kasrils wanted the Skuifraam project to be compliant with all the requirements laid down by the World Commission on Dams. The implementation of the project was only approved in 2001.[2124]

2120. Rich (1990:305–329).

2121. Environmental Monitoring Group (2004).

2122. Dr Paul Roberts [Pretoria] pers. comm., 12 March 2017; Roberts (2004).

2123. World Commission on Dams (2000).

2124. Dr Paul Roberts [Pretoria] pers. comm., 12 March 2017.

At the time, DWAF was sensitive to irresponsible and deterministic construction projects. There was evidence of a 'soft approach' to water resource development – a theoretical strategy outlined shortly before by Peter Gleick of the Pacific Institute in the US.[2125] In the case of South Africa, Rowlston singled out 'lack of equity in the development of resources' as one of the areas where the DWAF traditionally lagged behind. This would not be the case in future.[2126] However, the department remained open to investigating all potential sources of water. The construction of large dams was not the only solution, but it had meanwhile started planning Phase 2 of the LHWP.[2127]

In 2005, Johan van Rooyen, senior manager at DWAF's national water resource planning directorate, told the parliamentary portfolio committee that a wide variety of potential sources of water were under investigation. Towing icebergs from Antarctica posed logistical problems, but shipping water from the Zambezi or Congo rivers could be considered – but only for industrial purposes. The department had also been working on stimulating rainfall by seeding clouds. Annually, an amount of R10m was available for using this strategy, which had a proven record of success. Treated effluent for drinking water purposes was also a viable option, but the technology was only used on island settlements.[2128]

Desalination technologies had great potential and had been introduced along the coast at certain localities. In addition, rainwater and cloud harvesting were under investigation, as was the case with grey water use for irrigation purposes. Van Rooyen pointed out that water conservation management practices could reduce water requirements effectively and that this was a cheap method that could yield immediate results. However, for the interim, the department chose to stand by its earlier decisions on large dam construction projects. Internationally, South Africa's predicament was an example of what could be expected in many regions of the world in times of drought in an era of anthropogenic climate change.[2129]

■ The legacy of the industrial–energy hydraulic mission

The full impact of the long-term consequences of the industrial–energy hydraulic mission of South Africa's water registered profoundly in the new millennium.

2125. Gleick (2002:373–375, 2003:1524–1528); Wolff and Gleick (2002:1–29).

2126. Engineering News (2003:n.p.).

2127. RP130/2005 (2005:6).

2128. Parliamentary Monitoring Group (2005a).

2129. Smith (2008:17).

The first evidence of this was in the emergence of the AMD from gold mining in the former Witwatersrand region of Gauteng; the second was the growing demand for more energy from the country's thermal power stations.

Acid mine drainage on the Witwatersrand goldfields

In 2004 the government implemented the *Minerals and Petroleum Resources Development Act*, No. 28 of 2002. For South Africa's mining sector, this meant that for the first time the state took charge of the country's minerals and the way these resources would be consumed in future. In the case of the Witwatersrand goldfields, the long-established mining sector, historically operated by a few mining companies, underwent significant change. New small mining companies began to run some of the old mines.

Like its predecessors, the Mbeki administration supported the resuscitation of the once flourishing mining sector, with the objective of securing more job opportunities. Without an institutional knowledge base of the need for managing mine water properly, there were frequent instances of toxic pollution and AMD. The Witwatersrand gold mines were well beyond their peak production phase and the new mining operations focused for the most part on low-grade ore and recycling old mine dumps for the last remnants of gold.

Then, in 2004, for the first time since the 1960s, the government stopped subsidising the pumping of groundwater from dolomitic compartments in the western, central and eastern areas of the Witwatersrand. Previously, some 40 years earlier, the mining companies were responsible for emptying the dolomitic compartments themselves. The measures in place after 2004 once again put the onus on mine owners to pump groundwater out, but made it possible for gold mining activities to continue. It also assured job opportunities in the mining sector.

But the picture was changing rapidly. The natural groundwater in the Witwatersrand's gold mining areas was becoming more and more contaminated with AMD because of the ongoing underground mining operations. When the costly electric-powered pumping process, subsidised by the state, came to an end in 2002, AMD started decanting into surface water supplies in parts of the Witwatersrand region.[2130]

South Africa was no longer the world's premier gold producer. Between 2007 and 2008 the country's output of gold (largely from low-grade ore) declined from 252.6 tonnes to 212.7 tonnes, making it only the fourth largest gold producer in the world.[2131] By 2010 the government was forced to step in,

2130. Tempelhoff and All Rand Water Portfolios (2015:21–22).

2131. Naidoo (2017:34).

and through the Department of Water Affairs, it took charge of what was considered an imminent major water disaster in Gauteng, one of South Africa's most populous regions.[2132]

Contemplated from the perspective of panarchy, the problem of AMD in the first decade of the 21st century was a creative destruction phase, destined to follow an unpredictable back loop recovery process. This meant that anything could be expected. Because there were no orderly and systematic plans in place, the surface water supplies in many parts of the former gold mining areas in Gauteng were in danger of becoming contaminated with AMD. The long-term consequences of AMD and the short-term strategies put in place to address the problem, provided for an ecological disaster of substantial proportions.[2133]

Energy load-shedding

In January 2008, South Africa's power utility, Eskom, was unable to meet the electricity demand; the needs of the country were growing. With Eskom producing as much as 30% below its potential capacity of 39 855 MW, large parts of the country experienced power outages. This was the first time South Africa was exposed to a comprehensive service supply collapse since the introduction of a national electricity grid in the 1970s. The causes of the load-shedding that ensued – raising a furore in select areas of the country where there were power outages at key times, with drastic economic consequences – were ascribed to the lack of proper maintenance of the thermal power stations and the electricity grid, the need for emergency repairs, and an undersupply of coal to the power stations. For the next three months, South Africa's economy took a beating, and a mentality of irritation and cynicism was evident in society at large.[2134]

Subsequently, it transpired that at the time there was a distinct growth in the demand for coal at the country's power stations, especially in the Mpumalanga region of South Africa where most thermal power supplies were generated. One of the consequences of intensified local coal mining activity was that in areas on the north-eastern Highveld of the Drakensberg region of South Africa, mining was compromising the safety of pristine water resources in the river catchments of the Vaal and Olifants.

As discussed in earlier chapters, since the 1960s the DWAF had been responsible for comprehensive measures to abide by the stipulation, in the *Water Act* of 1956, to combat water pollution. There was a range of measures

2132. Tempelhoff and Winde (2013:77–87).

2133. Holling (2004:1–11).

2134. Tempelhoff (2009b:262–292).

in place and these were strictly enforced. In the coalfields, until the 1970s, the department and coal mining companies in the northern parts of Natal and the eastern Transvaal had collaborated with the CSIR and consulted experts to minimise the potential threat of coal mining AMD to surface water resources.

The transition in the 1980s to a regional system of water governance saw the first signs of negligence in the department as far as the enforcement of anti-pollution measures was concerned. There is reason to believe that the mining companies – aware that there would be significant political changes in time to come – started high-risk operations to extract as much coal as quickly as possible. In the 1990s, as the panarchy cycle of organisational creative collapse in DWAF was on course for a back loop-inspired revolutionary phase of change and reorganisation, law enforcement measures to prevent pollution were dwarfed; in many cases they were ignored.

The focus was now on a social ecological hydraulic mission. The preconditions and the security measures of the industrial–energy hydraulic mission was no longer in place. Panarchy's back loop process of recovery to resource conservation did not augur well for the future, not least because the front loop retraction that would typically have stored local knowledge of former times in dealing with the problem, was insufficient. It could not compete with a non-adaptive social ecological system. The back loop panarchy recovery was of a deconstructive nature. Irresponsible mining activities caused the further deterioration of river catchment water supplies.

The collapse of the national energy grid had already been predicted in the late 1990s, but government did not take appropriate measures. Experts warned that the water security of a significant part of South Africa was compromised because of many years of coal mining, the over-exploitation of local resources and the unsustainable exploitation of sensitive ecological systems for regional coal resources. In essence, coal mining, like gold mining, was reaching stages of peak exploitation.[2135]

Before the end of 2008, comprehensive plans were in place to address South Africa's energy crisis. Apart from two huge new thermal power stations, Medupi[2136] and Kusile,[2137] for the first time there was a growing interest in actively exploring the introduction of renewable energy generated from photovoltaic, solar, wind and hydro sources.[2138]

To return to the panarchy perspective, before 1994 the growing demand for electricity – as part of the energy component of the WEF nexus – tended to

2135. Spalding-Fecher, Williams and Van Horen (2000:8–17); McCarthy and Pretorius (2009:19–23).

2136. Barradas (2008).

2137. Creamer (2008).

2138. Montmasson-Clair, and Ryan (2014:507–526); Gcukumana (2009:19); Mbanga (2008:28–30).

veer in the direction of a front loop component of the panarchy cycle in the longer term. It was always possible to slow down the exploitation of the coal mines and allow for systems recovery in the conservation phase. Government and the private sector started collaborating more extensively than before, while the country's keenest minds were working behind the scenes to ensure that South Africa did not fall victim to ongoing load-shedding.[2139]

After 1994, in terms of the emergent social ecological hydraulic mission, government assumed that it would be possible to simply maintain its standards of selling energy to all and sundry at the lowest cost per unit in the world. At the same time, it was assumed blithely that it was possible to maintain its policy of free electricity to the country's previously disadvantaged people. By the mid-2000s the panarchy cycle of the power delivery system reflected the onset of an uncertain back loop development process.

The introduction of strategies in the early 2000s to introduce hydropower, even the Grand Inga project in the Democratic Republic of the Congo, dating back to the 1950s, suggests that the authorities remained aware of the role of water in generating electricity.[2140] Water maintained its relevance well into the first decade of the 21st century. However, it appears that the authorities in charge of the country's governance were unable to see an imminent collapse in the complex systems of the WEF nexus. Both water and energy security were compromised. One promising trend to emerge was the increasing use of solar-powered water heating devices in RDP projects throughout the country. It was evident that the state was determined to ensure that renewable energy could help provide the needs of the previously disadvantaged people resident in the rural and urban areas of South Africa.[2141] However, over the longer term, to meet this objective will require a much more dedicated focus on renewable energy technologies.

■ Conclusion: The free market and the water sector

The drive to promote free market principles clearly formed part of the neoliberal mindset prevalent in Mbeki's presidential term. However, its Achilles heel was the inability of the free market to lay to rest the cancer of poverty. Perhaps government was in too much of a hurry to eradicate poverty. In the services sector of water and sanitation the infrastructure was simply not in place to meet the voracious demand for more water and electricity – an intrinsic element of the emergent social ecological hydraulic mission in South Africa's WEF nexus of the 1990s.

2139. Davenport (2009).

2140. Showers (2009:31–58).

2141. Le Roux (2003); Davenport (2008); Motau (2010).

Developing South Africa's hydraulic mission since the beginning of the 20th century was a long-term project. It required careful planning, based on the evidence of past developments and security compromises in the WEF nexus. Making projections for the future of water resources in South Africa was a standard procedure; engineers worked from the most conservative projections on water availability for the future. They were typically the type of engineers and planners who preferred to posit security of supply as a prime focus in a water-stressed country. There was a level of thinking required that transcended even the conceptions of the free market in action.

Gumede sees the opposition to the Mbeki presidency emerging from the ranks of people who represented a 'new struggle'. The South African National Civic Organisation (SANCO) that had supported the ANC and civil society in the era of transition became increasingly marginalised after 1994. In the process of the new government taking firm control at all levels of governance, SANCO started losing its hold on local politics and leadership positions; it was destined to lose even more ground. The Mbeki government became increasingly astute in its dealing with the people, and a gap emerged for the Mbeki leadership group in the ANC to be bypassed. The focus was on the poor people who stood in line for water and sanitation service delivery while nothing seemed to happen at the local level. Many people were angered by electricity and water cut-offs, retrenchments and privatisation.[2142]

Importantly, Mbeki's approach, according to Suttner, was a top-down approach. By implication it meant that government's task was simply to ensure that water supplies reached the population. What was not taken into account were the consequences of the unevenness of infrastructure service distribution in a society notable for a distinct divide between the haves and the have-nots.[2143] Ultimately, Mbeki's free market views did not serve the purpose of the majority, especially those within the leadership of the ANC who opposed Mbeki's presidency. The global economic collapse by September 2008 was a conundrum the presidency was unable to deal with.[2144] The free market principle and the private sector did not quite lose its appeal for government and the water sector. Instead, it only had to have reasonable control of the state, preferably in the form of a mixed-economy for a developing country on the continent of Africa. That in itself – in terms of the WEF nexus – was problematic. It required of government to be constantly aware of the nexus in the triangular WEF structure. In developmental contexts there were, at times, a multitude of panarchies endlessly passing through various phases of conservation, collapse, recovery, demise and even stagnation. The inability of the sectoral governance authorities to seek appropriate adaptive strategies in response to a multitude

2142. Gumede (2005:351–360).

2143. Suttner (2009:117).

2144. Helleiner (2011:67–87).

of creative destruction processes compromised the resilience of a complex social ecology in a highly vulnerable phase of adaptation.

By 2009, private sector partnership with the public sector in South Africa had taken a new turn. There were indications of a renewed initiative for the Department of Water Affairs to bring in private sector partners for the development of infrastructure, specifically at the level of local government water and sanitation service delivery. Broad-based black economic empowerment was a significant driving force. The climate for greater private sector participation in infrastructure development was favourable. It created semi-skilled and specialised job opportunities in the 2006 'Accelerated and Shared Growth Initiative for South Africa' (Asgisa) under the stewardship of deputy president Phumzile Mlambo-Ngcuka.[2145]

In terms of the realisation of the social ecological hydraulic mission to which the department had aspired since 1994, there appears to have been a strong commitment to improve human livelihoods. However, progress was bedevilled by numerous complex problems related to securing water and proper sanitation for South Africans – even those in the most isolated areas of the country.

The willingness of government to commit itself to the MDGs meant that in the longer term South Africa performed well by the mid-2010s. The implications of the AMD problem that reared its head in 2002, and the electricity crisis in 2008, served as reminders for the water governance sector that although water and sanitation service delivery to the public was a prime objective, there remains an inherent responsibility to address legacy issues and to ensure sufficient supplies of water, precious water.

2145. Office of the Presidency (2008); Haskins (2008).

Chapter 15

Conclusion

A panarchy perspective on water governance

The 20th century saw the emergence in South Africa of a unique exceptionalism. It was possible for the inhabitants of Britain's southern African colonies and the former Afrikaner republics to form a lasting union that continued to grow well into the 21st century. The major accomplishment was the ability to take the first steps to a non-racial democratic society in 1994. The social ecological system of a united South Africa proved itself to be a resilient state entity. In the country's water governance sector, for the greater part of the century, there was a remarkable ability to make headway through periods of creative collapse (Ω) into states of near disaster and a multitude of sequences of panarchy cycles.

In many respects the country's water sector can be interpreted as a barometer for reflecting on the often rapid, sometimes turgid responses to change and the regrouping of available resources (r) to move swiftly into a mode of restoring a state conducive to the conservation (K) of valuable resources in a water-scarce country.

At the time of Union in 1910, the Department of Irrigation's knowledge of the water resources of the Union of South Africa was limited. The pace was slow, and water infrastructure was associated primarily with the development

How to cite: Tempelhoff, J.W.N., 2018, 'Conclusion', in *South Africa's water governance hydraulic mission (1912–2008) in a WEF nexus context*, pp. 545-556, AOSIS, Cape Town. https://doi.org/10.4102/aosis.2018.BK75.15

of an irrigation–food hydraulic mission. The establishment of a departmental meteorological section to study weather conditions provided valuable information on the conservation and use of the country's water resources. In turn, this paved the way for a better understanding of natural disaster events (droughts and floods) and how to move into appropriate modes of water resources conservation, with a view to stimulating the development of technology for better irrigation. Intermittent social panarchy cycles of creative destruction (Ω), such as the First World War (1914–1918); the Rand Strike (1922); a change of government (1924); the worldwide economic depression (1930–1933); the formation of a united government across party political divides (1934) and the Second World War (1939–1945), stimulated creative opportunities for recovery. Some panarchy cycles played off simultaneously, such as the economic depression (1929–1933) and the drought of *c.* 1930 to 1933 – the one economic, the other social ecological. Mostly, panarchies were related to the considerable resilience and adaptive capacity that were stored in local (indigenous) knowledge memory systems. For many communities in the country (as was the case in the water affairs department for a century) it was possible to overcome hardship and even thrive innovatively when it was possible to adapt to changing ecological conditions. Most 'smooth' panarchy cycles, where creative destruction was responsible for new and innovative plans for being resilient, were the result of an enabling political, economic and social ecology. Water, in an almost unobtrusive manner, was at the nucleus of the infinitely evolving cycles of panarchy.

In the early years of the 20th century, irrigation technology and innovation was driven primarily by private sector demands for comprehensive water storage facilities and by the state subsidising modern farming technologies. By the 1930s, irrigation and the development of water-related infrastructure became panarchy cycles of uplifting indigent white communities in many rural areas of South Africa. In the process, the Department of Irrigation's hydraulic mission meant that wider sources of knowledge and the comprehension of highly diverse aquatic ecosystems called for further exploration. These circumstances created long cycles of memory distillation that translated into opportunities for research and experimentation in the water sector, with advanced construction strategies.

The front loop processes of successive panarchy cycles in the water sector cleared the way ahead for the development of mnemonic systems of understanding how to develop new social ecological systems. Learning from the past and by example, provided a coarse-grained foundation for innovative strategies of water use and governance. For example, accommodating indigent white people on the construction works at water storage and irrigation schemes gave rise to the need for more knowledge on water and its use in conjunction with farming communities. Dedicated formal educational institutions created further opportunities for future farmers to flourish under circumstances of conserved mnemonic insight on how to operate in anthropogenic systems in which water stimulated food production.

Destructive back loop panarchy cycles were typically creative destruction phases of back loop development (*r*), responsible for uncertainty and the demise of vulnerable social ecological systems. The collapse of irrigation systems because of drought and/or flood conditions, are examples of fluctuating states in which only sheer resilience assured success. In most cases where collapse – in the form of natural disaster (droughts and floods) – was responsible for a diminished capacity to conserve available resources, the social ecological system was able to adapt resiliently to change, and simultaneously to recover.

■ Water governance in the 20th century

The agency role played by water in the development of predominantly white urban settlements, industrial development and farming enterprise, was far more complex than can be accounted for in mere causal terms. A contingent network of officials and advisers in key sectors was vitally important. The Department of Irrigation, in collaboration with the Department of Agriculture, advised the political leadership, who were well-connected with their constituency, making it possible to stem the tide of rural poverty with a measure of success. However, it was a space in time that only temporarily halted the surging tide of white urbanisation in South Africa in the first half of the century. In urban social ecological panarchy cycles, adaptation and the ability to thrive under conditions of collapse, signified a knowledge accumulation mode of revolt that had to drive change.

The political economy of South Africa, although still informed by a white, Western European capitalist mindset, became more diversified. In the water sector, officials in the irrigation circles transmitted relevant information from the periphery to the core of departmental and exogenous market-oriented operations. Although ethnicity played a role in political power transitions, it was shaped by economic forces, such as the growing contribution of the burgeoning mining industrial sector, which enabled the country to pass relatively easily through conditions of global economic depression in the early 1930s.

South Africans' international exposure and the experience gained under circumstances of the Second World War (1939–1945) informed the country's water sector on strategies of developing ecologies of security, support, utility and innovation. Although development was on hold in the water sector during the war years, the system had to be maintained, in the interest of WEF nexus security. Under conditions of rapid panarchy cycles shaped by belligerent conflict and international struggle, creative destruction translated into the first plans for a new hydraulic mission conducive to industrialisation (especially energy production), in addition to the existing support given to the food-producing sector.

In a phase of remarkable industrial development, the post-war era saw the rural-based irrigation–food hydraulic mission dwarfed by the growing need for water security. In terms of the WEF nexus, this marked the onset of a phase when energy (electricity) became part of a more expansive development process. Key creative destruction events responsible for change and transformation were not always at the epicentre of development. Exogenous forces, sometimes on the periphery of the national political economy, played an important triggering role. The introduction of an industrial–energy hydraulic mission was shaped and directly influenced by these profound changes that were stimulated by exogenous revolt and uncertainty. The onset of the European decolonisation of Africa (1957–1980); warfare in the Middle East (1965–1970s); the international oil crisis (1973); and intermittent events ascribed to the 'communist threat' in the era of the Cold War and the end of the East-West divide (1947–1989). In the evolving social ecological system of South Africa, the exogenous and intermittent states of revolt also registered internally. The rapid changes had a profound influence on the water sector and the operations of the state.

Endogenous contributors to creative destruction leading to states of revolt included:

- the unexpected change of government in the favour of a conservative white minority (1948)
- black opposition to apartheid – subdued (1955–1963), and overt (1976–1989)
- South Africa's increasing international political isolation, starting in 1960 and then escalating between 1976 and 1989
- the creation of 'independent' African homelands (1976–1982–1983)
- constitutional changes (1961, 1983–1984)
- drought conditions (1959–1966, 1978– *c*. 1987 and 1991–1993)
- the decline of peak gold mining (1973–1980)
- the transition to a more moderate white political leadership open to deliberations on political change across the long-standing racial divide in the country (1989–1994).

The 1950s – Post-war development

In the water sector, the Second World War created a sense of urgency for the need to provide sufficient resources for promoting industrialisation. The 1950s ushered in a period of exceptional growth in socio-economic terms. However, from an environmental perspective it was a phase of unsustainable development. The rapid growth and development could not be sustained ad infinitum.

South Africa, like most Western countries, opted for a modernity that was notable for its increasing reliance on deterministic and mechanistic strategies of governance and technological innovation. Under circumstances where science featured prominently in the industrial–energy hydraulic mission, water as a natural resource, secured its rightful place. The understanding was that available resources had to be shared, with a greater certainty of supply under circumstances of unprecedented change.

As a result of demographic shifts in the process of urbanisation and the demand for labour in an industrialising South Africa, government was prompted to increase access to water resources by subsidising the development of urban infrastructure, such as water purification and wastewater treatment. Energy, in the form of electricity, was a key driver of the changing face of South Africa. In the unfolding political economy, the state underestimated the future potential of near-revolutionary political protest in panarchy's front loop conservation process. It stimulated uncertainty in the form of international economic isolation.

The 1960s – Postcolonialism

The transforming African continent of the 1960s, where new African states replaced European colonial regimes, was a fear factor that drove the social ecological system of front loop conservation and production of profitable resources in the white-ruled state. It meant there had to be more deterministic technologies for securing reliable water and energy resources in the face of increasing isolation in an international society where human rights, since 1948, had become a moral touchstone of liberty. In ecological terms, production processes were destructive, as a result of the deterministic drive to bolster a hybrid sense of historical memory in the face of opposition. The persistence of an exclusive political ecology had dire consequences. Participation in democratic statecraft was beyond the reach of South Africans of colour.

The country's political economy sustained a social ecology where the natural forces inherent in water were redirected. Advanced home-grown technologies, large development schemes and significant advances in science and engineering neutralised the threat of political instability. In a remarkable phase of deterministic science and technology, water could be transferred to anywhere in the country where there was a demand for the resource. Concealing the state of water resources – often for national security purposes – while ensuring that urban dwellers secured copious domestic supplies, was a result of highly effective resource conservation measures. Signs of the creative destruction process registered in key river catchment areas of the country, where urban industrial communities shed wastewater indiscriminately.

This indiscriminate use of water had serious ramifications whenever natural disasters, such as droughts and floods, led to water security being increasingly compromised.

The 1970s – Infrastructure progress

By the 1970s, marketing water as a scarce natural resource mobilised an apparent sense of national pride in the country's accomplishments. It was conducive to the accumulation of a historical consciousness that supported long cycles of resource conservation, and mitigated potential security breaches in the WEF nexus. The Department of Water Affairs, armed with a comprehensive masterplan, made substantial headway. It was no longer merely a matter of civil engineers and pipes, pumps and proper storage facilities. Instead, the cornerstones of water sector operations became:

- optimising the country's limited exposure to developments in the international water sector
- conducting good scientific and technological research
- planning and embarking on infrastructure development projects by using home-grown management strategies
- successfully executing projects
- maintaining existing infrastructure.

In the 1970s, at a time when South Africa's industrial–energy hydraulic mission reached its peak, the first serious threat to the white minority government presented itself, in the Soweto uprisings of 1976. Attempts at maintaining the wobbling minority government with outdated apartheid policies proved futile. The country soon shifted increasingly towards a post-apartheid society. As South Africa became more isolated from the international community, international sanctions on trade and communication increased. In an era when gold producing had passed its peak, the country was spending vast sums on defence and its people were up in arms, the old regime floundered. The declining memories of economic growth and development, switched to repetitive states of revolt, in the back loop of the panarchy cycle.

The 1980s – Institutional change

By the 1980s the Department of Water Affairs, as a social ecological subset in the political economy of the day, underwent signal transformational changes. The department had to be integrated intermittently into other government departments, such as forestry and environmental affairs. At the same time, although the merger of departments was largely for economic reasons, it created valuable opportunities for intellectual cross-fertilisation of ideas between the departmental disciplines, and was conducive to the generation of new and relevant knowledge systems. However, the constant barrage of new and dynamic panarchy cycles of seismic political economic proportions had a negative effective on the country's water governance sector. In terms of the 1966 Helsinki Rules on the Uses of the Waters of International Rivers, by the 1980s the collaboration between white South Africa and the 'independent homelands', had paved the way for a nefarious water governance system. There were too many gaps within the socio-economic system in which the department operated, and its processes became increasingly opaque. Exogenous political and economic stresses put the institutional social ecology under severe duress, and the system was unable to adapt resiliently to change.

The 1990s – Social ecological development

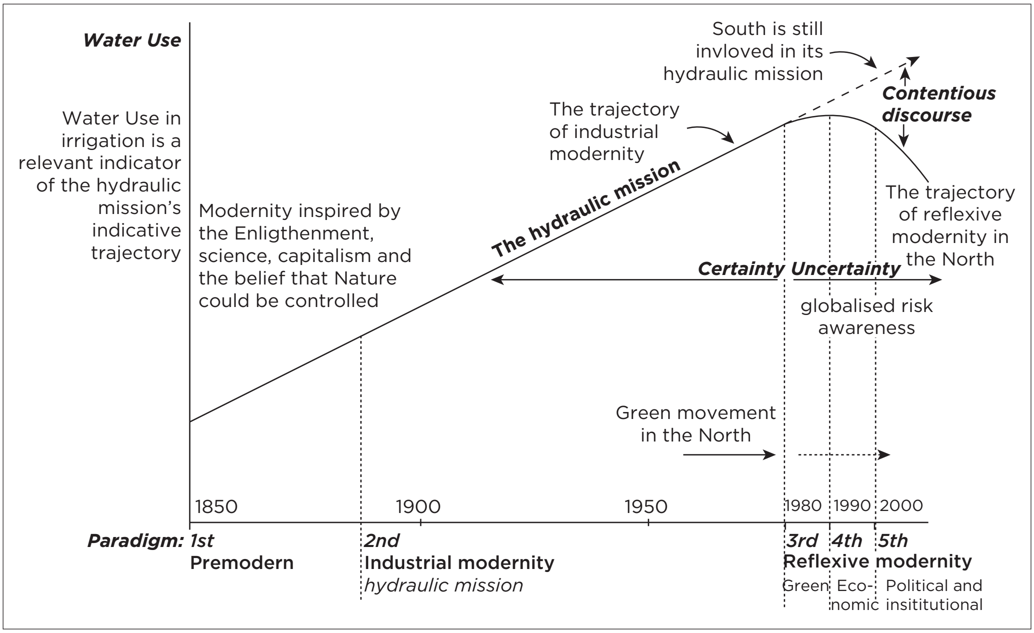
By the 1990s, the economy and a changing global political environment were responsible for a process of creative collapse that drove South Africa, and the water sector, into another development trajectory, replete with a new hydraulic mission – a people-centred (social) ecology. To understand South Africa's exceptional development path in the post-1990 period, it makes sense to take note of Allan's analysis. In 2004, addressing members of the IWHA at a UNESCO-sponsored symposium in Rome, Allan provided a comprehensive and mature exposition of the concept of the hydraulic mission.[2146]

He focused strongly on the 20th century and explained that whereas states in the northern hemisphere had abandoned the hydraulic mission in the 1970s, it still prevailed in the Global South. The green movement, for example, was successful in gaining significant support for advocating a more environmentally friendly stance towards riverscapes. At the same time, emergent postmodernist discourses called for a revision of water management in arid and semi-arid regions of the United States, Australia and in Israel. There were, Allan argued, changing water policies in the neo-liberal North, while the Global South still clung to late modernity. Furthermore, there was a changing perception of risk. This was at variance with the hitherto conventional risk and security management strategies. The passionate search for 'certainty' of supply now made way for an approach of dealing with and living with a sense of uncertainty.[2147]

Interestingly, the states of the Global South (of which South Africa forms part) persisted with a conventional hydraulic mission because of their ongoing aspiration to develop their national water infrastructures. For water historians, Allan's diagrammatic exposition of the five chronological development paradigms of the hydraulic mission must have been a useful pointer to developmental trends in the 20th century (Figure 15.1). It certainly caught the attention of many water sector theorists.

2146. Allan (2004:135–149).

2147. Allan (2004:136–139).



Source: Allan (2004:135–149).

FIGURE 15.1: Allan's five management paradigms of the hydraulic mission in the 20th century.

Subsequently there have been a number of additions to our understanding of the hydraulic mission; Molle's innovative views are of particular interest. His work takes the chronological trajectory further back in time and also links the concept to river and water resource management in which a bureaucracy, and even a politically strong 'hydrocracy' is able to take control of the way resources are governed.[2148] In South Africa we have clearly clung tenaciously (and safely) to the concept of the hydraulic mission – true to Allan's typology. But then there was also an emergent alternative discourse.

Comparing Allan's graphic exposition of international developments in the 20th century, it firstly becomes evident, as was pointed out in earlier sections of this study, that environmental awareness caught on in South Africa's water sector by the 1980s.[2149] This was not the case in many states of the Global South. Instead, they were mostly informed by international NGOs and their activist representatives. In South Africa this was not necessarily the case.

Although the local conceptualisation of what constituted environmental awareness was still a project under construction, there were clear indications of awareness and applications in the department's institutional knowledge system.[2150]

2148. Molle (2009:484–494); Molle, Mollinga and Wester (2009:328–349); Molle and Wester (2009).

2149. RP51/1981 (1981:92).

2150. Roberts pers. comm., 17 January 2017; Dominy (1970:1–4).

However, in times of emergency planning and crises (natural drought and the growing industrial–energy demand), environmental considerations were at times relegated to a lower priority status. The local water sector, as was the case in the northern hemisphere, was reflexive on matters related to green thinking. It was almost as if the department responsible for water governance managed, at times to move out of the conventional hydraulic mission paradigm. For example, in dealing with the demand for more water stresses, anthropogenic forays into deterministic technological strategies of water transfer systems were more compatible with systems operating in the post-hydraulic mission era in the northern hemisphere water sector.

Secondly, from 1990 to 1994, South Africa embarked on a social ecological hydraulic mission, notable for socialisation and the idea of access to water for all. Despite a declining economy, the state was hard at work to secure water and sanitation services for members of the country's previously disadvantaged rural communities. South Africa was once again part of the international water sector and it even entertained the idea of privatising water – a measure that would have asserted a profound influence on the way the department understood water services operations.[2151] In terms of the legislation of the 1990s, water planning in the DWAF was subject to economic constraints. Temporarily, there was a diminishing interest in resource planning. The planners' proposals were too costly for a state experiencing severe financial constraints.

Thirdly, in terms of the Global North's political and institutional development phase, there was a similar definitive South African shift towards water privatisation. But then South Africa aligned itself safely with the Global South states – a valued stand of exceptionalism that did not go unnoticed when external observers focused their research on trends in the Global South.[2152]

South Africa's water governance in the 21st century

The factors instrumental in driving creative destruction in the era of the social ecological hydraulic mission included:

- deliberations between key stakeholders (*r*) on the political future of South Africa (1987–1993)
- the country's re-absorption (*r*) into the international community of the world's states (1992)
- South Africa's multiracial democracy in 1994 (Ω)
- the weakening of the South African economy (α) as a result of political uncertainties (1996–2002)

2151. Muller (2007:41–42).

2152. McKinley (2005); Khan (2007); Trawick (2003:977–996); Ruiters (2002).

- an emergent global clash of religions (11 September 2001)
- neo-liberal economic theories (α) promoting water privatisation (1999–2006)
- lapses in sanitary water management (*r*) and the introduction of free water (2001)
- relapses and lapses in the water management of old gold mines (r-α) on the former Witwatersrand (2002)
- lapses in local authorities' water and sanitation service delivery (Ω) and the rise of civil protest (2004–2009)
- lapses in maintaining key elements of the industrial–energy hydraulic mission (Ω) of which the countrywide electricity load-shedding events were an acute symptom (2008)
- the global financial crisis of 2008 (α).

South Africa in the early 2000s, as was the case in the Global North, was part of what Allan describes as 'reflexive modernity'. Politically and economically the state supported neo-liberal economic principles despite deepening levels of societal poverty. The water sector adapted institutionally to providing societal support with the introduction of a free water policy, while also subscribing to the principles of environmental awareness, sustainable development and equity for all.

South African exceptionalism in the second half of the early 2000s – a time when economic growth and the introduction of a multiracial system of governance had entrenched itself – should be seen as the emergence of a complex, robust society. The birth of the new South Africa in 1994 was against the grain of popular pessimistic views of South Africa. There was a panarchy cycle of uncertainty in the back loop process (*r*) of the cycle as the country's leaders embarked on deliberations that paved the way for a new non-racial democracy. Cynical observers had it that it was merely a matter of time before the country would follow the same route as many other states on the continent. Politically and economically, after 1994, South Africa remained a trendsetting and influential role model in Africa, particularly in the context of the BRICS (Brazil, Russia, India, China and South Africa) group of developing states.[2153]

The country's water sector also stood up to critical scrutiny. The LHWP, the most comprehensive project of its kind on the continent at the time, began operations in the late 1990s. South Africa, now an integral part of the SADC was active in supporting transboundary water management strategies for the benefit of the subcontinent. By 2008, the young democracy had all the makings of a state of substance, playing a responsible and exemplary role in supporting

2153. Allan (2011:3264).

international climate change deliberations and the MDGs – areas in which the country's water sector had a substantial role to play.

On the downside of the equation, South Africa's exceptionalism did not preclude the country from becoming a typical developmental state in the Global South. This was evident in the water sector where, despite a few diehard remnants of the institutional knowledge that had been in the system prior to 1994, there were increasing indications of a lack of essential human resources to step in and take over the baton from an older generation of water workers, workers who had honed their skills on large construction projects, challenging technological innovations and the benefits of access to exclusive educational and research facilities.

The most disconcerting trend was a growing shortage of skills, particularly in the field of engineering.[2154] The knowledge system that evolved over a period of almost a century started disintegrating in some areas, as a result of a widening technology knowledge gap. This was evident in fields of research, in science and technology, in the maintenance of infrastructure, in water resource planning, and in the development of information communications technology and data systems. However, as Muller explains, many of the problems could be related to issues of water politics, with consulting engineers taking over in places where skilled water sector workers had earlier opted for retirement.[2155]

The first decade of the 21st century in South Africa, as was the case in the northern hemisphere states, was notable for persistent uncertainties in the water sector.[2156] Increasingly, the idea of the WEF nexus gained traction in the international water sector.[2157] Water, energy and food had been part of the country's hydraulic mission since 1912. In the new millennium, global climate change, population growth and rapid urban development posed a security threat to future economic development to most developing countries, largely as a result of the prevalence of uncertainty about the future.

South Africa had one major advantage. Since the 1970s the country had been exposed to constant social ecological and political transitions. Given the rapid and successive cycles of panarchical change, society had been able to develop a sense of resilience that enabled it to thrive under circumstances of social ecological change. Resilience is where there is an awareness of a social ecological system capable of rewarding, against all odds, whoever continues

2154. Lawless (2005).

2155. Muller (2007:37–38).

2156. Sedlack (2014).

2157. Muller (2015:675–694).

to adapt under difficult circumstances. The historical record suggests South Africa's water sector has, perhaps unwittingly, had a long and deep engagement with the WEF nexus in the water sector. Its ability to adapt, innovate and responsibly govern the increasingly finite resources, in the interest of the country and its people, augurs well for the future.

References

'A tribute to Dr GJ Stander', *SA Water Bulletin*, September, pp. 3–4.

'ANC looks internally for service delivery protest plotters', *SABC News*, 06 September, 2009a, n.p.

'Bushkoppie outfall sewer – Less than a year to completion; phase one is holed through', *Public Works Construction and Transport*, May, 1978, pp. 10–11.

'Common communication currency developed for resources', *SA Water Bulletin*, May–June, 1997, pp. 25–27.

'Constitution averts RDP water crisis', *Engineering News*, 14 May, 1999a, n.p.

'Decision looms for new Cape dam', *Engineering News*, 14 May, 1999b, n.p.

'Effective control of water pollution ensured by new Act – Ministry of Health', *SA Water Bulletin*, August, 1978, pp. 10–12.

'Fishing industry: Pollution studied', *SA Water Bulletin*, May, 1982a, pp. 1–3.

'Honour for S.A.: Marais to aid Brazil on water', *SA Water Bulletin*, October, 1975, p. 3.

'Important notice', *SA Water Bulletin*, November, 1976a, p. 1.

'Luxembourg – Pollutants discussed: Howell: UK no to EEC unified standards', *SA Water Bulletin*, February, 1976b, p. 4.

'Machadodorp protest spills over to nearby town', *SABC News*, 13 October, 2009b, n.p.

'Maguga hailed as co-operation symbol', *The Civil Engineering Contractor*, June, 2002, pp. 34–36.

'New tannery in Harrismith: High salinity is largest threat says minister', *SA Water Bulletin*, August, 1982b, pp. 18–19.

'Pilot plant for tannery effluent commissioned', *SA Water Bulletin*, November, 1977a, pp. 5–9.

'Progress on pollution – Stander warns: Economic aid could cripple countries', *SA Water Bulletin*, November, 1976c, p. 1.

'Qedusizi Dam – The suffering has ended', *The Civil Engineering & Building Contractor*, March, 1998, n.p.

'Qedusizi dam to avert further Ladysmith flooding,' *Construction World*, August, 1996, pp. 38-39.

'River reviewed', *SA Water Bulletin*, March–April, 1994, n.p.

'SA water bill runs into trouble', *World Water and Environmental Engineering,* 1998, n.p.

'SA will build more large dams', *Engineering News*, 19 June, 2003, n.p.

'UN report: Water management – Changes essential', *SA Water Bulletin*, June, 1976d, n.p.

'Vrugte- en groenteïnmaak: Water onder die loep', *SA Water Bulletin*, August, 1982c, pp. 1–2.

'Wastewater: Conference a landmark say delegates', *SA Water Bulletin*, June, 1977b, pp. 8–10.

'Water reclamation: 'S.A. showed the way' – U.K. editor', *SA Water Bulletin*, 1977c, pp. 1–2.

'Workshop discusses "tools for cleaner production"', *SA Water Bulletin*, 2001, p. 1.

'World Bank is satisfied with progress', *Pretoria News*, 24 October, 1996, n.p.

'World in water crisis', *Engineering News*, 28 April, 2000, n.p.

'World Water Forum meets in The Hague', *SA Water Bulletin*, March–April, 2000, pp. 4–5.

'WRC new contracts: Co-operation invited....', *SA Water Bulletin*, May, 1982d, p. 9.

'WRC workshop looks at SA's future salinity', *SA Waterbulletin January*, 1990, pp. 16–19.

Abrams, L., 1994, '*Sanitation in South Africa – What is the position?',* n.p.

Acemoglu, D. & Robinson, J., 2012, *Why nations fail: The origins of power, prosperity, and poverty*, Crown Publishers of Random House, New York.

ActionAid, 2016, 'Running on empty: What business, government and citizens must do to confront South Africa's water crisis', *Water interrupted campaign*, p. 64, ActionAid South Africa, n.p.

Adler, R.A., Claassen, M., Godfrey, L. & Turton, A.R., 2007, 'Water, mining, and waste: An historical and economic perspective on conflict management in South Africa', *The Economics of Peace and Security Journal* 2(2), 33-41.

Advertisement, 1921, 'The "Gearing" windmill', *The Sun and Agricultural Journal of South Africa* 12(1), 74.

African National Congress, 1994, *The Reconstruction and Development Programme: A policy framework*, Umanyano Publications, Johannesburg.

African Union, 2016, *New Partnership for Africa's Development (NEPAD)*, viewed 17 December 2016, from http://bit.ly/2hbRJGK.

Agricultural Journal of South Africa, 1916a, 'McNamara shot drill', *Agricultural Journal of South Africa* 4(20), 51–53.

Agricultural Journal of South Africa, 1916b, 'Opening of Klerksdorp irrigation reservoir and works', *Agricultural Journal of the Union of South Africa* 4(19), 4–6.

Agricultural Journal of South Africa, 1916c, 'The progress of agriculture', *Agricultural Journal of South Africa* 3(18), 161–164.

Agricultural Journal of South Africa, 1921, 'The true wealth of South Africa', *Agricultural Journal of South Africa* 12(1), 73–75.

Agricultural Journal of South Africa, 1923, 'Irrigation progress: (Gas engines for irrigation Eastern Transvaal)', *Agricultural Journal of South Africa* 14, 27.

Agricultural Journal of the Union of South Africa, 1911, 'South African irrigation association: First annual congress', *Agricultural Journal of the Union of South Africa* 2(6), 799–809.

Albertyn, J.R. & Rothmann, M.E., 1932, 'Sociological report: The poor white and society; and Mother and daughter in the poor family', *The poor white problem in South Africa: Report of the Carnegie Commission of Investigation*, vol. 5, Pro Ecclesia, Stellenbosch.

Alexander, W., 2002, *No water no future: A water focus for Johanesburg*, United Nations, Washington DC.

Alexander, W., 2014, 'A walk down memory lane: Remembering the golden years of dam building: Water history', *Water Wheel* 13(1), 20–23.

Allan, J.A., 1999a, 'The Nile basin: Evolving approaches to Nile waters management', *SOAS Occasional Paper* 20, 1–11.

Allan, J.A., 1999b, 'Water stress and global mitigation: Water food and trade', *Arid Lands Newsletter* 45.

Allan, J.A., 2004, 'Water resource development and the environment in the 20th century: First the taking, then the putting back', paper presented at the The Basis of Civilization – Water Science?, *Proceedings of the UNESCO/IAHS/IWHA Symposium*, Rome, December 2003, n.p.

Allan, J.A., 2006, 'IWRM: The new sanctioned discourse?', in P.P. Molinga, A. Dixit & K. Athukorala (eds.), *Integrated water resources amanagement: Global theory, emerging practice and local needs*, pp. 38–63, Sage, New Delhi.

Allan, J.A., 2011, *Virtual water: Tackling the threat to our planet's most precious source*, I.B. Taurus, London.

Allouche, J., 2010, 'The multi-level governance of water and state building processes: A longue dureé perspective', in K. Wegerich & J. Warner (eds.), *The politics of water: A survey*, pp. 45–67, Routledge, London.

Altona, R.E., 1963, 'Agriculture in the Republic of South Africa past, present and future', *South African Journal of Science* 59(11), 517–523.

Anderson, A.J., Mahlangu, M.S., Cullis, J. & Swarts, S., 2008, 'Integrated monitoring of water allocation reform in South Africa', *Water SA* 34(6), 731–737.

Andrews, H.G., 1931, The Hartebeestpoort irrigation scheme with side-lights on land policies, University of South Africa, n.p., 1931.

Annan, K., 2000, *We the people: The role of the United Nations in the 21st century*, United Nations Organisation, New York.

Anonymous, n.d.a, *About us*, viewed n.d., from http://goo.gl/Yiu8zP.

Anonymous n.d.b, *eWISA company members: Magalies Water*, viewed n.d., from http://goo.gl/rGYxjx.

Anonymous, n.d.c, *Fanie Botha, a senior member of the cabinet, announced his resignation…*, viewed n.d., from http://goo.gl/DxFcGp.

Anonymous, n.d.d, *Umgeni Water Amanzi: Promotion of access to information Act Manual. Compiled in terms of Section 14 of the Promotion of access to information Act, Act. No 1 of 200: 2012–2013*, viewed n.d., from http://goo.gl/2wObBH.

Anonymous, n.d.e, *Virtual water – Tony Allan*, viewed n.d., from http://bit.ly/2cw1VGX.

Arbousset, T. & Daumas, F., 1846, *An exploratory tour to the north-east of the colony of the Cape of Good Hope*, transl. J.C. Brown, Saul Solomon & Co., Cape Town.

Archer, S., 2002, 'Technology and ecology in the Karoo: A century of windmills, wire and changing farming practice', in S. Dovers, R. Edgecombe & B. Guest (eds.), *South Africa's environmental history: Cases and comparisons*, pp. 112–138, Ohio Press, Athens.

Ashton, P., 1994, 'Setting realistic user requirements to enhance water quality', *Proceedings of the International Waste Management Conference*, Midrand, South Africa, n.d., pp. 1–7.

Ashton, P.J., Earle A., Malzbender D., Moloi M.B.H., Patrick, M.J. & Turton, A.R., 2006, *A compilation of all the international freshwater agreements entered into by South Africa with other states*, Water Research Commission, Gezina.

Ashton, P.J., Turton, A.R. & Roux, D.J., 2006, 'Exploring the government, society, and science interfaces in integrated water resource management in South Africa', *Journal of Contemporary Water Research & Education* 135(1), 28–35. https://doi.org/10.1111/j.1936-704X.2006.mp135001004.x

Asmal, K., Hadland, A. & Levy, M., 2011, *Kader Asmal: Politics in my blood: A memoir*, Jacana, Auckland Park.

Atkinson, D., 2007, 'Taking to the streets: has developmental local government failed in South Africa', in S. Buhlungu, J. Daniel, R. Southall and J. Lutchmann (eds), *State of the Nation South Africa 2007*, HSRC Press, Cape Town.

Atkinson, G., n.d., *Towards a new policy for water supply & sanitation in South Africa*, Undated notes on a verbal contribution, n.p.

Austin, W.D., 2008, *Drought in South Africa: Lessons lost and/or learnt from 1990 to 2005*, Masters dissertation, Faculty of Science, University of the Witwatersrand.

Backeberg, G.R., 2004, 'Research management of water economics in agriculture – An open agenda', *Agrekon* 43(3), n.p., https://doi.org/10.1080/03031853.2004.9523655

Badenhorst, L.T., 1962, 'A demographic profile of the Vaal catchment area', in VRCA (eds.), *Vaal: Problems of a river's future (Papers read at a Symposium on the future of the Vaal River, Johannesburg 30–1 October, 1961)*, The Vaal River Catchment Association, Johannesburg, n.p.

Baghel, R., 2014, 'River control in India: Spatial, governmental and subjective dimensions', in M. Nüsser (ed.), *Advances in Asian human-environmental research*, Springer, Cham.

Bailey, I.W., 2003, *The impact of introducing treated water on aspects of community health in a rural community in KwaZulu-Natal*, vol. 181, Water Research Commission, Pretoria.

Baines, G., 2007, 'The master narrative of South Africa's liberation struggle: Remembering and forgetting June 16, 1976', *The International Journal of African Historical Studies* 40(2), 283–302.

Bakker, K. & Hemson, D., 2000, 'Privatising water: Bott and hydropolitics in the new South Africa', *South African Geographical Journal* 82(1), 3–12. https://doi.org/10.1080/03736245.2000.9713679

Bakker, K., 2007, 'The "Commons" versus the "Commodity": Alter-globalization, anti-privatization and the human right to water in the Global South', *Antipode* 39(3), 430–455. https://doi.org/10.1111/j.1467-8330.2007.00534.x

Ballard, C., 1986, 'Drought and economic distress: South Africa in the 1800s', *Journal of Interdisciplinary History* 17(2), 359–378.

Balon, E.K., 1978, 'Kariba: The dubious benefits of large dams', *Ambio* 7(2), 40–48.

Banister, J.M., 2014, 'Are you Wittfogel or against him? Geophilosophy, hydro-sociality, and the state', *Geoforum* 57, 205–214. https://doi.org/10.1016/j.geoforum.2013.03.004

Barnard, C.J., 1950, *Robert Jacob Gordon se loopbaan aan die Kaap*, Argiefjaarboek vir Suid-Afrikaanse Geskiedenis 1 vols., vol. 13, Staatsdrukker, Parrow.

Barradas, S., 2008, *Medupi (previously Project Alpha and Project Charlie), South Africa*, viewed 03 March 2017, from http://bit.ly/2mAHD8l.

Basson, J.L., 1980, *J.G. Strijdom: Sy politieke loopbaan van 1929 tot 1948*, Wonderboom-uitgewers, Pretoria.

Basson, N., 1996, *Passage to progress: The CSIR's journey of change. 1945–1995*, Jonathan Ball Publishers, Johannesburg.

Baynham, S. & Mills, G., 1987, 'Lesotho: Between sependence and destabilisation', *The World Today* 43(3), 52–54.

Bean, C.E.W., 1913, 'The wool industry in the British Dominions', *Journal of the Royal Society of Arts* 61(3143), 327–347.

Bearak, B., 2009, 'South Africa's poor renew a tradition of protest', *The New York Times*, 06 September, n.p.

Behrmann, H.I., 1963, 'The agricultural economy of the Natal Region', *Agrekon* 2(4), 32–38. https://doi.org/10.1080/03031853.1963.9524675

Beinart, W. & Delius, P, 2015, 'The historical context and legacy of the Natives Land Act of 1913', *Journal of Southern African Studies* 40(4), 667–688. https://doi.org/10.1080/03057070.2014.930623

Beinart, W. & McGregor, J., 2003, 'Introduction', in W. Beinart & J. Mcgregor (eds.), *Social history and African environments*, pp. 1-24, David Philip, Cape Town.

Beinart, W., 1984, 'Soil erosion, conservationism and ideas about development: A southern African exploration, 1900–1960', *Journal of Southern African Studies* 11(1), 52–83. https://doi.org/10.1080/03057078408708088

Beinart, W., 2003, *The rise of conservation in South Africa: Settlers, livestock, and the environment 1770–1950*, Oxford University Press, Oxford.

Bell, M., 2000, 'American philanthropy, the Carnegie Corporation and poverty in South Africa', *Journal of Southern African Studies* 26(3), 481–504. https://doi.org/10.1080/713683579

Bennett, B. & Kruger, F., 2015, *Forestry history and water conservation SA: History, science + policy*, World forest history series, Australian National University Press, Bennet.

Berges, F. & Folke, C., 2002, *Back to the future: Ecosystems dynamics and local knowledge*, Island Press, Washington DC.

Berkes, F., Colding, J. & Folke, C., 2000, 'Rediscovery of traditional ecological knowledge as adaptive management', *Ecological Applications* 10(5), 1251–1262. https://doi.org/10.1890/1051-0761(2000)010[1251:ROTEKA]2.0.CO;2

Bernstein, A., 2010, 'Water: A looming crisis?', *CDE Round Table* 14, 1–39.

Biesheuvel, S., 1963a, 'Orange river development conference', *South African Journal of Science* 59(10), 445–447.

Biesheuvel, S., 1963b, 'Summary of proceedings and recommendations', *South African Journal of Science* 59(10), 504–509.

Biggs, R., Westley, F.R. & Carpenter, S.R., 2010, 'Navigating the back loop: Fostering social innovation and transformation in ecosystem management', *Ecology and Society* 15(2), viewed n.d., from http://goo.gl/AEYS43.

Binns, T. & Nel, E., 1999, 'Beyond the development impasse: The role of local economic development and community self-reliance in rural South Africa', *The Journal of Modern African Studies* 37(3), 398–408. https://doi.org/10.1017/S0022278X99003067

Bizikova, L., Roy, D., Swanson, D., Venema, H.D. & McCandless, M., 2013, *The water–energy–food security nexus: Towards a practical planning and decision-support framework for landscape investment and risk management*, The International Institute for Sustainable Development, Winnipeg.

Bloch, R., 2011, 'Integrating urban planning and water management in sub-Saharan Africa', in M. Jacobsen, M. Webster & K. Vairavamoorthy (eds.), *Directions in development: The future of water in African cities: Why waste water?*, pp. 1–58, The World Bank, n.p.

Blyden, B.J., 1970, 'Apartheid and imperialism: A study of U. S. corporate involvement in South Africa', *Africa Today* 17(5), 1–39.

Boag, G. & McDonald, D.A., 2010, 'A critical review of public-public partnerships in water service', *Water Alternatives* 3(1), 1–25.

Bolitho, V., 1975, 'Economic aspects of wastewater treatment in South Africa', *Water SA* 1(3), 118–120.

Bolitho, V., 1976, 'Controlling the access of nutrients from point and diffused sources with special reference to the Pretoria/Witwatersrand/Vereeniging region', *Water SA* 2(5), 145–149.

Bond, P., 1999, 'Basic infrastructure for socio-economic development, environmental protection and geographical desegregation: South Africa's unmet challenge', *Geoforum* 30(1), 43–59. https://doi.org/10.1016/S0016-7185(98)00031-1

Bond, P., 2002, 'An answer to marketization: Decommodification and the assertion of rights to essential services', *Multinational Monitor* 23(7/8), 14–17.

Boniface, A., 1999, 'Some technical lessons learnt from construction of the Lesotho Highlands Water Project transfer tunnel', *Tunnelling and Underground Space Technology* 14(1), 29–35. https://doi.org/10.1016/S0886-7798(99)00011-5

Bonner, P., 2011, 'South African society and culture, 1910–1948', in R. Ross, A. Kelk Mager & B. Nasson (eds.), *The Cambridge history of South Africa 1885–1994*, pp. 254-318, Cambridge University Press, Cambridge.

Bonnin Hobson, S., 1897, 'Dam scrapers and irrigation', *Agricultural Journal of the Cape of Good Hope* 11(2), 90–92.

Bosman, I.P. & Osborn, G.J., 1924, 'King of cereals: Maize industry and South Africa', *Agricultural Journal of South Africa* 15(1), 83–86.

Botha, S.P., 1969, 'Minister sets the scene for "Water Year" 1970', *Civil Engineering* 11(11), 293–297.

Bottomley, J., 1992, 'The Orange Free State and the Rebellion of 1914: The influence of industrialization, poverty and poor whiteism', in R. Morrell (ed.) *White but poor: Essays on the history of poor whites in southern Africa 1880–1940*, pp. 29–39, University of South Africa Press, Pretoria.

Bourblanc, M. & Blanchon, D., 2014, 'The challenges of rescaling South African water resources management: Catchment Management Agencies and interbasin transfers', *Journal of Hydrology* 519(Part C), 2381–2391. https://doi.org/10.1016/j.jhydrol.2013.08.001

Bowman, L.W., 1968, 'The subordinate state system of Southern Africa', *International Studies Quarterly* 12(3), 231–261. https://doi.org/10.2307/3013506

Bozzoli, B., 1996, 'From governability to ungovernability: Race, class and authority in South Africa's black cities', in Institute for Advanced Social Research (eds.), *Seminar Paper*, p. 33, University of the Witwatersrand, Johannesburg.

Bozzoli, B., 2017, 'SA today: What would Marx have done?' *Politicsweb*, viewed n.d., from http://www.politicsweb.co.za/opinion/sa-today-what-would-marx-have-done.

Bozzoli, G.R., 1997, *Forging ahead: South Africa's pioneering engineers*, Witwatersrand University Press, Johannesburg.

Brain, J.B., 1982, 'Mariannhill centenary: A look at the early years', *Natalia* 12, 58–70.

Braine, C.D.H., 1911, 'Two methods of farm irrigation', *South African Journal of Science* 7(6), 242–250.

Braine, C.D.H., 1924a, 'Irrigation problems in South Africa – The case for small schemes', *The Journal of the South African Institution of Engineers*, 202–206.

Braine, C.D.H., 1924b, 'Private irrigation achievements', *Agriculture Journal of South Africa* 15, 66–71.

Braine, C.D.H., 1925, 'Mr. Braine on irrigation report', *The Sun and Agricultural Journal of South Africa* 16, 396.

Brand, S., Kelly, K., Rose, A. & Saffo, P., 2013, *The SALT summaries: October 02003–June 0212*, The Long Now Foundation, San Francisco.

Braun, Y.A., 2007, 'Development trade-offs in Africa: Dam building in Lesotho', in K. DiFrancesco & K. Woodruff (eds.), *Global perspectives on large dams: Evaluating the state of large dam construction and decommissioning across the world*, pp. 231–238, Yale University, New Haven, CT.

Braune, E. & Rogers, K.H., 1987, 'The Vaal River catchment: Problems and research needs', *South African National Scientific Programmes, vol. 143*, Foundation for Research Development, Pretoria.

Braune, E., 2000, *Towards a new phase of groundwater resource management assessment: Directorate geohydrology workshop 3 November 2000*, pp. 1–8, Department of Water Affairs and Forestry, South Africa.

Braune, E., Adams, S. & Fourie, F., 2014, *20 Years of groundwater research, development and implementation in South Africa 1994–2014*, Water Research Commission, Gezina.

Briscoe, J., 1992, 'Poverty and water supply: How to move forward', *Finance & Development* 29(4), 16–17.

Brits, J.P., 1993, 'The last years of South African Party rule', in B.J. Liebenberg & S.B. Spies (eds.), *South Africa in the twentieth century*, JL van Schaik, Pretoria.

Bromberger, N., 1978, 'Mining employment in South Africa, 1946–2000', *Saldru working papers, No. 15, vol. 112*, University of Cape Town, Cape Town.

Brown, J.C., 1877, *Water supply of South Africa and facilities for the storage of it*, Oliver & Boyd, Edinburgh.

Brown, K., 2002, 'Cultural constructions of the wild: The rhetoric and practice of wildlife conservation in the Cape Colony at the turn of the twentieth century', *South African Historical Journal* 47(1), 75–95. https://doi.org/10.1080/02582470208671435

Brown, K., 2003, 'Agriculture in the natural world: Progressivism, conservation and the state: The case of the Cape Colony in the late 19th and early 20th centuries', *Kronos* 9(2003), 109–138.

Bruwer, J.J. & van Heerden, P.S., 1995, 'Spotlight on irrigation development in the RSA: The past, present and future', *The South African irrigation symposium*, Water Research Commission, Durban, South Africa, June 04–06, 1991, pp. 3–10.

Bryant, R. & Goodman, M.K., 2008, 'Pioneering reputation: Assessing Piers Blaikie's contributions to political ecology', *Geoforum* 39, 708–715. https://doi.org/10.1016/j.geoforum.2007.01.012

Buckley, C.A., 1980, *Limnology of some selected South African impoundments*, p. 228, University of Natal, Durban.

Bundy, C., 1979, *The rise and fall of the South African peasantry*, pp. 45–46, University of California Press, Berkeley.

Bundy, C., 2016, *Poverty in South Africa: Past and present*, Jacana Media, Auckland Park.

Burtt-Davy, J., 1912, 'The preservation and use of maize for stock feed', *Agricultural Journal of the Union of South Africa* 4(6), 843–853.

Butzer, K.W., 2012, 'Collapse, environment, and society', *Proceedings of the National Academy of Sciences* 109(10), 3632–3639. https://doi.org/10.1073/pnas.1114845109

Cape of Good Hope, 1899, *76–99. Special report on colonial irrigation and hydrographic survey with statistics and map of the proposed hydrographical districts*, Government Printers, Cape Town.

Cape of Good Hope, CI/1903, 1903, *Report of the select committee on the system of deep well boring and the use of diamond drills*, Cape Times, Cape Town.

Carrere, R. & Lohman, L., 1996, *Pulping the South: Industrial tree plantations and the world paper economy*, Zed Books, London.

Carruthers, J., 2008, 'Wilding the farm or farming the wild? The evolution of scientific game ranching in South Africa from the 1960s to the present', *Transactions of the Royal Society of South Africa* 63(2), 160–181. https://doi.org/10.1080/00359190809519220

Carter, A.C., 1966, 'Discussion: Basutoland as a source of water for the Vaal Basin – bespreking', *Civil Engineering* 8(5), 1156–1166.

Carter, G.M., 1963, 'African nationalist movements in South Africa', *The Massachusetts Review* 5(1), 147–164.

Casalis, E., 1889, *My life in Besuto land: A story of missionarey enterprise in South Africa*, transl. J. Brierly, The Religious Tract Society, London.

CCGUA-Sot UN, 1990, *Annex: New Delhi statement: Some for all rather than more for some, 11 October*, International Environmental Law Research Centre, Geneva.

Centre for Water Resources Research, n.d., *Home*, viewed n.d., from https://www.ukzn.ac.za/tag/centre-for-water-resources-research/.

Chanson, H. & James, D.P., 2001, 'Historical development of arch dams: From cut-stone arches to modern concrete designs', *Australian Civil Engineering Transactions* 43, 39–51.

Chenge, M. & Johnson, P. (eds.), 1996, *Water in Southern Africa*, Southern African Development Community (SADC) & Southern Africa Research and Documentation Centre (SARD), The World Conservation Union (IUCN), Harare.

Chikoore, H., 2016, *Drought in southern Africa: Structure, characteristics and impacts*, University of Zululand, n.p.

Christie, R., 1978, '"Slim Jannie" and the forces of production: South African industrialisation 1915–1925', *Collected Seminar Papers. Institute of Commonwealth Studies* 22, 94–115.

Christie, R., 1984, *Electricity, industry and class in South Africa*, State University of New York Press, Albany.

Christopher, A.J., 1970, 'The European concept of a farm in Southern Africa', *Historia* 15(2), 93–99.

Christopher, A.J., 1984, *The crown lands of British South Africa 1853–1914*, Limestone Press, Kingston.

Chunnett, E.P., 1965, 'Indirect benefits as the major incentive to the establishment of irrigation schemes', *South African Journal of Science* 61(3), 99–103.

Civil Engineering = Siviele Ingenieurswese, 1999, 'All-round excellence – International technical award', *Civil Engineering = Siviele Ingenieurswese* 7(11–12), 13–18.

Civil Engineering, 1966, 'Division of hydraulic engineering – Symposium on methods for estimated evapotranspiration', *Civil Engineering* 10(5), p. 294.

Civil Engineering, n.d., *Civil engineering,* viewed 03 January 2017, from https://goo.gl/u1tIA6.

Clapham, C., 1993, 'Democratisation in Africa: Obstacles and prospects', *Third World Quarterly* 14(3), 423–438. https://doi.org/10.1080/01436599308420335

Clarke, J. & Wheeler, P.W., 1976, *The environmental crisis: An illustrrated guide to global environmental challenges*, The Star, Johannesburg.

Clayton, J., 2009, 'Foreigners flee as violence reignites in South African townships', Timesonline.co.uk, 25 July, n.p.

Cleghorne, W.S.H., 1915, 'The power of windmills', *Agricultural Journal of South Africa* 2(10), 148–152.

Cline, E.H., 2014, *1177B.C.: The year civilization collapsed*, Princeton University Press, Princeton.

Clynick, T., 1987, 'Chiefs, concessionaires and reserve politics on the Tlaping alluvial diamond diggings at Taungs, 1919-1921: A local perspectiove on segregation and class interests', *Wits History Workshop: The Making of Class*, University of the Witwatersrand, South Africa, February 09-14, 1987, pp 1-39.

Cole, M.M., 1957, 'The Witwatersrand conurbation: A watershed mining and industrial region', *Transactions and Papers (Institute of British Geographers)* 23, 249–265. https://doi.org/10.2307/621166

Comaroff, J. & Comaroff, J., 1986, 'Christianity and colonialism in South Africa', *American Ethnologist* 13(3), 1–22.

Comparative and International Law Journal of Southern Africa, 2000, 'Current legal developments', *Comparative and International Law Journal of Southern Africa* 33(3), 1–12.

Conley, A., 1988, 'The Department of Water Affairs a tradition of engineering excellence', *Civil Engineering* 30(5), 221–347.

Conley, A.H. & Van Niekerk, P.H., 2000, 'Sustainable management of international waters: The Orange River case', *Water Policy* 2(1), 131–149. https://doi.org/10.1016/S1366-7017(99)00026-4

Conradie, S.R., Messerschmidt, L.J.M. & Morgan, A.J., 2000, *Symphony of power: The Eskom story*, Chris van Rensburg Publications (Pty) Limited, Johannesburg.

Cooley, J.K., 1984, 'The war over water', *Foreign Policy* 54, 3–26. https://doi.org/10.2307/1148352

Cornell, C., 1921, 'The lower reaches of the Orange River', *The Geographical Journal* 574(4), 241–252. https://doi.org/10.2307/1780556

Cosser, E.M., 1987, *Water supply and utilization in Johannesburg, 1886–1905*, University of the Witwatersrand, Johannesburg.

Coyne, R., 2005, 'Wicked problems revisited', Design Studies 26, 5–17. https://doi.org/10.1016/j.destud.2004.06.005

Creamer, M., 2008, *On the air (15/08/2008)*, viewed 03 March 2017, from http://bit.ly/2mAHiCU.

Croucamp, W.S., 1983, 'SANCOLD-simposium beraadslaag oor veiligheid van damme', *Civil Engineering = Siviele Ingenieurswese* 25(1), 43–44.

Crush, J. & Jeeves, A., 1993, 'Transitions in the South African countryside', *Canadian Journal of African Studies* 27(3), 351–360. https://doi.org/10.1080/00083968.1993.10804325

CSIR, [2000] 2005, *Guidelines for human settlement planning and design: Volumes I and II*. Boutek Report BOU/E2001, CSIR Building and Construction Technology, Pretoria.

Daniels, R., 1987, 'The nature of the Agrarian land question in the Republic of South Africa', *The American Journal of Economics and Sociology* 46(1), 1–16. https://doi.org/10.1111/j.1536-7150.1987.tb01752.x

Davenport, J., 2008, 'Cape Town's largest-ever housing project seeks to cut reliance on Eskom power', Engineering News, 20 August, n.p.

Davenport, J., 2009, 'Enviro study into R1,5bn Western Cape wind farm project to start next month', *Engineering News*, 28 August, n.p.

Davies, R. & O'Meara, D., 1985, 'Total strategy in Southern Africa: An analysis of South African regional policy since 1978', *Journal of Southern African Studies* 11(2), 183-211 .

Davies, R., Kaplan D., Morris, M. & O'Meara, D., 1976, 'Class struggle and the periodisation of the state in South Africa', *Review of African Political Economy* 7, 4–30. https://doi.org/10.1080/03056247608703298

Davies, R.J., 1972, *The urban geography of South Africa*, p. 314, University of Natal, Pietermaritzburg.

Day, J. & Van der Merwe-Botha, M., 2010, 'Observations', paper presented at the Water: A Looming Crisis, Johannesburg, 14 April.

De Coning, C. & Sherwill, T., 2003, *An assessment of the water policy process in South Africa (1994 to 2003)*, Water Research Commission, Gezina.

De Pruydt, P.E., n.d., *Panarchy in Revue Trimestrielle, (Brussels, July 1860): Translation*, viewed n.d., from http://goo.gl/uwa8Sw.

De Villiers, H., 1973, 'Waterstudie'. *Panorama*, April, 1973, pp. 1–5.

De Villiers, J., 2004, 'Sosio-ekonomiese dimensies van Suid-Afrika in die dekade 1930–1940: Arm, maar darem, of ondernemend en presterend?', *Tydskrif vir Geesteswetenskappe* 44(2–3), 167–179.

De Wet, C., 1990, 'The socio-ecological impact of development schemes in the "homelands" of South Africa', *South African Journal of Science* 86(7–10), 440–447.

Debbané, A. M. & Keil, R., 2004, 'Multiple disconnections: Environmental justice and urban water in Canada and South Africa', *Space and Polity* 8(2), 209–225. https://doi.org/10.1080/1356257042000273968

Deedat, H., 2010, 'Observation', paper presented at the Water: A Looming Crisis Summit, Johannesburg, 14 April.

Delius, A., 1963, 'The intellectual's plight in South Africa', *Africa Report* 8(4), 23.

Dennett, D., 2017, *From bacteria to Bach and back: The evolution of minds*, WW Norton and Co., London.

Dent, M., 1989, 'The role of the Computing Centre for Water Research in Geographic Information Systems in southern Africa', *Paper presented at the International Confererence on Geographic Information Systems in southern Africa*, Pietermaritzburg, South Africa, n.d., 1989, n.p.

Department of Agriculture, 1926, *The great drought problem of South Africa*, Government Printer, Pretoria.

Department of Environmental Affairs, 1981, *TR102: PT Adamson, Southern African storm rainfall*, Government Printer, Pretoria.

Department of Envionmental Affairs, 1992, *Building the foundation for sustainable development in South Africa: National report to the United Nations Conference on Environment and Development (UNCED) to be held in Rio de Janeiro, June 1992*, Department of Environment Affairs, Pretoria.

Department of Information, 1971, *Taming a river giant: The story of South Africa's Orange River Project*, Department of Information, Pretoria.

Department of Irrigation, 1926, *Report of the Kalahari reconnaissance of 1925 with 5 plates and 29 figures*, Government Printer, Pretoria.

Department of Irrigation, 1951, *The water resources and use of water in the Transkei, Great Kei and Amatola main drainage regions, including the native territories of the Transkei and Ciskei*, Government Printer, Pretoria.

Department of Provincial and Local Government, 1998, *The white paper on local government*, Department of Provincial and Local Government, Pretoria.

Department of Provincial and Local Government, 2000, *White paper on municipal services partnerships. Notice 1689 of 2000, in Government Gazette, 418(21126), 26 April 2000*, Department of Provincial and Local Government, Pretoria.

Department of Provincial and Local Government, 2004, *The municipal infrastructure grant programme: An introductory guide*, Department of Provincial and Local Government, Pretoria.

Department of Public Service Administration, 1997, 'Batho Pele – "People first": White paper on transforming public service delivery', *Government Gazette*, Notice 1459 of 1997, 388(18340), 1 October 1997, Department of Public Service Administration, Pretoria.

Department of Water Affairs and Forestry & Water Research Commission, 1996, *Water law review process: The philosophy and practice of integrated catchment management: Implications for water resource management in South Africa*, pp. 1–146, Water Research Commission, Pretoria.

Department of Water Affairs and Forestry, n.d.a, *Annual report 2002/2003*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, n.d.b, *Sub-directorate: Operation and maintenance support for institutional arrangements*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, n.d.c *Report on flood damage: Hydrological gauging*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, n.d.d, *Electronic archives. National Toxicity monitoring programme for surface water: Record of decision report*, viewed n.d., from http://www.dwa.gov.za/iwqs/water_quality/ntmp/1Background_Ver1_23.pdf.

Department of Water Affairs and Forestry, 1961, *TR22: Agrohydrology*, Department of Water Affairs, Pretoria.

Department of Water Affairs and Forestry, 1973, *FTR56: Fisiese en chemiese eienskappe van damme in die Republiek van Suid Afrika*, HRI, Pretoria.

Department of Water Affairs and Forestry, 1975, *TR66: Remote sensing techniques applied to salinity problems of part of the Pongola Government Water Scheme*, Hydrological Research Institute, Pretoria.

Department of Water Affairs and Forestry, 1977, *TR72: The radiation balance over natural surfaces, Technical Reports Archive*, Department of Water Affairs, Pretoria.

Department of Water Affairs and Forestry, 1978, *TR80: Long range prediction of river flow: A preliminary assessment*, Department of Water Affairs, Pretoria.

Department of Water Affairs and Forestry, 1986a, *Management of the water resources of the Republic of South Africa*, Government Printer, Pretoria.

Department of Water Affairs and Forestry, 1986b, *Water transfer schemes in South Africa*, Government Printer, Pretoria.

Department of Water Affairs and Foresty, 1988, *Report of the committee on water demands in the Vaal River supply area forecast to year 2025*, Technical report, Volume A, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, 1994a, *White paper on water supply and sanitation policy*, vol. 38, Government Printer, Cape Town.

Department of Water Affairs and Foresty, 1994b, *Water supply and sanitation policy white paper: Water – An indivisible right*, Department of Water Affairs and Forestry, Cape Town.

Department of Water Affairs and Forestry, 1995, *You and your water rights: South African Water law Review: A call for public response*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, 1997a, *White paper on a national water policy for South Africa*, 64 unnumbered, South African Government, Pretoria.

Department of Water Affairs and Foresty, 1997b, *Minimum standards and guidelines for groundwater resource development for the community and sanitation programme*, pp. 1–104, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, 2000a, *Media Statement by the Minister of Water Affairs and Forestry Mr Ronnie Kasrils: Vaal River System Yield*, viewed n.d., from http://www.dwa.gov.za/Communications/PressReleases/2000/Media%20Statement%20on%208%20November%202000.pdf.

Department of Water Affairs and Foresty, 2000b, *Strategic plan 2000/2001*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, 2001, *Managing the water quality effects of settlements: The capacity gap in local government*, Water quality management series, p. 19, DWAF and the Danish Government's DANCED Programme, n.p.

Department of Water Affairs and Forestry, 2002, 'Towards a water services white paper: Issues and options discussion paper', *Government Gazette*, Notice 438 of 2002.05.03, 23377, 3 May 2002, pp. 1–48, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, *c.* 2002/2003, *Masimbambane – Let's work together to build a strong water services sector, Annual report 2001–2002*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, 2004a, *National water resources strategy*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, 2004b, *Our blue print for survival: National water resource strategy*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, *c.* 2006, *A history of the first decade of water service delivery in South Africa 1994–2004: Meeting the Millennium Development Goals*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs and Forestry, 2007, *Proposal for the establishment of the Berg Catchment Management Agency*, Department of Water Affairs and Forestry, Pretoria.

Department of Water Affairs, n.d., *Brugspruit water pollution control works in Water quality management*, viewed n.d., from https://goo.gl/eJwPMW.

Department of Water Affairs, 1959, *TR1: JF Enslin On the selection and delineation of suitable catchments for hydrological research*, edited by Department of Water Affairs, Pretoria.

Department of Water Affairs, 1961, *TR22: JS Whitmore, Agrohydrology*, edited by Department of Water Affairs, Pretoria.

Department of Water Affairs TR49, 1971, *HMG Barker The effect of cetyl/stearyl alcohol monolayer on the aquatic life of Vaal Dam*, edited by Department of Water Affairs, Pretoria.

Department of Water Affairs, 1986, *Management of the water resources of the Republic of South Africa*, Government Printer, Pretoria.

Department of Water Affairs, 1987, *WATER: Meeting the needs of the Nation. Seventy-five years of conserving and supplying water to all population groups in South Africa and ensuring that the future demands for this scarce natural resource are met*, Target Communications for the Department of Water Affairs, Jukskei Park.

Department of Water and Sanitation, 2016a, *Department of Water Affairs and Forestry Annual Report 01 April 1999 – 31 March 2000,* South African Government, Pretoria.

Department of Water and Sanitation, 2016b, 'Proposal for the establishment of the Berg-Olifants catchment management agency in terms of Section 78(3) of the National Water Act (36 of 1998)', *Government Gazette*, no. 39657, 5 February 2016, p.14, Government Printer, Pretoria.

Department of Water and Sanitation, 2017, *Business case for the establishment of a single catchment management agency*, pp. i-58, Department of Water and Sanitation, Pretoria.

Department of Water and Sanitation, *c*. 2014, 'Water quality monitoring sites grouped by 19 water management areas (excluding borehole data)', in RQI Services (ed.), *Water Management System*, Department of Water and Sanitation, Pretoria.

Department of Water and Sanitation, n.d.a, *Technical Reports Archive*, viewed n.d., from http://www.dwa.gov.za/iwqs/reports/tr.aspx.

Department of Water and Sanitation, n.d.b, *Caledon/Modder transfer scheme: Water transfer schemes in the Middle Orange River*, viewed n.d., from https://goo.gl/9wq78L.

Department of Water and Sanitation, n.d.c, Gariep Dam, viewed n.d., from https://goo.gl/ysqO4.

Department of Water and Sanitation, n.d.d, Gariep Dam, viewed 2 September 2018, from https://goo.gl/VOTgQ4.

Department of Water and Sanitation, n.d.e, Vanderkloof Dam, viewed n.d., from https://goo.gl/cHDVG0.

Diamond, J., 2005, *Collapse: How societies choose to fail or succeed*, Viking Press, New York.

Dick, R.I., 1972, 'Sludge treatment, utilization, and disposal', *Journal of the Water Pollution Control Federation* 44(6), 959–972.

Dieleman, H., 2017, 'Transdisciplinary hermeneutics: A symbiosis of science, art, philosophy, reflective practice, and subjective experience', *Issues in Transdisciplinary Studies* 35, 170–199.

Dillard, D., 1946, 'The pragmatic basis of Keynes's political economy', *The Journal of Economic History* 6(2), 121–152. https://doi.org/10.1017/S0022050700056904

Directorate of Water Resources Planning, 2002a, 'Breede water management area: Water resources situation assessment – Main report – Volume 1 of 2', in DWAF (ed.), *Breede water management area*, Department of Water Affairs and Forestry, Pretoria.

Directorate of Water Resources Planning, 2002b, *Upper Vaal water management area*, Department of Water Affairs and Forestry, Pretoria.

Directorate of Water Resources Planning, 2003a, 'Limpopo water management area: Water resources situation assessment', in DWAF (ed.), *Limpopo water management area*, pp. i-iv, Department of Water Affairs and Forestry, Pretoria.

Directorate of Water Resources Planning, 2003b, *Luvuvhu/Letabe water management area: Water resources situation area: Main report*, Department of Water Affairs and Forestry, Pretoria.

Dlamini, J., 2009, 'Protesting to join the queue for the gravy train', Business Day, 22 August, n.p.

Dominy, F.E., 1970, 'Management plans for dams', *Water Year 1970, Convention on Water for the Future*, Department of Water Affairs, Pretoria, November 16-20, 1970, p. 1–4.

Donnelly, J., 1924, 'Irrigation by pumping: Centrifugal pumps', *Agriculture Journal of South Africa* 15, 84–86.

Draper, D., 1912, 'Some sections on the Farm Zuurbekom', *South African Journal of Geology* 15(1912), 90–93.

Drewes, J.E. & Van Aswegen, M., 2013. 'National planning in South Africa: A critical review', *WIT Transactions on Ecology and The Environment* 173, 193–204.

Du Plessis, I.P.J., 1963, 'Concerning our water resources', *South African Journal of Science* 59(2), 45–50.

Du Toit, A.L., 1916, 'Notes on the Karroo system in the Southern Kalahari', *South African Journal of Geology* 19, 1–13.

Du Toit, P.J., 1910, 'Future development of agriculture in South Africa', *Agricultural Journal of the Union of South Africa* 36(6), 692–699.

Du Toit, P.J.V., 1995, 'Nie-gewelddadige aksie (NGA) en die ontwikkeling van swart plaaslike regering: 'n Histories-kritiese ontleding – 1982–1994', PhD thesis, University of South Africa.

Dubb, A., 1977, 'The development of an African township', *South African Journal of Science* 73(3), 86–88.

Dubow, S., 2009, 'How British was the British world? The case of South Africa', *The Journal of Imperial and Commonwealth History* 37(1), 1–27. https://doi.org/10.1080/03086530902757688

Duffy, A., 2012, 'Reenen van Reenen's (1884–1935) attempt to change the Afrikaner's view of San rock art', *Suid-Afrikaanse Tydskrif vir Kultuurgeskiedenis* 26(1), 1–13.

Duvenhage, T.J., 1998, *An environmental management plan for the Merriespruit slimes dam disaster area*, University of Johannesburg, Johannesburg.

Eales, K., 2011, 'Water services in South Africa 1995–2009', in B. Schreiner & R. Hassan (eds.), *Transforming water management in South Africa*, pp. 33-71, Springer, Heidelberg.

Earle, A., Goldin, J. & Kgomotso, P., 2005, *Domestic water provision in the Democratic South Africa – Changes and challenges*, n.p.

Editor, 1974. 'Editorial', *Civil Engineering* 16(3), 87–89.

Editorial, 1966, 'Announcement of policy for drought-stricken areas', *Farming in South Africa* 42(3), 5.

Eisenstadt, S.N., 1958, 'The study of oriental depotisms as systems of total power', *The Journal of Asian Studies* 17(3), 435–446. https://doi.org/10.2307/2941426

Eldredge, N. & Gould, S.J., 1972, 'Punctuated equilibria: An alternative to phyletic gradualism', in TJM Schopf (ed.), *Models in paleobiology*, pp. 82–115, Freeman Cooper and Company, San Francisco.

Elliott, C.R., 1962, 'Future demands on the Vaal River in the Northern Cape and adjoining areas', in Vaal River Catchment Association (eds.), *Papers read at a symposium on the future of the Vaal River*, pp. 68–72, Vaal River Catchment Association, Johannesburg.

Elliott, J.E., 1978–1979, 'Marx's 'Grundrisse': Vision of capitalisms' creative destruction', *Journal of Post Keynesian Economics* 1(2), 148–169. https://doi.org/10.1080/01603477.1978.11489107

Elmqvist, T., 2015, 'Tempelhoff Personal Archive (TPA) Notes of T. Elmqvist', *Presentation on emergent trends in resilience studies, Faculty of Science, North-West University, Potchefstroom campus on 18 November 2015*, n.p.

Eloff, S. & Sevenhuysen, K., 2011, 'Urban black living and working conditions in Johannesburg, depicted by township art (1940s to 1970s)', *SA Tydskrif vir Kultuurgeskiedenis* 25(1), 1–25.

Emmett, T. & Rakgoadi, S., 1993, *Collaboration with the HSRC, water supply and sanitation services in South Africa*, SALDRU, Cape Town.

Endfield, G.H. & Nash, D.J., 2002, 'Missionaries and morals: Climatic discourse in nineteenth century central Southern Africa', *Annals of the Association of American Geographers* 92(4), 727–742. https://doi.org/10.1111/1467-8306.00313

Environmental Monitoring Group, 2004, *South African multi-stakeholder initiative on the World Commission on Dams: Applying the World Commission on Dams Report in South Africa*, Environmental Monitoring Group in Association with the South African Multi-stakeholder Initiative on the World Commission on Dams, Cape Town.

European Investment Bank, *Lesotho Highlands Water Project*, viewed n.d., from http://bit.ly/2nhGeRO.

Evenson, R.E. & Gollin, D., 2003, 'Assessing the impact of the Green Revolution, 1960 to 2000', *Science* 300(5620), 758–762. https://doi.org/10.1126/science.1078710

Fabricius, A.F., 1964, 'Drought investigation: North-Western Transvaal', *South African Journal of Science* 60(9), 267–275.

Fair, T.J.D. & Mallows, E.W.N., 1959, 'The Southern Transvaal: An emerging metropolitan complex in Africa', *The Town Planning Review* 30(2), 125–138. https://doi.org/10.3828/tpr.30.2.c06247118t624100

Fair, T.J.D. & Manfred Shaffer, N., 1964, 'Population patterns and policies in South Africa, 1951–1960', *Economic Geography* 40(3), 261–274. https://doi.org/10.2307/142426

Fedderke, J. & Simkins, C., 2012, 'Economic growth in South Africa', *Economic History of Developing Regions* 27(1), 176–208. https://doi.org/10.1080/20780389.2012.682408

Feinberg, H.M., 2015, *Our land, our life, our future: Black South African challenges to territotial segregation, 1913–1948*, Hidden histories series, edited by J. De Bruyn & R. Viljoen, Unisa Press, Pretoria.

Feinstein, C.H., 2005, *An economic history of South Africa: Conquest, discrimination and development*, Cambridge University Press, Cambridge.

Ferguson, D.L., 1960, 'Health education in South Africa', *South African Medical Journal* 34(13), 263–264.

First, R., Steele, J. & Gurney, C., 1972, *The South African connection: Western investment in apartheid*, 1 vols, Temple Smith, London.

Folke, C., 2006, 'Resilience: The emergence of a perspective for social–ecological systems analyses', *Global Environmental Change* 16(3), 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Forde, C.D., 1925, 'Irrigation in South Africa', *The Geographical Journal* 65(4), 342–349. https://doi.org/10.2307/1782527

Formanek, H.P. & Muller, M., *c.* 1991, *Halfway House*, pp. 1–5, n.p.

Formanek, H.P., *c.* 1991, *Water supply 2000: 'A view from private industry'*, pp. 20–24, n.p.

Frankopan, P., 2016, *The Silk roads: A new history of the world*, Bloomsbury, London.

Fremantle, H.E.S., 1912, 'The statistics of South Africa', *Journal of the Royal Statistical Society* 75(3), 314–322. https://doi.org/10.2307/2340253

Freund, B., 2011, 'The Union years, 1910–1948', in R. Ross, A. Kelk Mager & B. Nasson (eds.), *The Cambridge history of South Africa, 1885–1994*, pp. 211-253, Cambridge University Press, Cambridge.

Gale, G.W., 1949, 'Health services', in E. Hellmann (ed.), *Handbook on race relations in South Africa. South African Institute of Race Relations*, n.p., Oxford University Press, Cape Town.

Galvin, M. & Habib, A., 2003, 'The politics of decentralisation and donor funding in South Africa's rural water sector', *Journal of Southern African Studies* 29(4), 865–884. https://doi.org/10.1080/0305707032000135860

Gary, J.E., 2011, 'Toward a new macrohistory: An extension to Sardar's "postnormal times"', *Futures* 43(1), 48–51. https://doi.org/10.1016/j.futures.2010.04.033

Gcukumana, M., 2009, 'Search for renewable energy heats up: Alternative energy research', *CSIR Science Scope* 4(1), 19.

Geringer, J.J., 1995, 'Suid-Afrika se eerste ICOLD-kongres 'n besondere sukses', *Civil Engineering* 2(8), 24–27.

Gibson, J.J., 1977a, *The ecological approach to visual perception*, 2015 edn., The Psychological Press, New York.

Gibson, J.J., 1977b, 'The theory of affordances', in J. Royce & J. Bransford (eds.), *Perceiving, acting, and knowing: Toward an ecological psychology*, pp. 67–82, Lawrence Erlbaum, Hillsdale.

Giliomee, H. & Mbenga, B., 2007, *Nuwe geskiedenis van Suid-Afrika*, Tafelberg, Kaapstad.

Giliomee, H., 1995, 'Democratization in South Africa', *Political Science Quarterly* 110(1), 83–104. https://doi.org/10.2307/2152052

Giliomee, H., 2002, '"Wretched folk, ready for any mischief": The South African state's battle to incorporate poor whites and militant workers, 1890–1939', *Historia* 47(2), 601–653.

Giliomee, H., 2003, *The Afrikaners: Biography of a people*, Tafelberg, Cape Town.

Ginster, M., Gouws, C., Gouws, C.M., Maki, H., Mathipa, R., Nyandoro, M. & Tempelhoff, J.W.N., 2010, 'Views on unlawful water abstraction along the Liebenbersgvlei River, South Africa', *TD-The Journal for Transdiscipliunary Research in Southern Africa* 6(1), 1-24.

Glantz, M.H. & Katz, R.W., 1985, 'Drought as a constraint to development in Sub-Saharan Africa', *Ambio* 14(6), 334–339.

Gleick, P.H., 1998, *The world's water: The biennial report on Freshwater resources 1998–1999*, Island Press, Washington, D.C.

Gleick, P.H., 2002, 'Water management: Soft water paths', *Nature* 418(6896), 373–375. https://doi.org/10.1038/418373a

Gleick, P.H., 2003, 'Global freshwater resources: Soft-path solutions for the 21st century', *Science* 302(5650), 1524–1528. https://doi.org/10.1126/science.1089967

Goldblatt, M., 1996, 'Making the cup run over – The challenge of urban water supply for South Africa's Reconstruction and Development Programme', *GeoJournal* 39(1), 21–26. https://doi.org/10.1007/BF00174924

Goldblatt, M., 1998, *The economic value of watershed protection in South Africa: A case study in the Upper Tugela Catchment, KwaZulu-Natal*. University College London, London.

Gotts, N., 2007, 'Resilience, panarchy, and world-systems analysis', *Ecology and Society* 12(1). https://doi.org/10.5751/ES-02017-120124

Gouws, C., Moeketsi, I., Motloung, S., Tempelhoff, J.W.N., Van Greuning, G. & Van Zyl, L., 2009, *'I hate it when people don't like me': SIBU and the crisis of water service delivery in Sannieshof*, North West Province, North-West University, Vaal Triangle Campus, Vanderbijlpark.

Gouws, C.M., Mbambo, B., Moeketsi, I., Morotolo, M., Motloung, S. & Tempelhoff, J.W.N., 2011, *What about the votes? Water, sanitation and civil disorientation: The case of Maluti-a-Phofung local municipality (Harrismith)*, North-West University, Vaal Triangle Campus, Vanderbijlpark.

Green, M. (ed.), 1997, *The magic of delivery: Water to 1 million persons, 3.6 million trees planted*, Department of Water affairs and Forestry, Pretoria.

Greenberg, D.S., 1970, 'South Africa (I): Booming nation's research and industry benefit from close ties with the United States', *Science* 169(3941), 157–163. https://doi.org/10.1126/science.169.3941.157

Grobler, L., 2011, 'The Windpump', in A. Grundling & S. Huigen (ed.), *Reshaping remembrance: Critical essays on Afrikaans places of memory*, pp. 79–88, Rosenberg Publishers, Amsterdam.

Grosskopf, J.F.W., 1932, *Economic report: Rural impoverishment and rural exodus. The poor white problem in South Africa: Report of the Carnegie Commission of Investigation*, Pro Ecclesia, Stellenbosch.

Grove, A.T., Miles M.R., Worthington E.B., Doggett H., Dasgupta B. & Farmer, B.H., 1977, 'The geography of semi-arid lands', *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 278(962), 457–475. https://doi.org/10.1098/rstb.1977.0055

Grove, R., 1989, 'Scottish missionaries, evangelical discourses and the origins of conservation thinking in southern Africa 1820–1900', *Journal of Southern African Studies* 15(2), 163–187. https://doi.org/10.1080/03057078908708196

Gumede, W.M., 2005, *Thabo Mbeki and the battle for the soul of the ANC*, Zebra Press, London.

Gumede, W.M., 2009, 'ANC at war with itself: Zuma walks politically risky tightrope', Sowetan, 23 September, n.p.

Gunderson, L. & Light, S.S., 2006, 'Adaptive management and adaptive governance in the everglades ecosystem', *Policy Sciences* 39(4), 323–334. https://doi.org/10.1007/s11077-006-9027-2

Gunderson, L.H. & Holling, C.S., 2002, *Panarchy: Understanding transformations in human and natural systems*, Island Press, Washington DC.

Gunthorp, M.R., 1973, 'The Vaal-Hartz irrigation scheme', *Civil Engineering* 15(2), 44–47.

Gupta, J. & Van der Zaag, P., 2008, 'Interbasin water transfers and integrated water resources management: Where engineering, science and politics interlock', *Physics and Chemistry of the Earth, Parts A/B/C* 33(1), 28–40. https://doi.org/10.1016/j.pce.2007.04.003

Haarhoff, J., Juuti, P. Mäki, H., 2012, 'A case for strong municipal governance: The water supply of Pretoria 1855–1935', *South African Historical Journal* 64(4), 769–786. https://doi.org/10.1080/02582473.2011.647318

Haasbroek, J.K., 2016, 'A historical perspective of the information scandal', MA dissertation, University of the Free State.

Habib, A., 2003, 'State-civil society relations in post-apartheid South Africa', in J. Daniel, A. Habib & R. Southall (eds.), *State of the Nation 2003–2004*, pp. 227–241, HSRC Press, Cape Town.

Hadebe, S.P., 2011–2012, *South Africa's military intervention in Lesotho – A critical overview*, Alliant International University, Mexico City.

Hall, A.L., 1921, 'On the occurrence of oil on Madrid No. 281 in the Bethlehem District of the Orange Free State' [In English], *South African Journal of Geology* 24(1921), 98–110.

Hall, C.G. & Burger, A.P., 1974, *Hall on water rights in South Africa*, 4th edn., Juta & Co, Cape Town.

Hall, C.G., 1939, *The origin and development of water rights in South Africa*, Oxford University Press, Oxford.

Hall, C.G., 1947a, *The origin and development of water rights in South Africa.*, 2nd edn.,Oxford University Press, Oxford.

Hall, C.G., 1947b, *Water rights in South Africa*, 2nd edn., Oxford University Press, Oxford.

Hall, D. & Lobina, E., 2002, *Water privatization in Latin America*, Public Services International Research Unit, University of Greenwich, Greenwich.

Hall, D., Lobina, E. & De la Motte, R., 2005, 'Public resistance to privatisation in water and energy', *Development in Practice* 15(3/4), 286–301. https://doi.org/10.1080/09614520500076126

Halliday, S., 2001, *The great stink of London: Sir Joseph Bazalgette and the cleansing of the Victorian metropolis*, The History Press, Stroud.

Hanssen, C.P.A., 1966, 'The agricultural economy of South-West Africa', *Agrekon* 5(4), 30–38. https://doi.org/10.1080/03031853.1966.9525027

Haq, G. & Paul, A., 2012, *Environmentalism since 1945*, Routledge, Abingdon.

Harington, J.S., McGlashan, N.D. & Chelkowska, E.Z., 2004, 'A century of migrant labour in the gold mines of South Africa', *Journal-South African Institute of Mining and Metallurgy* 104(2), 65–72.

Harrison, P., 1992, 'Urbanisations: The policies and politics of informal settlement in South Africa: A historical perspective', *Africa Insight* 22(1), 14–22.

Hartnady, C.J.H., 1998, 'A review of the earthquake history and seismotectonic interpretation of the Kingdom of Lesotho', *Paper presented at the Proceedings of Workshop: 'Review of the Current State of Knowledge of the Seismotectonic Setting of Lesotho and Its Significance in Predicting Seismic Design Parameters for the Katse and Mohale Dams and Further Phases of the LHWP'*, Maseru, Lesotho, May 25–30, 1998, n.p.

Hartnady, C.J.H., 2009, 'South Africa's gold production and reserves', *South African Journal of Science* 105(9–10), 328–329.

Haskins, S., 2008, 'Local government manages infrastructure poorly – Survey', Engineering News, 15 February, n.p.

Heese, K. & Allen, K., 2009, 'Reading the figures in the flames to find the future of protest', Business Day, 24 August, n.p.

Helleiner, E., 2011, 'Understanding the 2007–2008 global financial crisis: Lessons for scholars of international political economy', *Annual Review of Political Science* 14, 67–87. https://doi.org/10.1146/annurev-polisci-050409-112539

Hemson, D., 2000, 'Policy and practice in water and sanitation', *Indicator South Africa* 17(4), 48–53.

Hendricks, F.T., 1989, 'Loose planning and rapid resettlement: The politics of conservation and control in Transkei, South Africa, 1950–1970', *Journal of Southern African Studies* 15(2), 306–325. https://doi.org/10.1080/03057078908708202

Hindson, D.C., 1985, 'Orderly urbanization and influx control: From territorial apartheid to regional spacial ordering in South Africa', *Cahiers d'Etudes Africaines* 25(99), 401–432. https://doi.org/10.3406/cea.1985.1737

Hirschmann, D., 1990, 'The black consciousness movement in South Africa', *The Journal of Modern African Studies* 28(1), 1–22. https://doi.org/10.1017/S0022278X00054203

Hitchcock, R.K., 2015, 'The Lesotho Highlands Water Project: Dams, Development, and the World Bank', *Sociology and Anthropology* 3(10), 526–538. https://doi.org/10.13189/sa.2015.031004

Hlongwane, A., Laganparsad, M. & George, Z., 2009, 'Rash pledges foment unrest', The Times, 27 July, n.p.

Hobbs, L.D. & Phélines, R.F. (eds.), 1987, *Water 75*, Erudita Publications (Pty) Ltd, Johannesburg.

Hobbs, P, Oelofse, S.H. & Rascher, J., 2011, 'Impacts from coal mining in the Upper Olifants River catchment as a function of age and scale', *International Journal of Water Resources Development* 24(3), 417–431. https://doi.org/10.1080/07900620802127366

Holling, C.S., 2004, 'From complex regions to complex worlds', *Ecology and Society* 9(1), 1–11.

Hollingworth, B.E., Jackson, B.M. & Muller, M., 1994, 'Water management in social transformation SAICE', *Proceedings: 50 Years of Water Engineering in South Africa: A Tribute to Prof. Des Midgley*, South African Institution of Civil Engineers, Johannesburg, South Africa, July 14–15, 1994, n.p.

Horak, D., 1978, 'An interview with Dr Daniel Kokot', *Civil Engineering* 20(12), 329–330.

Horwitz, R.B., 2001, *Communication and democratic reform in South Africa*, Cambridge University Press, Cambridge.

Horwood, C.B., 1912, 'Note on the relationship between the Black Reef Formation and the Ventersdorp diabase', *South African Journal of Geology* 15(1912), 77–80.

Hoskyns, C., 1964, 'The African States and the United Nations 1958–1964', *International Affairs (Royal Institute of International Affairs 1944-)* 40(3), 466–480. https://doi.org/10.2307/2610829

Hugo, C.F., 1933, 'Location of South Africa and its economic consequences', *Economic Geography* 9(3), 217–229. https://doi.org/10.2307/140833

Hunt, R.C., 1988, 'Size and the structure of authority in canal irrigation systems', *Journal of Anthropological Research* 44(4), 335–355. https://doi.org/10.1086/jar.44.4.3630504

Hunt, R.C., Hunt, E.,Ahmed, G.M., Bennett, J.W., Cleek, R.K., Coy P.E.B. et al., 1976, 'Canal irrigation and local social organization [and comments and reply]', *Current Anthropology* 17(3), 389–411.

Hurley, F.A., 1906, 'Irrigation in the Transvaal', *Transvaal Agricultural Journal* 4(16), 733–742.

Hutton, P.H.,1972, 'The new science of Giambattista Vico: Historicism in its relation to poetics', *The Journal of Aesthetics and Art Criticism* 30(3), 359–367.

Hyden, G., 1996, 'The challenges of analysing and building civil society', *Africa Insight* 26(2), 96–102.

Hydrological Research Institute, 1972, *Souvenir programme*, Roodeplaat, Pretoria.

IMIESA, 2004, 'SA water project authority wins big: Cover story', *IMIESA* 29(2), 4–5.

IMIESA, 2006, 'Former minister of water affairs and forestry, Buyelwa Sonjica: Interview', *IMIESA* 31(6), 37.

Ingold, T., 2011, *Being alive: Essays on movement, knowledge and description*, Routledge, Abington.

Innes, R.T.A., 1915, 'The land hunger', *Agricultural Journal of South Africa* 2(9), 117–128.

Institute of Municipal Engineering of Southern Africa, 2005, 'DWAF supporting project consolidate: Water and environment', *Institute of Municipal Engineering of Southern Africa* 5(1), 79–81.

International Rivers, 2005, *Lesotho Highlands Water Project: What went wrong?*, viewed n.d., from https://www.internationalrivers.org/resources/lesotho-highlands-water-project-what-went-wrong-4060.

Isaacman, A. & Sneddon, C., 2000, 'Toward a social and environmental history of the building of Cahora Bassa Dam', *Journal of Southern African Studies* 26(4), 597–632. https://doi.org/10.1080/713683608

Isaacs, Z., 2004, 'Women in water honoured', *Engineering News*, 19 March, 2004, viewed n.d., from http://www.engineeringnews.co.za/login.php?url=/article/women-in-water-honoured-2004-03-19/searchString:women+in+water+honoured.

Isaacson, I., 1977, 'Kanthack, Francis Elgar', in D.W. Krüger & C.J. Beyers (eds.), *Suid-Afrikaanse biografiese woordeboek III*, pp. 473–474, Tafelberg Uitgewers, Elsiesrivier.

Jacobs, N., 1996, 'The Flowing Eye: Water management in the Upper Kuruman Valley, South Africa, *c*. 1800–1962', *The Journal of African History* 37(2), 237–260. https://doi.org/10.1017/S0021853700035210

Jacobs, N., 2003, *Environment, power, and justice: A South African history*, Cambridge University Press, Berkeley.

Jansen, E.G., 1930, 'Strengthen our rural life – Message to the farmer', *Farming in South Africa* 5(46), 1.

Jeeves, A., 2004, 'South Africa in the 1940s: Post-war reconstruction and the onset of apartheid', *South African Historical Journal* 50, 1–11. https://doi.org/10.1080/02582470409464791

Jevons, H. 1931. 'The Second Industrial Revolution', *The Economic Journal* 41(161), 1-18.

Johnson, R.W., 1982, *How long will South Africa survive? The looming crisis*, The Macmillan Press, London.

Johnstone, F.A., 1970, 'White prosperity and white supremacy in South Africa today', *African Affairs* 69(275), 124–140. https://doi.org/10.1093/oxfordjournals.afraf.a095990

Joint Monitoring Programme for Water Supply and Sanitation, 2000, *Global Water Supply and Sanitation Assessment 2000 Report*, World Health Organization and the United Nations Children's Fund, New York.

Jolly, J.H., 1973, 'The mineral industry of the Republic of South Africa', *Minerals Yearbook Area Reports: International* 1973(3), 745–769.

Jonker, L., 2007, 'Integrated water resources management: The theory–praxis–nexus, a South African perspective', *Physics and Chemistry of the Earth, Parts A/B/C* 32(15–18), 1257–1263. https://doi.org/10.1016/j.pce.2007.07.031

Jooste, C.J., 1963, 'Sosiologiese aspekte van die Oranjerivier-projek', *South African Journal of Science* 59(10), 473–479.

Jordaan, B., 2017, 'Ships go dry in the Table Bay docks: Victoria and Alfred Waterfront offers tank and roof water for resident fleet', *Sunday Times*, 22 October, 2017, n.p.

Jordaan, J.M. & Kovács, Z., 1985, 'Effects at Pongolapoort Dam (South Africa) of an extreme flood caused by tropical cyclone Domoina', *Paper presented at the Papers presented at the 2nd International Conference on the the [sic] Hydraulics of Floods & Flood Control*, Cambridge, England, September 24–26, 1985, n.p.

Joubert, D.M., 1966, 'Along the lower Limpopo', *South African Journal of Science* 62(11), 349–351.

Journal of the Department of Agriculture, 1920, 'Irrigation in the Union', *Journal of the Department of Agriculture* 1(7), 676–677.

Journal of the Department of Agriculture, 1924, 'Ostrich farming – Producing the world-famed plume', *Journal of the Department of Agriculture* 8(2), 238–243.

Journal of the Department of Agriculture, 1925, 'Notes: South African Irrigation experience-Important experiments at Grootfontein', *Journal of the Department of Agriculture* 11(5), 377–379.

Journal of the Royal African Society, 1942, 'South Africa's Social and Economic Planning Council: General Smuts's plans for a better and greater Southern Africa', *Journal of the Royal African Society* 41(165), 231–233.

JSTOR, n.d., *The study project on Christianity in apartheid society*, viewed n.d., from https://www.aluka.org/struggles/collection/SPROCAS.

Jubb, R.A., 1979, 'On trek with Schwarz in the Kalahari', *African Wildlife* 33(3), 20–21, 23.

Juritz, C.F., 1919, 'Science and progress in South Africa', *Journal of the Royal African Society* 18(70), 88–100. https://doi.org/10.1093/oxfordjournals.afraf.a099713

Kane-Berman, J., 1993, *Political violence in South Africa*, South African Institute of Race Relations, Johannesburg.

Kanthack, F.E., 1908, 'The destruction of mountain vegetations', *Agricultural Journal of the Cape of Good Hope* 33(2), 194–204.

Kanthack, F.E., 1909, 'Irrigation: Past, present and future', *Agricultural Journal of the Cape of Good Hope* 34(6), 17–25.

Kanthack, F.E., 1910, 'Irrigation development in South Africa with state aid', *Agricultural Journal of the Cape of Good Hope* 36(5), 530–540.

Kanthack, F.E., 1913, 'Presidential address', *Civil Engineering* 11, 1–6.

Kanthack, F.E., 1924a, 'Irrigation in the Union: A discussion of policy in relation to the conservation of water', *Journal of the South African Institution of Engineers, pp.* 174–181.

Kanthack, F.E., 1924b, *The principles of irrigation engineering: With special reference to South Africa*, Longman's Green and Co., London.

Kaplan, I., McLaughlin, J.L., Marvin, B.J., Nelson, H.D., Rowland, E.E., Whitaker, D.P., 1971, *Area handbook for the Republic of South Africa*, Foreign Area Studies, The American University, Washington, D.C.

Kasrils, R., 2001, *Free basic water*, media release 14 Feb. 2001, Department of Water Affairs, Pretoria, viewed n.d., from Department of Water Affairs Electronic Archive.

Kearns, C.K., 2014, *An illustration of changing paradigms in water resource management in South Africa*, University of Cape Town, Cape Town.

Keller, B., 2013, 'Nelson Mandela, South Africa's liberator as prisoner and president, dies at 95. In New York Times, 5 December (2013)', *New York Times*, 05 December, pp. 107–121.

Kelley, D.R., 2013, 'Intellectual history: From ideas to meaning', in N. Partner & S. Foot (eds.), *The Sage handbook of historical theory*, pp. 81–92, Sage, Los Angeles.

Kelly, K., 2009, 'What technology wants', in K. Kelly (ed.), *The technium*, Kevin Kelly.

Kelly, K., 2017. *The inevitable: Understanding the 12 technological forces that will shape our future*, Penguin Books, New York.

Kerr, R.A., 1985, 'Fifteen years of African drought', *Science* 227(4693), 1453–1454. https://doi.org/10.1126/science.227.4693.1453

Kgomosotho, D., 1997, *The history of Tumelong Mission in the Diocese of Pretoria with specific reference to the period 1939–1996*, UNISA, n.p.

Khan, A., 2007, *Water privatisation in South Africa: A critique of the application of the neo-liberal policy framework*, University of New Brunswick, n.p.

King, J. & Brown, C., 2006, 'Environmental flows: Striking the balance between development and resource protection', Ecology and Society 11(2), n.p. https://doi.org/10.5751/ES-01682-110226

King, J. & Pienaar, H., 2011, *Sustainable use of South Africa's inland waters: A situation assessment of Resource Directed Measures 12 years after the 1998 National Water Act*, WRC Report TT492/11, Water Research Commission, Pretoria.

King, J.M., Tharme, R.E. & De Villiers, M.S., 2000, *Environmental flow assessments for rivers: Manual for the building block methodology*, Water Research Commission, Pretoria.

Klunne, W.J., 2013, 'Small hydropower in Southern Africa – An overview of five countries in the region', *Journal of Energy in Southern Africa* 24(3), 14–25.

Kokot, D.F., 1942, 'Irrigation possibilities in the Union of South Africa', *Civil Engineering* 40, 166–219.

Kotze, A.P.L., 1982, 'Project planning and progress control for the Grootegeluk Coal Project', *Journal of the Southern African Institute of Mining and Metallurgy* 82(12), 365–369.

Kovàcs, Z.P., Du Plessis, D.B., Brachner, P.R., Dunn, P. & Mallory, G.C.L., 1985, *Documentation of the 1984 Domoina floods*, Government Printer, Pretoria.

Kracauer, S., 1966, 'Time and history', *History & Theory* 6(6), 65–78.

Kriel, R. & Van Der Walt, R., *c*. 2000, *Vaal Dam*, Department of Water Affairs and Forestry, Pretoria.

Krog, A., 1997, 'Preamble: Water in our lives', *White Paper on A National Water Policy for South Africa*, Department of Water Affairs and Forestry, Pretoria.

Krohn, W., 2010, 'Interdisciplinary cases and disciplinary knowledge', in R. Frodeman, J.T. Thompson Klein, C. Mitcham & J.B. Holbrook (eds.), *The Oxford handbook of interdisciplinarity*, pp. 31–49, Oxford University Press, Oxford.

Krüger, D.W., 1981, 'Theron, Hendrik Schalk', in C.J. Beyers (ed.), *Suid-Afrikaanse biografiese woordeboek IV*, Butterworth & Kie (SA) Edms Beperk, Durban.

Kruger, F.J. & Bennett, B.M., 2013, 'Wood and water: An historical assessment of South Africa's past and present forestry policies as they relate to water conservation', *Transactions of the Royal Society of South Africa* 68(3), 163–174. https://doi.org/10.1080/0035919X.2013.833144

Kruger, N., 2013, 'A socio-environmental history of water in the Karoo *c.*1762–2012, with specific focus on Prince Albert and Williston', MA dissertation, University of Stellenbosch.

Langham-Carter, R.R., 1971, 'Four early British families in Cape Town', *Familia* 8(2), 3–5.

Lavin, D., 2005, 'Irrigation development in South Africa – The Smart Syndicate and the Cape Sundays River Settlement Co', in J.W.N. Tempelhoff (ed.), *African water histories: Transdisciplinary discourses*, pp. 133–149, North-West University (Vaal Triangle), Vanderbijlpark.

Lawless, A., 2005, *Numbers & needs: Addressing imbalances in the civil engineering profession*, South African Institution of Civil Engineers, Midrand.

Le Roux, H., 2003, 'RDP houses lacking in energy efficiency, says company', Engineering News, 06 June, n.p.

Legassick, M., 1974, 'Legislation, ideology and economy in post-1948 South Africa', *Journal of Southern African Studies* 1(1), 5–35.

Legg, W.A., 1912, 'Irrigation in South Africa', *Journal of the Royal Society of Arts* 60(3090), 327–344.

Legum, C., 1960, 'Crisis in South Africa', *The World Today* 16(6), 233–242.

Leistner, G.M.E., 1975, 'Southern Africa in transition', *Africa Insight* 5(1), 5–13.

Lepawsky, A., 1963, 'International development of river resources', *International Affairs (Royal Institute of International Affairs* 39(4), 533–550.

Leslie, J.P., 1951, 'Presidential address: The supply of water within the area served by the Rand Water Board and its relation to social and economic development with special reference to the Vaal River', *Civil Engineering* 1(1), 17–27.

Lever, J., 1973, 'South Africa's political alternatives: The report of the Spro-cas political commission a review', *Africanus* 3(2), 14–22.

Lewis, A.D., 1915, *Irrigation and settlement in America*, Government Printing and Stationary Office, Pretoria.

Lewis, A.D., 1925, 'Presidential Address', *Civil Engineering* 23, 4–16.

Lewis, A.D., 1935, *Small earth dams across streams*, Irrigation Department Professional Paper No. 8, Government Printer, Pretoria.

Leys, R., 1975, 'South African gold mining in 1974: "The gold of migrant labour"', *African Affairs* 74(295), 196–208. https://doi.org/10.1093/oxfordjournals.afraf.a096586

Lichtenthaeler, G. & Turton, A.R., 1999, 'Water demand management, natural resource reconstruction and traditional values: A case study from Yemen', *SAOAS Occasional Paper* 14, 1–14.

Liebenberg, B.J., 1984, 'Hertzog in power, 1924–1939', in C.F.J. Muller (ed.), *Five hundred years: A history of South Africa*, n.p., Academia, Pretoria.

Liebenberg, E., 2014, 'Achieving the impossible: The 1: 500 000 "Irrigation Map" of South Africa, 1935–1937', *The Cartographic Journal* 51(3), 237–248. https://doi.org/10.1179/1743277414Y.0000000086

Lodge, T., 1983, *Black politics in South Africa since 1945*, 6th reprint edn., Longman, London.

Lodge, T., 2011, *Sharpeville: An apartheid massacre and its consequernces*, Oxford University Press, Oxford.

Lodge, T., 2012, 'Resistance and reform, 1973–1994', in R. Ross, A.K. Mager & B. Nasson (eds.), *The Cambridge history of South Africa, 1885–1994*, Cambridge University Press, Cambridge.

Louw, A., 2014, 'The forgotten work of the inter-colonial irrigation commission', *Water Wheel* 13(2), 26–29.

Lubbe, S.J., 1942, *Die geografiese aspekte van die Vaalbankdam; en van die Vaalhartsbesproeiingsprojek*, University of Pretoria, Pretoria.

Ludi, P., 2016, *Smuts: Lost in transmission?*, University of Pretoria, Pretoria.

Lumby, A., Matete, M. & Rwelamira, J., 1995, 'Industrial history in South Africa: Past trends and future needs', *South African Journal of Economic History* 10(1), 74–88. https://doi.org/10.1080/10113436.1995.10417242

Lumby, A., Matete, M. & Rwelamira, J., 2005, 'The management of South Africa's water resources with particular reference to the period 1956–1998', *South African Journal of Economic History* 20(2), 83–108. https://doi.org/10.1080/10113430509511187

M'Gonigle, R.M., 1999, 'Ecological economics and political ecology: Towards a necessary synthesis', *Ecological Economics* 28(1), 11–26. https://doi.org/10.1016/S0921-8009(98)00121-9

Mabin, A. & Smit, D., 1997, 'Reconstructing South Africa's cities? The making of urban planning 1900–2000', *Planning Perspectives* 12(2), 193–223. https://doi.org/10.1080/026654397364726

MacDonald, W., 1910, 'The principles of land settlement', *Transvaal Agricultural Journal* 8(32), 599–604.

Mackenzie, L.A., 1947, *Memorandum on the water resources of the Union of South Africa: A memorandum for presentation by the director of irrigation to the inaugural meeting of the Natural Resources Development Council December 1947 (Typewritten mansucript)*, Department of Irrigation, Pretoria.

Mackenzie, L.A., *c*. 1947–1948, *Irrigation in South Africa*, Department of Irrigation, Pretoria.

MacMillan, E.J., 1910, 'The production of maize in the province of the Free State', *Transvaal Agricultural Journal* 9(33), 14–17.

Maharaj, V. & Pietersen, T., 2004, 'Consulting South Africa's diverse population about the country's proposed National Water Resource Strategy', *Water SA* 30(5), 125–132.

Mäki, H., 2008, *Water sanitation and health: The development of the environmental services in four South African cities, 1840–1920*, 1st edn., Juvenes Print, Tampere.

Malan, T., 1975, 'The energy situation in South Africa', *Africa Insight* 5(1), 47–65.

Malherbe, E.G., 1932, *Education and the poor white. The poor white problem in South Africa: report of the Carnegie Commission of Investigation*, vol. 3, Pro Ecclesia, Stellenbosch.

Mangcu, X., 2012, 'African modernity and the struggle for people's power: From protest and mobilization to community organizing', *The Good Society* 21(2), 279–299. https://doi.org/10.5325/goodsociety.21.2.0279

Marais, E.N., 1914, 'Notes on some effects of extreme drought in Waterberg', *Agricultural Journal of the Union of South Africa* 7, 161–170.

Marais, H., 2001, *South Africa limits to change: The political economy of transition*, 2nd edn., Zed Books, London.

Matthews, P.E., 1969a, 'Diversion of water to the upper region of the Tugela Basin', Paper presented at the Symposium on Progress in River Engineering, presented by the Hydraulic Engineering Division, South African Institution of Civil Engineers, Pietermaritzburg, July.

Matthews, P.E., 1969b, *Diversion of water to the upper region of the Tugela basin: A study of the three-dimensional structure of the Tugela River system and its hydrological and geological significance*, Natal Town and Regional Planning Commission Report 16, Town and Regional Planning Commission, Pietermaritzburg, p. 30.

May, J., 2006, 'Constructing the social policy agenda: Conceptual debates around poverty and inequality', in V. Padayachee (ed.), *The development decade? Economic and social change in South Africa, 1994–2004*, pp. 143–159, HSRC Press, Pretoria.

Maylam, P., 1990, 'The rise and decline of urban apartheid in South Africa', *African Affairs* 89(354), 57–84. https://doi.org/10.1093/oxfordjournals.afraf.a098280

Maylam, P., 1995, 'Explaining the apartheid city: 20 years of South African urban historiography', *Journal of Southern African Studies* 21(1), 19–38. https://doi.org/10.1080/03057079508708431

Mazibuko, G. & Pegram, G., 2006, 'Guide for catchment management agency cooperation with local government', pp. 1-31, Water Research Commission, Pretoria.

Mbanga, S., 2008, 'Cities network – Renewable energy summit: Electricity', *IMFO : Official Journal of the Institute of Municipal Finance Officers* 8(4), 16–21.

Mbongwa, M., Van den Brink, R. & Van Zyl, J., 1996, 'Evolution of the agrarian structure in South Africa', in J. Van Zyl, J. Kirsten & H.P. Binswanger (eds.), *Agricultural reform in South Africa: Policies, markets and mechanisms*, p. 300, Oxford University Press, Cape Town.

McCann, J., 1999, 'Climate and causation in African history', *The International Journal of African Historical Studies* 32(2–3), 261–279. https://doi.org/10.2307/220342

McCarthy, T.S. & Pretorius, K., 2009, 'Coal mining on the Highveld and its implications for future water quality in the Vaal River system', paper presented at the International Mine Water Conference, n.p., n.d.

McGowan, P. & Johnson, T.H., 1984. 'African military coups d'etat and underdevelopment: A quantitative historical analysis', *The Journal of Modern African Studies* 22(4), 633–666. https://doi.org/10.1017/S0022278X00056275

McKinley, D.T., 2005, 'The struggle against water privatisation in South Africa', in B. Balanyá, B. Brennan, O. Hoedeman, S. Kishimoto & P. Terhorst (eds.), *Reclaiming public water: Achievements, struggles and visions from around the world*, pp. 181–189, Transnational Institute (TNI) & Corporate Europe Observatory (CEO), Amsterdam.

McNab, J.F., 1915, 'Sheep in South Africa', *Agricultural Journal of the Union of South Africa* 1(3), 427–431.

Meissner, R. & Turton, A.R., 2003, 'The hydrosocial contract theory and the Lesotho Highlands Water Project', *Water Policy* 5, 115–126.

Meissner, R., 1998, *Water and South Africa's involvement in Lesotho*, AWIRU Occasional Paper, University of Pretoria, Pretoria.

Mellor, E.T., 1915, 'The East Rand', *South African Journal of Geology* 18(1915), 57–71.

Mellor, E.T., 1922, 'Recent additions to our knowledge of the South African coalfields', *South African Journal of Geology* 25(1922), 1–22.

Merrey, D.J., Levite, H. & van Koppen, B., 2009. 'Are good intentions leading to good outcomes? Continuities in social, economic and hydro-political trajectories in the Olifants River Basin, South Africa', in F. Molle & P. Wester (eds.), *River basin trajectories: societies, environments and development*, pp. 52–53, International Water manatement Institute (IWMI), Wallingford.

Midgley, D.C., 1949, 'The water conservation aspect of planned resource utilisation in the union of South Africa', *Civil Engineering = Siviele Ingenieurswese* 47(1), 114–159.

Midgley, D.C., 1952, *A preliminary survey of the surface water resources of the Union of South Africa*, University of Natal, Pietermaritzburg.

Midgley, D.C., 1959, *Taming our wild rivers: Inaugural lecture*, Witwatersrand University Press, Johannesburg.

Midgley, D.C., 1963, 'Application of modern planning concepts to the development of the Orange River', *South African Journal of Science* 59(10), 461–467.

Midgley, D.C., 1970, 'Hydrological research in Southern Africa', *Civil Engineering* 66(12), 380–391.

Midgley, D.C., 1971, 'The impact of the Water '70 campaign', *South African Journal of Science* 67(4), 269–275.

Midgley, D.C., *c*. 1962, 'A water policy for the Vaal: Papers read at a symposium on the future of the Vaal River, Johannesburg 30–1 October, 1961', in Vaal River Catchment Association (VRCA) (ed.), *Vaal: Problems of a river's future*, n.p., VRCA, Johannesburg.

Milkman, R., 1977–1978, 'Apartheid, economic growth, and US foreign policy in South Africa', *Berkeley Journal of Sociology* 22, 45–100.

Minnaar, A. de V., 1984, 'The establishment and growth of Empangeni', *Contree* 15, 5–16.

Minnaar, A. de V., 1985, 'Richards Bay', *Contree* 17, 15–20.

Minnaar, A., 1990, 'The effects of the Great Depression (1929–1934) on South African White agriculture', *South African Journal of Economic History* 5(2), 83–108. https://doi.org/10.1080/20780389.1990.10417176

Molle, F. & Wester, P., 2009, *River basin trajectories: Societies, environments and development*, International Water Manatement Institute (IWMI), Wallingford.

Molle, F., 2009, 'River-basin planning and management: The social life of a concept', *Geoforum* 40(3), 484–494. https://doi.org/10.1016/j.geoforum.2009.03.004

Molle, F., Mollinga, P.P. & Wester, P., 2009, 'Hydraulic bureaucracies and the hydraulic mission: Flows of water, flows of power', *Water Alternatives* 2(3), 328–349.

Montmasson-Clair, G. & Ryan, G., 2014, 'Lessons from South Africa's renewable energy regulatory and procurement experience', *Journal of Economic and Financial Sciences* 7(Special Issue 1), 507–526.

Moolman, J.H., 1946, 'The Orange River South Africa', *Geographical Review* 36(4), 653–674. https://doi.org/10.2307/211420

Moore, D., 2001, 'Neoliberal globalisation and the triple crisis of "modernisation" in Africa: Zimbabwe, the Democratic Republic of the Congo and South Africa', *Third World Quarterly* 22(6), 909–929. https://doi.org/10.1080/01436590120099713

Morgan, W.S.G., 1976, 'Fish detect toxicants in pollution', *SA Water Bulletin*, February, p. 2.

Morris, M. & Padayachee, V., 1988, 'State reform policy in South Africa', *Transformation* 7, 1–26.

Motau, D., 2010, 'Increased demand for solar water heaters', Engineering News, 14 May, n.p.

Motloung, S., 2011, *The influence of political culture and socialization on integrated water resource management (IWRM): The case of the Thabo Mofutsanyane District Municipality*, North-West University, Vaal Triangle Campus, Vanderbijlpark.

Mountain, E.D., 1976, 'Schwarz, Ernest Hubert Lewis', in W.J. de Kock (ed.), *Suid-Afrikaanse biografiese woordeboek I*, pp. 733–734, Tafelberg uitgewers, Cape Town.

Movik, S., 2012, *Fluid rights: Water allocation reform in South Africa*, HSRC Press, Cape Town.

Mudzanani, L., Ratsaka-Mathokoa, M., Mahlasela, L., Netshidzivhani, P. & Mugero, C., 2004, 'Cholera', *South African Health Review*, 2003/2004(1), 257–264.

Muller, M., 1991a, 'Institutional options for water supply and sanitation in a changing South Africa', Draft paper, 25 January, 1991, n.p.

Muller, M., 1991b, 'One city – One country? Institutional options for water supply and sanitation in a changing South Africa', Paper, n.p., 11 March, 1991, n.p.

Muller, M., 1991c, *Institutional options for water supply and sanitation in a changing South Africa*, Draft paper, pp. 1–9, n.p.

Muller, M., 1992, *Marketing and presentation issues water supply and sanitation sector 1992. Standing committee on water supply and sanitation: Marketing and communication*, n.p.

Muller, M., 1994, *Water and sanitation in rural areas: The SCOWSAS drive*, pp. 1–9, n.p.

Muller, M., 1998, 'Water sector reform in South Africa – A midterm report', *World Bank Water Week Conference*, Annapolis, United States of America, n.d., n.p.

Muller, M., 2001, 'Water delivery: Making it work', *Indicator South Africa* 18(1), 57–61.

Muller, M., 2003, 'Public–private partnerships in water: A South African perspective on the global debate', *Journal of International Development* 15(8), 1115–1125. https://doi.org/10.1002/jid.1055

Muller, M., 2007, 'Parish pump politics: The politics of water supply in South Africa', *Progress in Development Studies* 7(1), 33–45. https://doi.org/10.1177/146499340600700104

Muller, M., 2008, 'Free basic water – A sustainable instrument for a sustainable future in South Africa', *Environment & Urbanization* 20(1), 67–87. https://doi.org/10.1177/0956247808089149

Muller, M., 2009, 'Attempting to do it all: How a new South Africa has harnessed water to address its water development challenges', in R. Lenton & M. Muller (eds.), *Integrated water resources management in practice: Better water management for development*, pp.169-187, Earthscan, London.

Muller, M., 2014, 'Allocating powers and functions in a federal design: The experience of South Africa', in D. Garrick, G.R.M. Anderson, D. Connell & J. Pittock (eds.), *Federal rivers: Managing water in multi-layered political systems*, pp. 179–195, Edward Elgar Publishing Limited, Cheltenham.

Muller, M., 2015, 'The "Nexus" as a step back towards a more coherent water resource management paradigm', *Water Alternatives* 8(1), 675–694.

Muller, M., 2016, 'Greater security with less water: Sterkfontein Dam's contribution to systemic resilience', in C. Tortajada (ed.), *Increasing resilience to climate variability and change: The roles of infrastructure and governance in the context of adaptation*, pp. 251–278, Springer, Singapore.

Murray, J.M., Hoal W.C. & Gross G.N. (eds.), 1952, *The Union Statutes 1910–1947, Classified and annotated reprint*, 1st edn., vol. 12, Butterworth and Co. (Africa) Ltd., Durban.

Murray, K., 1992, *Wastewater treatment and pollution control*, 2nd edn., Water Research Commission, Gezina.

Murray, K.A., 1992, *Wastewater treatment and pollution control*, 2nd edn., Water Research Commission, Gezina.

Murray, M., Hoal, W.C. & Gross, G.N. (eds.), 1952, *The Union Statutes 1910–1947, Classified and annotated reprint*, 1st edn., 12 vols, vol. 12, Butterworth and Co. (Africa) Ltd, Durban.

Murray, W.A., 1932, *Health report the poor white problem in South Africa: Report of the Carnegie Commission of Investigation*, 5 vols, vol. 4, Pro Ecclesia, Stellenbosch.

Myers, F., 2000, 'Harold Macmillan's' winds of change' speech: A case study in the rhetoric of policy change', *Rhetoric & Public Affairs* 3(4), 555–575. https://doi.org/10.1353/rap.2000.0012

Naidoo, S., 2017, *Acid mine drainage in South Africa: Development actors, policy impacts, and broader implications,* Springer Nature, Switzerland.

National Archives Repository Archives (NARA), 1916, 'SAB, MNW355, Department of Mines', MNW355, MM2937/16, FE Kanthack – Secretary for Mines and Industries, Pretoria.

National Archives SAB, n.d., *URU183, Minute765/1914: FT Patterson, Second grade engineer; SAB, URU307, Minute 302/1917, CDH Braine, engineer; SAB, URU333, Minute 2489/1917, Joseph William Hodsworth, engineer; SAB, URU354, Minute 816/1918, D Holthausen, second grade assistant engineer; SAB, URU355, Minute 888/1918, PA Taylor, second grade assistant engineer; SAB, URU357, Minute 1051/1918, KR Shand, CJ McGowan and CS DoU of SA, UG las, assistant engineers; SAB, URU401, Minute 1052, CO Ehrlich, assistant engineer; SAB, URU410, Minute1595/1919, Leopold Levenkind; SAB, URU418, Minute 1960/1919, WO Sutton, assistant engineer; SAB, URU418, Minute 1961, CWJ Sandrock, assistant engineer*, n.p.

National Department of Health, 2001, *National guidelines for cholera control, Communicable Disease Control*, National Department of Health Directorate, Pretoria.

Nauright, J., 1998, '"The Mecca of Native Scum" and "a running sore of evil": White Johannesburg and the Alexandra Township removal debate, 1935–1945', *African Historical Review* 30(1), 64–88. https://doi.org/10.1080/00232089885310051

Ndaba, D.J., 1998, 'Opposition by black rural communities to being forcibly removed to black homelands with the emphasis on the Kwangema and Driefontein communities in the Wakkerstroom district: A historical perspective, 1980–1985', PhD thesis, University of Zululand.

Ndletanya, M. & Muzondidya, M., 2009, 'Reviewing municipal capacity in the context of local government reform: 1994–2009', in P. Jackson, J. Muzondidya, V. Naidoo, M. Ndletanya & M.P. Sithole (eds.), *South African governance in review: Anti-corruption, local government, traditional leadership*, pp. 21-38, HSRC Press, Cape Town.

Ndlovu, S.M., 2004, 'The Soweto Uprising', in South African Democracy Education Trust (ed.), *The road to democracy in South Africa 1970–1980*, vol. 2, pp. 317–368, Unisa Press, South Africa.

Neser, M.L., 1965, 'Can we eradicate malnutrition in South Africa?', *South African Medical Journal* 39(45), 1158–1163.

NEWS24WIRE, 2017, 'Time and money – Two major obstacles in tackling Cape Town's water crisis', *Engineering News*, 19 October, n.p.

Nienaber, P.J., 1977, 'Van Reenen, Reenen Jacob', in D.W. Krüger & C.J. Beyers (eds.), *Suid-Afrikaanse biografiese woordeboek*, Tafelberg Uitgewers, Cape Town.

Noble, J., 1886, *History productions, and resources of the Cape of Good Hope*, WA Richards & Son, Government Printer, Cape Town.

NSTTeam, 1996, *National sanitation policy*, Government Printer, Pretoria.

O'Malley, P., n.d., *O'Malley Archive: The Heart of Hope (1985–1996), Native building workers Act, 27 of 1951*, Nelson Mandela Centre of Memory, viewed 28 August 2016, from https://goo.gl/vUn7hw.

Oakes, D., 1995, *Reader's Digest illustrated history of South Africa: The real story*, expanded 3rd edn., Reader's Digest Association, Cape Town.

Obertreis, J., Moss, T., Mollinga, P. & Bichsel, C., 2016, 'Water, infrastructure and political rule: Introduction to the special issue', *Water Alternatives* 9(2), 168–181.

OBF1536, 1982, 'P.E. Odendaal, "Die ontstaan, doelstellings en werkwyses van die Waternavorsingskommissie"', *WNK, Inligtingsessie met betrekking tot die werksaamhede van die Waternavorsingskommissie, 13th Januarie 1982*, Water Research Commission, Pretoria.

Office of the Presidency, 2008, *Asgisa annual report 2007: Accelerated shared growth initiative for South Africa*, Office of the Presidency, Pretoria.

Olivera, O. & Lewis, T., 2004, *Cochabamba! Water war in Bolivia*, South End Press, Cambridge, MA.

Olivier, H., 1965, 'Time disciplines in hydraulic engineering', *Civil Engineering* 7(9), 203–212.

Olivier, H., 1975, *Damit*, Macmillan South Africa (Pty) Ltd, n.p.

Olivier, H., 1976, *Great dams in Southern Africa*, Purnell, Cape Town.

Oosthuizen, C. & Elges, H.F.W.K., 1988, 'Risk-based safety evaluation of dams', *The Civil Engineer* 30, 555–559.

Oosthuizen, C., Hatting, L., Segers, I., Beukes, J., van der Westehuizen, W. & Moloi, L., 2011, 'Rehabilitation of dams in South Africa … 40 years on', *Paper Presented at the Dam maintenance and rehabilitation*, Zaragoza, Spain, n.d., 2011, n.p.

Orlik, P.B., 1970, 'South Africa: How long without TV?', *Journal of Broadcasting* 14(2), 245–258. https://doi.org/10.1080/08838157009363592

Ovendale, R., 1995, 'Macmillan and the wind of change in Africa, 1957–1960', *The Historical Journal* 38(2), 455–477.

Palmer Development Group & the University of Cape Town, 1993, *Urban sanitation evaluation: Summary report*, Water Research Commission, Pretoria.

Palmer Development Group, 1993, 'Backyard living in inner city townships: A survey of on-site access to water and waste services', in *Water and sanitation in urban areas: Survey of on-site conditions*, p. 141, Water Research Commission, Cape Town.

Palmer Development Group, 1994a, 'Meeting the demand for water and sanitation services: Getting it right in the transition', in *Water and sanitation in urban areas: Financial and institutional review*, p. 110, Water Research Commission, Cape Town.

Palmer Development Group, 1994b, 'Summary report', in *Water and sanitation in urban areas: Financial and institutional review*, p. 64, Water Research Commission, Cape Town.

Parliamentary Monitoring Committee, 1999, *Briefing by the Water Research Commission and briefing on Department of Water Affairs and Forestry Budget*, Minutes: Briefing by Dr Mokeyane on the budget of the department, viewed n.d., from https://pmg.org.za/committee-meeting/10067/.

Parliamentary Monitoring Group, 2000, *Water affairs and forestry portfolio committee on: Water regulation: Public hearings*, *01 Oct. 2000*, Parliamentary Monitoring Commission, South Africa.

Parliamentary Monitoring Group, 2003a, *National water resource strategy: Briefing*, Parliamentary Monitoring Group, Cape Town.

Parliamentary Monitoring Group, 2003b, *Water affairs and forestry portfolio committee, 09 April 2003, Department strategic plan: Briefing,* Parliamentary Monitoring Group, Cape Town.

Parliamentary Monitoring Group, 2005a, *Water affairs and forestry portfolio committee,* 08 March 2005, Department strategic plan and budget 2005/06: Briefing, n.p.

Parliamentary Monitoring Group, 2005b, *Water affairs and forestry portfolio committee*, 14 September 2005, Alternative water supplies: Department Briefing, n.p.

Parliamentary Monitoring Group, 2005c, *Water affairs and forestry portfolio committee,* 02 June 2005, Implementation of National Water Resource Strategy: Department Briefing, n.p.

Parliamentary Monitoring Group, 2005d, *Water affairs and forestry portfolio meeting*, 30 Aug. 2005, National Sanitation task team progress report: Briefing, n.p.

Parliamentary Monitoring Group, 2005e, *Water affairs and forestry portfolio meeting,* 30 August 2005, National Sanitation task team progress report: Briefing, n.p.

Parnell, S. & Mabin, A., 1995, 'Rethinking Urban South Africa', *Journal of Southern African Studies* 21(1), 39–61. https://doi.org/10.1080/03057079508708432

Pearce, A.B., 2008, 'A preventative policing style for public violence in the towns of Harrismith and Warden in the Eastern Free State', Masters thesis, UNISA, South Africa.

Perret, S.R., 2002, 'Water policies and smallholding irrigation schemes in South Africa: A history and new institutional challenges', *Water Policy* 4(3), 283–300. https://doi.org/10.1016/S1366-7017(02)00031-4

Pfister, C., 2010, 'The "1950s syndrome" and the transition from a slow-going to a rapid loss of global sustainability', in F. Uekotter (ed.), *The turning points of of environmental history*, pp. 90–118, University of Pittsburgh Press, Pittsburgh.

Phelines, R.F., Coke, M. & Nicol, S.M., 1973, 'Some biological consequences of the damming of the Pongolo river', *Paper Presented at the Commission Internationale Des Grands Barrages, Eleventh Congress*, Madrid, Spain, n.d., 1973, n.p.

Pieterse, E., Parnell, S. & Haysom, G., 2015, *Towards an African urban agenda*, United Nations Human Settlements Programme (UN-Habitat), Nairobi.

Pitman, W.V., 2011, 'Overview of water resource assessment in South Africa: Current state and future challenges', *Water SA* 37(5), 659-664. https://doi.org/10.4314/wsa.v37i5.3

Ploeger, J., 1977, 'Mentz, Hendrik', in D.W. Krüger & C.J. Beyers (eds.), *Suid-Afrikaanse biografiese woordeboek III*, pp. 615–616, Tafelberg Uitgewers, Cape Town.

Plug, C., 2014, *Van Reenen, Mr Reenen Jacob*, S2A3, viewed n.d., from http://goo.gl/nHGI76.

Plug, C., 2016, 'Gamble, John George', in C. Plug (ed.), *S2A3 Biographical database of Southern African Science*, Southern Africa Association for the Advancement of Science, Pretoria.

Plug, C., 2017, *Gessert, Mr Ferdinand, S2A3*, viewed n.d., from 2017.2001.2022.

Plug, C., n.d.a, *Schwarz, Mr Ernest Hubert Lewis (geology, geography)*, viewed n.d., from http://bit.ly/2b5qXNZ.

Plug, C., n.d.b, *Struben, Mr Arthur Marinus Alexander*, viewed n.d., from http://bit.ly/292w9U5.

Plunkett, H., 1925, 'The agricultural problem in South Africa', *Journal of the Department of Agriculture* 11(4), 304–318.

Pogue, T., 2006, 'The evolution of research collaboration in South African gold mining: 1886-1933', PhD thesis, Maastricht University.

Pohlandt-McCormick, H., 2000, '"I Saw a Nightmare…: Violence and the construction of memory (Soweto, June 16, 1976)', *History and Theory* 39(4), 23–44. https://doi.org/10.1111/0018-2656.00144

Pollard, S. & Du Toit, D., 2008, 'Integrated water resource management in complex systems: How the catchment management strategies seek to achieve sustainability and equity in water resources in South Africa', *Water SA* 34(1), 671–679.

Poole, L.M.G., 1995, 'Recent studies of meteors in South Africa', *Astrophysics and Space Science* 230(1–2), 471–478. https://doi.org/10.1007/BF00658203

Porter, R.N., 1977, 'Damming the Umfolozi: Environmental impact assessment', *South African Journal of Science* 73(112), 323.

Posel, D., 2011, 'The Apartheid project, 1948–1970', in A.K. Mager, B. Nasson and R. Ross (eds.), *The Cambridge history of South Africa 1885–1994*, p. 2, Cambridge University Press, Cambridge.

Potgieter, F.J., 1970, *Suid-Afrika se water*, 1st edn., Tafelberg-Uitgewers, Cape Town, 1970.

Powell, D., 2012, 'Imperfect transition – Local government reform in South Africa 1994–2012', in S. Booysen (ed.), *Local elections in South Africa: Parties, people, politics*, pp. 12–30, Sun Press, Bloemfontein.

PRC/Report(a), 1962, *CPR Roberts, Report on the investigation of dam sites in the Eastern Transvaal for E.S.C.O.M. water supply*, pp. 1–30, Department of Water Affairs, Pretoria.

Price, D.H., 1994, 'Wittfogel's neglected hydraulic/hydroagricultural distinction', *Journal of Anthropological Research* 50(2), 187–204.

Prinsloo, D., 1987, 'Dr Piet Meyer in Johannesburg, 1936–1984', *Historia* 32(1), 44–54.

Prinsloo, P.J.J., 1992, *Die geskiedenis van Vereeniging*, Potchefsrroom Universiteit vir Christelike Hoër Onderwys, Vanderbijlpark.

Rademayer, C., 1985, 'Bestuur, nie administreer', *Publico*, December, 1985, pp. 4–6.

Raper, P.E., 2004, *New dictionary of South African place names*, 3rd edn., Jonathan Ball, Johannesburg.

Reader, D.H., 1964, 'A survey of categories of economic activities among the peoples of Africa', *Africa: Journal of the International African Institute* 34(1), 28–45. https://doi.org/10.2307/1157360

Redaksioneel, 1984, 'Dit was amper', *Waboom*, December, 1984, p. 2.

Reeve, W.H., 1960, 'Progress and geographical signifciance of the Kariba Dam', *The Geographical Journal* 126(2), 140–146. https://doi.org/10.2307/1793954

Reisner, M., 1993, *Cadillac desert: The American West and its disappearing water*, Viking Penguin, New York.

Reisner, M.P., 1994, 'Deconstruction in the arid West', *West-Northwest Journal of Environmental Law-Policy-Thought* 1, 1–12.

Reitz, D., 1943, *No outspan*, Faber and Faber, London.

Reitzes, M., 2009, *The impact of democracy on development: The case of South Africa*, Centre for Policy Studies, Johannesburg.

Republic of South Africa, 1996, *Constitution of the Republic of South Africa*, *Act No. 108*, pp. 1–56, Government Printer, Pretoria.

Republic of South Africa, 1997, *Draft White Paper on transforming public service delivery*, South African Government, South Africa.

Republic of South Africa, 1997, *National water policy white paper*, viewed n.d., from http://www.gov.za/documents/white-papers?page=2.

Republic of South Africa, 1998a, *National Water Act*, vol. 398, Office of the President, p. 200, Government Gazette, Pretoria.

Republic of South Africa, 1998b, *National Environmental Management Act*, vol. 401, Office of the President, Government Gazette, Pretoria.

Republic of South Africa, n.d., *Water Act, 54 of 1956, in conjunction with the Water Amendment Act, 16 of 1991*, viewed n.d., from http://extwprlegs1.fao.org/docs/pdf/saf1272.pdf.

Republic of South Africa, n.d., *Water Act, 54 of 1956, Section 9C*, viewed n.d., from https://goo.gl/F3KbhI.

Resilience Alliance, 2010, *Assessing resilience in socio-ecological systems: Workbook for practitioners*, Version 2.0 edn., Resilience Alliance.

Reuss, M., *c*. 2003/2004, 'Historical explanation and water issues', in F. Hassan, et al. (eds.), *From potential conflict to cooperation potential (PCCP): Water for peace, World Water Assessment Programme*, UNESCO IHP, Paris.

Rich, B., 1990, 'The emperor's new clothes: The World Bank and environmental reform', *World Policy Journal* 7(2), 305–329.

Richardson, P., 1982, 'The Natal sugar industry, 1849–1905: An interpretative essay', *The Journal of African History* 23(4), 515–527. https://doi.org/10.1017/S0021853700021332

Richfield, L.S., 1966, 'The planning of electricity supply projects for villages in underdeveloped areas', *South African Journal of Science* 62(11), 356–360.

Rittel, H.W.J. & Weber, M.M., 1973, 'Dilemmas in a general theory of planning', *Policy Sciences* 4, 155–169. https://doi.org/10.1007/BF01405730

Roberts, C.P.R. & Alexander, W.J.R., 1982, 'Lessons learnt from the 1981 Laingsburg flood', *Civil Engineer in South Africa* 24(1), 17–27.

Roberts, D.F., 1954, 'The water resources of South Africa. What of the future?' *Civil Engineering* 4(10), n.p.

Roberts, D.F., 1962, 'The water resources of South Africa. What of the future?', *Civil Engineering* 4(4), 119–128.

Roberts, M., 1963, 'South Africa: Behind the boom', *The World Today* 19(10), 415–422.

Roberts, P., 2004, 'The Berg water project, South Africa: A WCD test case', *ICOLD Conference*, South Korea, Seoul, n.d., n.p.

Roberts, P., 2015, 'SANCOLD celebrates its 50th anniversary: Water engineering', *Civil Engineering = Siviele Ingenieurswese* 23(5), 68–69.

Robertson, T.C., 1970, 'Water', in The Caltex Service for Community Development (ed.), *Caltex booklet*, pp. 170–232, National Commercial Publishers, Cape Town.

Robins, S.L., 2008, *From revolution to rights in South Africa: Social movements, NGOs & popular politics after apartheid*, James Currey, Woodbridge.

Roefs, M. & Atkinson, D., 2010, 'Public perceptions of local government', in B. Roberts, M. wa Kivilu & D. Davids (eds.), *South African social attitudes: Reflection on the age of hope*, 2nd report, pp. 43–67, HSRC Press, Cape Town.

Rogers, K., Roux, D. & Biggs, H., 2000, 'Challenges for catchment management agencies: Lessons from bureaucracies, business and resource management', *Water SA* 26(4), 505-511.

Romano, M.P., 1964, 'The water resources of the Maputo (Southern Mozambique)', *South African Journal of Science* 60(8), 245–251.

Roos, N., 2011, 'Work colonies and South African historiography', *Social History* 36(1), 54–67. https://doi.org/10.1080/03071022.2011.549749

Rose, J.F.P., 2016, *The well-tempered city: What modern science, ancient civilizations and human nature teach us about the future of human life*, HarperCollins, New York.

Rossouw, P., 1951, 'Die arbeidskolonie Kakamas', *Argiefjaarboek vir Suid-Afrikaanse geskiedenis*, n.p., Government Printer, Pretoria.

Roux, D., Murray, K. & Van Wyk, E., 2009, *Enabling effective learning in catchment management agencies: A philosophy and strategy*, pp. 1–90, Water Research Commission, Pretoria.

Roux, D.J., Ashton, P.J., van Vliet, H.R. & Jooste, S., 1995, 'African water quality guidelines for the natural aquatic environment', *Water Science Technology* 32(5–6), 293–299.

RP101/2000, 2000, *Report of the Department of Water Affairs and Forestry 01 April 1999 to 31 March 2000: Viva water viva forests*, Department of Water Affairs, Pretoria.

RP105/1982, 1982, *Report of the director-general: Environmental affairs for the period 1981 to 31 March 1982*, Government Printer, Pretoria.

RP109/1979, 1979, Re*port of the interdepartmental committee concerning the division of water between the black states, the remainder of the Republic of South Africa and the republics of Bophuthatswana and Transkei*, Government Printer, Pretoria.

RP130/2005, 2005, *Report of the Department of Water Affairs and Forestry 01 April 2004 to 31 March 2005*, Department of Water Affairs and Forestry, Pretoria.

RP134/1996, *c.* 1996, *Report of the Director-General: Water affairs and forestry for the period 01 April 1995 to 31 March 1996*, CTP Book Binders, Cape Town.

RP163/2009, 2009a, *Annual report: 01 April 2008 to 31 March 2009*, Department of Water Affairs and Forestry, Pretoria.

RP163/2009, 2009b, *Report of the Department of Water Affairs and Forestry, 01 April 2008 to 31 March 2009*, Department of Water Affairs and Forestry, Pretoria.

RP166/2006, 2006, *Report of the Department of Water Affairs and Forestry, 01 April 2005 to 31 March 2006*, Department Water Affairs and Forestry, Pretoria.

RP18/1965, 1965, *Report of the secretary for water affairs for the period 1st April, 1963, to 31st March, 1964*, Government Printer, Pretoria.

RP186/1997, c1997, *Report of the Director-General: Water affairs and forestry for the period 01 April 1996 to 31 March 1997*, CTP Book Binders, Cape Town.

RP246/2008, 2008, *Report of the Department of Water Affairs and Forestry, 01 April 2007 to 31 March 2008*, Department of Water Affairs and Forestry, Pretoria.

RP25/1964, 1964, *Report of the secretary for water affairs for the period 1st April 1962, to 31 March 1963*, Government Printer, Pretoria.

RP28/1984, 1985, *Report of the director-general: Environmental affairs for the period 1 April 1983 to 31 March 1984*, Government Printer, Pretoria.

RP28/1985, 1986, *Report of the director-general: Environmental affairs for the period 1983 to March 1984*, Government Printer, Pretoria.

RP30/1966, 1966, *Report of the secretary for water affairs for the period 1st April, 1964, to 31st March, 1965*, Government Printer, Pretoria.

RP30/1979, 1979, *Report of the secretary for water affairs for the period 1 April 1977 to 31 March 1978*, Government Printer, Pretoria.

RP33/1963, 1963, *Report of the secretary for water affairs for the period 1st April, 1961, to 31st March, 1962*, edited by DWA, Government Printer, Pretoria.

RP33/1993, 1993, *Report of the director-general: Water affairs and forestry for the period 1 April 1991 to 31 March 1992*, Government Printer, Pretoria.

RP34/1967, 1967, *Report of the secretary for water affairs for the period 1st April, 1965- to 31st March, 1966*, Government Printer, Pretoria.

RP34/1970, 1970, *Report of the commission of enquiry into water matters*, Government Printer, Pretoria.

RP35/1991, 1991, *Report of the director-general: Water affairs for the period 1 April 1989 to 31 March 1990*, Government Printer, Pretoria.

RP35/1992, 1992, *Report of the director-general: Water affairs and forestry for the period 1 April 1990 to 31 March 1991*, Government Printer, Pretoria.

RP39/1989, 1989, *Report of the director-general: Water affairs for the period 1 April 1987 to 31 March 1988*, Government Printer, Pretoria.

RP46/1986, 1986, *Report of the director-general: Water affairs for the period 1 April 1984 to 31 March 1985*, Government Printer, Pretoria.

RP48/1973, 1973, *Report of the secretary for water affairs for the period 1 April 1971 to 31 March 1972*, Government Printer, Pretoria.

RP49/1969, 1969, *Report of the secretary for water affairs for the period 1st April, 1967, to 31st March, 1968*, Government Printer, Pretoria.

RP49/1980, 1980, *Report of the secretary for water affairs for the period 1 April 1978 to 31 March 1979*, Government Printer, Pretoria.

RP51/1978, 1978, *Report of the secretary for water affairs for the period 1 April 1976 to 31 March 1977*, Government Printer, Pretoria.

RP51/1981, 1981, *Report of the director-general: Water affairs, forestry and environmental conservation for the period 1 April 1979 to 31 March 1980*, Government Printer, Pretoria.

RP53/1988, 1988, *Report of the director-general: Water affairs for the period 1 April 1986 to 31 March 1987*, Government Printer, Pretoria.

RP56/1977, 1977, Report of the secretary for water affairs for the period 1 April 1975 to 31 March 1976, Government Printer, Pretoria.

RP58/1984, 1984, *Report of the director-general: Environmental affairs for the period 1982 to 31 March 1983*, Government Printer, Pretoria.

RP61/1974, 1974, *Report of the secretary for water affairs for the period 1 April 1972 to 31 March 1973*, Government Printer, Pretoria.

RP61/1995, 1995, *Report of the director-general: Water affairs and forestry for the period 1 April 1993 to 31 March 1994*, CTP, Cape Town.

RP62/1975, 1975, *Report of the secretary for water affairs for the period 1 April 1973 to 31 March 1974*, Government Printer, Pretoria.

RP65/1977, 1977, *Report of the secretary for water affairs for the period 1 April 1974 to 31 March 1975*, Government Printer, Pretoria.

RP67/1977, 1977, *Report of the secretary for water affairs for the period 1 April 1975 to 31 March 1976*, Government Printer, Pretoria.

RP72/1962, 1962, *Report of the Bantu Affairs Commission for the year 1 January 1961, to 31 December 1961*, Government Printer, Pretoria.

RP73/2002, 2002, *Report of the Department of Water Affairs and Forestry, April 01 2001 to March 31 2002*, Department of Water Affairs and Forestry, Pretoria.

RP75/1987, 1987, *Report of the director-general: Water affairs for the period 1 April 1985 to 31 March 1986*, Government Printer, Pretoria.

RP75/1994, 1994, *Report of the director-general: Water affairs and forestry for the period 1 April 1992 to 31 March 1993*, Government Printer, Pretoria.

RP88/2001, 2001, *Report of the Department of Water Affairs and Forestry, April 01 2000 to March 31 2001*, Department of Water Affairs and Forestry, Pretoria.

RP91/1989, 1989, *Report of the director-general: Water affairs for the period 1 April 1988 to 31 March 1989*, Government Printer, Pretoria.

RP96/1981, 1981, An*nual report of the department of water affairs, forestry and environmental conservation 1980/81*, Government Printer, Pretoria.

Rubidge, C.J., 1965, 'This dam trouble', *South African Journal of Science* 61(6), 223–225.

Rudd, R.T., 1973, 'The impact of slimes-dam formation on water quality and pollution', *Journal of the Southern African Institute of Mining and Metallurgy* 74(5), 184–192.

Ruiters, G., 2002, *Commodified water, race and social justice in South Africa: A study of three privatisation experiences in post-apartheid South African municipalities 1990–2000*, Johns Hopkins University, n.p.

SA Irrigation, 2007, 'Water Research Commission initiated project: Advertorial, 29(5) 2007', *SA Irrigation* 29(5), n.p.

SA Water Bulletin, 1976, 'Besluit in Mexiko: Deurbraak vir SA komitee i.s. groot damme', *SA Water Bulletin* 2(8), 1.

SA Water Bulletin, 1979, 'Wakers oor ons waters', *SA Water Bulletin*, October, 1979, pp. 12–21.

SA Water Bulletin, 1985, 'Droughts in perspective', *SA Water Bulletin* 11(4), 10–11.

Sabatini, R.J.L., 2003, 'A socio-economic history of the public passanger tramways of Kimberley: 1880–2000', PhD thesis, Rand Afrikaans University.

Saul, J.S. & Bond, P., 2014, *The present as history from Mrs Ples to Mandela and Marikana*, James Currey, Woodbridge.

SAWHAR AHCA1/007, 1989, *AHCA1/007 Water Decade and Beyond*, North-West University, South Africa.

SAWHAR AHCA1/011, 1990, 'African Development Bank (ADB), strategy for the 1990s', *Document presented at the African Water Supply and Sanitation Sector Conference*, Abidjan, Côte d'Ivoire, 10–11 May, 1990, n.p.

SAWHAR AHCA1/10, 1985, F. Wilson, 'Water sewerage and fuel', *Workshop on basic need in rural areas*, Foundation for Research Development (FRD), CSIR, n.p. 19 February, 1985, p. 5.

SAWHAR AHCA12/199, 1989, 'Anonymous, "Shaping the future"', *Water*, November, 1989, p. 3.

SAWHAR AHCA12/199a, 1989, "Hold up the mirror to 1989," *Water*, November, 1989. n.p..

SAWHAR AHCA16/136, 1996, 'The programme that gives hope', *DWAF Newsletter*, February 1996, pp. 1–4, Department of Water Affairs and Forestry, Pretoria.

SAWHAR AHCA18/001, 1984, *Department of Water Affairs: Olivier Shand Consortium, Lesotho Highlands Water Project: General information*, n.p.

SAWHAR AHCA18/002, 1985, *Kingdom of Lesotho, Ministry of water, energy and mining: Lahmeyer Macdonald Consortium (Ireland) and Olivier Shand Consortium (Johannesburg)*, Draft Lesotho Highlands water project: Feasibility study, main report, December, n.p.

SAWHAR AHCA18/003, 1992, 'Deloitte and Touche, Lesotho Highlands Water Project: Tariffs and levies for Vaal River system', *Report presented to the TCTA Board*, n.p., 21 October, 1992, n.p.

SAWHAR AHCA18/010, 1992, *Lesotho Highlands Water Project: Volume 2*, KSC Ltd, Kent.

SAWHAR AHCA2/006, 1990, *AHCA2/006 C Triebel – HI(SB) A Conley*, North-West University, South Africa.

SAWHAR AHCA2/009, 1990, *HRI, Design of national reservoir water quality monitoring network*, n.p., pp. 1–7.

SAWHAR AHCA2/0149, 1999, *E Mailula, Executive government and local authorities Y2K – Director-general DWAF*, c/o AH Conley, Pretoria.

SAWHAR AHCA2/016, 1992, *Directorate of strategic planning, Draft policy for managing the natural environment*, p. 107, n.p.

SAWHAR AHCA2/018, 1991, *Water supply to the Eastern Transvaal Highveld*, Department of Water Affairs, Pretoria.

SAWHAR AHCA2/019, 1992, 'J Clarke, "Not seeing wood for the trees"', *Star*, 05 May, 1992, n.p.

SAWHAR AHCA2/021, 1990, Correspondence: C.G. Swiegers – A.H. Conley, 1990.09.01: 1; Notas oor gesprek tussen amptenare van die department ontwikkelingshulp (DOH) en van die die department waterwese (DWW) op 18 Julie 1990, Pretoria: 2–3; Proposed consultants' brief: 4–6; Direkteur: inligtingsdienste, Versoek om goedkeuring van nuwe projek: evaluering van bestaande meganismes ten opsigte van watervoorsiening: 7–9; (and) Addendum, Evaluaring van bestaande meganismes ten opsigte van watervoorsiening: 15–16; Evaluering van bestaande meganismes ten opsigte van watervoorsiening taak raamwerk (dated 1990.05.17): 12–13. 1990.

SAWHAR AHCA2/030, 1990, *M van Veelen (HRI) – Director: Water pollution control. 1990.05.09. Draft terms of reference: The development of a national reservoir water quality monitoring network (RESNET)*, pp. 1–7, n.p.

SAWHAR AHCA2/043, 1990, *Stratters and Associates, A brief review of forestry and forest products in relation to planning the use of water*, Report, pp. 1–29, n.p.

SAWHAR AHCA2/067, 1989, *Policy investigation: Water resources conflict in critical catchments*, pp. 1–23, Report Directorate Strategic Planning, Pretoria.

SAWHAR AHCA25/132(b), n.d., *AF Mackenzie, recollections of Marico*, n.p.

SAWHAR AHCA25/132(e), n.d., *AF Mackenzie, recollections of Marico,* n.p.

SAWHAR AHCA25/132(i), n.d., *Mackenzie, recollections*, n.p.

SAWHAR AHCA25/132(k), n.d., *AF Mackenzie, recollections of Marico*, n.p.

SAWHAR AHCA25/132(l), n.d., *AF Mackenzie, recollections of Marico*, n.p.

SAWHAR AHCA25/132(m), n.d., *Mackenzie, Recollections of Marico*, n.p.

SAWHAR AHCA25/132, n.d., *AF Mackenzie, Recollections of Marico (A contrast in construction methods) (1976)*, pp. 1–4, n.p.

SAWHAR AHCA3(9), 1980, *White files: One of undated set of six illustrations*, n.p.

SAWHAR AHCA5/022, 2000, 'T Lamberti and Sapa, Dams coping at over-capacity as rains set new highs', *Business Day*, 11 February, n.p.

SAWHAR AHCA5/022a, 2000, 'P Krost, "Threats to Jo'burg's protests', Saturday Star, 05 February, n.p.

SAWHAR AHCA5/044, 2008, 'N Bramdaw, "Eau de privatisation: French quench powerful thirst in SA"', Business Day, 25 August, n.p.

SAWHAR AHCA5/090, 1987, *Report on training 1986–87*, n.p.

SAWHAR AHCA5/091, 1985, *Voorgestelde herstrukturering van die departement van waterwese ten opsigte van professionele personeel*, University of South Africa, Pretoria.

SAWHAR AHCA7/003, 1996, *DWAF, Overview of water resources and availability and utilisation in South Africa*, Draft report, DWAF: Directorate of Planning, Pretoria.

SAWHAR AHCA9/001, 1998, *DWAF, Director of water quality studies, terms of reference to assist with the development of a water use authorisation management system*, Fischer & Associates, Menlo Park, Pretoria.

SAWHAR AHCA9/014, 1999, W.E. Bertram, H.V.E. Boshoff & W.R.G. Orpen, *National groundwater information system (NGIS): Executive action report*, DWAF, Directorate of Geohydrology, Pretoria.

SAWHAR AHCA9/031, 2000, *Water sector support project: Strategic transformation restructuring of the water resources management function and regional offices*, Global Edge Consulting, n.p., pp. 1–107.

SAWHAR DH DWSA/Alumni1, 2017, *Heads of department (1910–2017)*, Department of Water and Sanitation, Pretoria.

SAWHAR DH1, 1972, 'F.E. Kanthack collection TC Watermeyer, Kanthack's work in the field of water power and subsequent developments', *The Civil Engineer in South Africa* 1972 14(11), 364-368.

SAWHAR DH11/D1654, 1987, JG du Plessis Collection. JG du Plessis, *Gedenklesing: 75 jaar van waterontwikkeling*, Holiday Inn, Pretoria, pp. 1263–12731987.

SAWHAR DH11/D2090 J.G. du Plessis Collection, 1985, 'Anonymous, Phalaborwa Waterraad: Ons oudste waterraad', *Water*, November, 1985, p. 2025.

SAWHAR DH11/D394 JG du Plessis Collection, n.d.*, JG du Plessis, Persoonlike herinneringe*, Chapter 4, n.p.

SAWHAR DH11/JD1603 JG du Plessis Collection, 1985, 'Kom kuier saam op Trichardtsfontein', *Water*, June, 1985, pp. 3–4.

SAWHAR DH11/JD1624 JG du Plessis Collection, *c*.1980, *Boodskap aan personeel van die direktoraat waterwese (Boodskap met aanstelling as adjunk direkteur general van waterwese)*, pp. 1212–1218, n.p.

SAWHAR DH11/JD1634 JG du Plessis Collection, 1985, 'JG du Plessis, "Vandag en more: Ons DG aan die word"', *Water*, June, 1985, pp. 1227–1228.

SAWHAR DH11/JD1713 JG du Plessis Collection, 1983, 'C Uys, "Meet South Africa's Mr Water"', *Pretoria News*, 11 April, 1983, n.p.

SAWHAR DH11JD J.G. du Plessis Collection, 1987, 'Anonymous, "Mense: Senior aanstellings by waterwese"', *The Civil Engineer in South Africa*, July, 1987, p. 244.

SAWHAR DH11JD770, n.d., *DH11JD770 J.G. du Plessis Collection (Ch. 6)*, North-West University, South Africa.

SAWHAR DH5/MKC/004 Mackenzie Collection, *c*. 1950–1952, *Undated typed (Rough draft), Advice on water policy for the Western Cape,* n.p*.*

SAWHAR DH5/MKC2a, 1988, *DWA, Vaal Dam*, Government Printer, Silverton.

SAWHAR DH5/MKC2b, 1956, *Anonymous, The story of Vaal Dam: History*, Department of Water Affairs, Pretoria.

SAWHAR DH5/MKC3a, 1932, *Correspondence: Asst-director of irrigation*, n.p., Pretoria.

SAWHAR DH5/MKC3b, 1934, *Correspondence: A.D. Lewis, Pretoria – LA Mackenzie, Vaalbank dam, 1934.09.22*, n.p.

SAWHAR DH5/MKC5/003, 1952, *Correspondence: Deputy Assistant director – LA Mackenzie, 1952.01.15, (Undated typed record of meeting where CG Hall and DF Kokot led a discussion on the preliminary report of the commission*, Cape Town.

SAWHAR DH8/article J.M. Jordaan collection, 1995, *J.M. Jordaan, Engineers just keep going…, Siviele Ingenieurswese*, n.p.

SAWHAR DH8/J003 J.M. Jordaan, 1996, *Compilers: JM, JH, AJ and SL Jordaan, Colleagues and friends*, *A life portrait of J.M. Jordaan Pr. Eng. 7.11.1906-28.9.1994*, Bpk, Pretoria.

SAWHAR DH8/J003, 1996, J.M. Jordaan, Compilers: JM, JH, AJ and SL Jordaan, Colleagues and friends, *A life portrait of J.M. Jordaan Pr. Eng. 7.11.1906-28.9.1994* (JP van der Walt en Seun (Edms), Bpk, Pretoria.

SAWHAR DH8/J0043 Jordaan Collection, 1950, J.M. Jordaan, *Water control and utilisation in the United States of America*, Government Printer, Pretoria.

SAWHAR DWSA/Alumni2, 2017, *Ministers of department (1910–2017)*, Department of Water and Sanitation, Pretoria.

SAWHAR EBC/SA Groundwater, 1998, *Past achievements and future challenges for groundwater management in South Africa, Geo-congress paper*, pp. 1–17, n.p., Pretoria.

SAWHAR ITC/articles(a), 1985, JG du Plessis, "Wat is ICOLD/SANCOLD" in *The Civil Engineer*, September, 1985, p. 501.

SAWHAR ITC/articles(b), 1984, 'WCS Legge, "Reports on the Domoina cyclone floods: Pongolapoort (Jozini) Dam absorbs Domoina floods"', *Die Siviele Ingenieur*, March, 1984, p. 113.

SAWHAR ITC/articles, 2013, *W Alexander, Post WWII dam construction*, pp. 1–10, n.p.

SAWHAR ITC/DWS(c), 1978, *Woodstock Dam*, n.p.

SAWHAR ITC/DWS(d), n.d.a, *Qedusizi flood attenuation dam*, n.p., Undated DWA summary, Department of Water Affairs, Pretoria.

SAWHAR ITC/DWS(d), n.d.b, *Vision delivery future*, pp. 1–8, Trans-Caledon Tunnel Authority, Centurion.

SAWHAR JKC/Brochures folder: Unnumbered, 1974, *Blyderivierspoort Dam: Drainage region 200, Post 1974*, n.p., pp. 1–5.

SAWHAR JKC/Dams folder: Illus. 7, 1970–1974, *Blyderivierspoort Dam*, n.p.

SAWHAR PAM1265b2, 1970, 'TPC van Robbroeck, RA Pullen, R Graber and A van Schalkwyk, Hydro-electricity, the key to the multi-purpose development of the Tugela River', *Water year 1970, Convention: Water for the future*, pp. 1–13, Department of Water Affairs, Pretoria.

SAWHAR SCO 1 111/114/1/1/1, 1993, 'SCOWSAS: Sub-committees and conveners', *Water and Sanitation, 2000 Newsletter*, 02 December, 1993, n.p.

SAWHAR SCO 1 111/114/1/1/2, 1994, 'Anonymous, … and now get down to work', *Water and Sanitation 2000 Newsletter*, 03 May, 1994, n.p.

SAWHAR SCO 1 111/1151/1/1/5/4, 1991, *Water systems management, proposal for the development of rural water supply schemes*, pp. 1–8, n.p., Pietersburg.

SAWHAR SCO 1 111/1151/1/1/5/9, 1991, *Rural water & sanitation,* n.p.

SAWHAR SCO 1 121/121/1/5, 1996, *External evaluation of the Mvula Trust, Main report*, vol. 1, n.p., Johannesburg.

SAWHAR SCO 1 141, *c.* 1992, 'General correspondence M Muller, 1991/1993', Draft letter: AM Muller-Chairman Daily Management Committee, Codesa, n.p.

SAWHAR SCO 1 144/3/3/3, 1991, *Water and sanitation 2000 correspondence Barry Jackson*, Summary WS2000 Workshop, n.p., 26 September, 1991, n.p.

SAWHAR SCO 1 144/3/3/45, 1991, *Water and Sanitation correspondence Barry Jackson. Strategy for coordinating, mobilising, and optimising activities and funding for the effective provision of water and sanitation [in developing areas] including informal settlement*, n.p.

SAWHAR SCO 1 144/3/3/76, 1990, 'Water and sanitation correspondence Barry Jackson', *Minutes of Meeting*, DBSA, Midrand, South Africa, November 19, 1990, n.p.

SAWHAR SCO 1 144/3/3/78, 1990, 'Water and sanitation correspondence Barry Jackson', *Correspondence: I Palmer – President of the Water Institute of South Africa*, Parklands, South Africa, August 03, 1990, n.p.

SAWHAR SCO 1 144/3/3/80, 1990, 'Water and sanitation correspondence Barry Jackson', *correspondence: I Palmer – B Jackson*, n.p., June 11, 1990, n.p.

SAWHAR SCO 1 144/3/3/81, 1990, 'Water and sanitation correspondence Barry Jackson', *Minutes of Meeting at DBSA*, n.p., May 15, 1990, n.p.

SAWHAR SCO1 111/1151/1/1/5/2, 1992, *Memorandum: BM Jackson – AM Muller*, Backlogs in Water Supply and Sanitation, pp. 3–8, n.p.

SAWHAR SCOa 1 111/111/7/7, n.d., *Marketing and presentation issues water supply and sanitation sector 1992*, Attachment 2: Institutional framework sub-committee: Draft interim report, n.p.

SAWHAR SCOa 1 141, 1991, *General correspondence M Muller, 1991/1993, N Macleod, Durban – M Muller, c/o DBSA*, pp. 167–168, Halfway House, n.p.

SAWHAR SCOa 1 144/3/3/3, 1991, 'Water and sanitation 2000 correspondence Barry Jackson', *Correspondence: VC Milne, Central Witwatersrand Metropolitan Chamber, Johannesburg – M Muller*, DBSA, Midrand, South Africa, October 16, 1991, n.p.

SAWHAR SCOb 1 111/114/1/1/1, 1993, 'Mission statement', *Water and Sanitation 2000 Newsletter*, 02 December, 1993, n.p.

SAWHAR SCOb 1 111/1151/1/1/5/1, 1993, 'SCOWSAS water and sanitation "A way to provide for all"', *Workshop Proceedings*, n.p., September 24–25, 1993, n.p.

SAWHAR SCOb 1 121/121/2/5, 1996, *External evaluation of the Mvula Trust*, vol. 2: Annexes, n.p.

SAWHAR SCOb 1 141, 1991, *General correspondence M Muller, 1991/1993, N Macleod, Durban – M Muller, c/o DBSA*, p. 168, Halfway House, n.p.

SAWHAR SCOc 1 111/111/7/7, n.d., *Marketing and presentation issues water supply and sanitation sector 1992*, Attachment 2: Institutional framework sub-committee: Draft interim report, n.p.

SAWHAR SCOc 1 111/1151/1/1/5/1, 1993, 'SCOWSAS water and sanitation "A way to provide for all"', *Workshop Proceedings*, n.p., September 24–25, 1993, (Handwritten minutes), n.p.

SAWHAR SCOc 1 141, 1992, *General correspondence M Muller, 1991/1993, Anonymous, 'Water management considerations during constitutional change'*, p. 168, n.p.

SAWHAR SCOd 1 111/111/7/7, *c.* 1991a, *Annexure A: Urban water supply and sanitation: The current situation*, pp. 1–5.

SAWHAR SCOd 1 111/111/7/7, *c.* 1991b, *Annexure B: Urban water supply and sanitation: The current situation – Cost of bulk services*, pp. 6–12.

SAWHAR SCOd 1 111/1151/1/1/5/1, 1993, 'SCOWSAS water and sanitation "A way to provide for all"', *Workshop Proceedings (Typed minutes)*, n.p., September 24–25, 1993, n.p.

SAWHAR SCOd 1 141, 1992, *General correspondence M Muller, 1991/1993, SCOWSAS: Minutes, inaugural meeting*, Rand Water Board, p. 60, n.p.

SAWHAR SCOe 1 141, 1992, *General correspondence M Muller, 1991/1993, Memorandum: AM Muller – D Richter, J Kruger, P Freeman and N Vink*, p. 453, n.p.

SAWHAR WAC2/2/1 Scientific aspects. WJR Alexander, 1950, *A memorandum on the Vaal River and the engineering development of its water resources*, Irrigation Department, Pretoria.

SAWHAR WAC2/2/2/6 Scientific Aspects, 1965, *WJR Alexander, Draft of Talk to S.A.I.C.E. – Bloemfontein, n.p*.

SAWHAR WAC7/1/1–14 ORP and OFT: White Papers and Regional Planning 1924–1971, 1962, *Official announcement on connection with the Orange River development project*, Cape Town.

SAWHAR WAC7/10/1 Notes on other schemes. G Whysal, 1944, *Vaalharz irrigation scheme*, Vaalhartz Hoërskool Jaarblad, n.p.

SAWHAR WAC7/11/1 General Correspondence, 1952–1967a, *The construction of Erfenis Dam (C) and 'Trites…'*, n.p.

SAWHAR WAC7/11/1 General Correspondence, 1952–1967b, *Erfenis Dam 'D','E'*, n.p.

SAWHAR WAC7/11/1 General Correspondence, 1952–1967c, *WJR Alexander, The construction of Erfenis Dam.*

SAWHAR WAC7/11/1 General Correspondence, 1952–1967, 1958, *WJR Alexander, The construction of Floriskraal Dam, August 1958 (Pages unnumbered),* n.p.

SAWHAR WAC7/12/14 Personal Correspondence, 1950–1968, 1955, *WJR Alexander, Pretoria – Dr EH Hamlin, Johannesburg*, pp. 3–4, n.p.

SAWHAR WAC8/1/2 Department of Water Affairs, 1966, *Programme of the official start of construction work on the site of the Hendrik Verwoerd Dam*, Philipolis.

SAWHAR WAC8/4/2 ORP Brochures, *c*. 1968, *Department of Information, South Africa tames a river giant*, Government Printer, Pretoria.

SAWHAR WAC8/l/1 Department of Water Affairs, 1960, *Souvenir programme: Erfenis Dam, 30 November 1960*, n.p. pages unnumbered.

SAWHAR WLC B572. NM Krige, 1986, 'Financial and manpower requirements', *NIWR, WRC and DWA, Symposium on water for the future*, Pretoria, South Africa, n.d., 1986, n.p..

SAWHAR WLC B574, 1986,'GCD Claassens, Water management: Policies and strategies to meet future requirements', *Paper presented at Symposium on water for the future*, CSIR Conference Centre, Pretoria South Africa, October 31, 1986, n.p.

SAWHAR WLC B576, 1986, *Water management: data acquisition and decision support systems NIWR, WRC and DWA Symposium on Water for the Future*, CSIR Conference Centre, Pretoria.

SAWHAR WLC C0909, 1992, 'The Dublin statement on water and sustainable development', *International Conference on Water and Environment: Development Issues for the 21st Century*, Dublin, Ireland, January 26–31, 1992, n.p.

SAWHAR WLC C1327, 1983, 'N Teichmann, "Waak teen slaggate"', *Landbouweekblad*, 03 December, 1983, pp. 38–39.

SAWHAR WLC C1409ac, 1993, 'SJL Mallory, "Hydrological modelling of farms"', *Proceedings of the Sixth South African National Hydrological Symposium: Hydrology in Developing Regions… The Road Ahead*, Pietermaritzburg, South Africa, September 08–10, 1993, n.p.

SAWHAR WLC C1464h, 1994, 'A van Schalkwyk and WJ Uys, Water supply to developing communities in the rural areas of the Northern Transvaal region during the past 50 years', in *Water Engineering Division, SAICE, 50 years of water engineering in South Africa, 14–15 July 1994: A tribute to Prof. Des Midgley*, p. 108, South African Institution of Civil Engineering, Johannesburg.

SAWHAR WLC C2459, 1992, *Department of Environmental Affairs (DEA), Building the foundation for sustainable development in South Africa: National report to the United Nations Conference on Environment and Development (UNCED) to be held in Rio de Janeiro*, Department of Environment Affairs, Pretoria.

SAWHAR WLC C3231, 1998, 'C.F. Pretorius, "Design, construction and operation of a high density sludge lime treatment plant"', *WISA 98, Biennial conference and exhibition of the Water Institute of South Africa (WISA): Papers*, vol. 3, Cape Town, South Africa, May 04–07, 1998, pp. 1–6.

SAWHAR WLC PAM1265g4, 1970, 'JC Vogel, The use of natural isotopes in hydrology', *Conference paper, Convention on Water for the Future*, Pretoria, South Africa, November 16–20, 1970, pp. 1–5.

SAWHAR WLC PAM1265i3, 1970, 'AB Thomas, "Planning of gold mines to minimize water problems at closure', in *Water year 1970, Convention: Water for the future*, pp. 1–6, Department of Water Affairs, Pretoria.

SAWHAR WLC PAM1265i5, 1970, 'MR Henzen, Mineral pollution: South Africa's greatest problem in water quality protection', *Water year 1970, Convention: Water for the future*, Pretoria, South Africa, November 16–20, 1970, pp. 1–13.

SAWHAR WLC PAM15033, 1984, 'RSA, Water Amendment Act, 96 of 1984', *Government Gazette of the Republic of South Africa* 229(9330), 1–103.

SAWHAR WLC PAM1889, *c*. 1965, *Water and power for South Africa's expanding economy – A glimpse into the future*, n.p. pp. 20–40.

SAWHAR WLC PAM2293, 1951, 'EJ Hamlin, "The history of, development, present, past and future trends of sewage disposal in South Africa"', *Conference Paper at Annual Conference of the Institute of Sewage Purification*, Buxton, United Kingdom, June 19–22, 1951, pp. 1–116.

SAWHAR WLC PAM2305, *c*. 1943, *JP Leslie, Control of river pollution*, Rand Water Board, Johannesburg.

SAWHAR WLC PAM2333, 1971, *TR49, HMG Barker, The effect of Cetyl/Staeryl alcohol monolayer on the aquatic life of Vaal Dam*, HRI, Department of Water Affairs, Pretoria.

SAWHAR WLC PAM3091/72(b), 1972, *ESCOM, Hendrik Verwoerd Dam c. 1972*, Public Relations division Escom, Graphis, n.p.

SAWHAR WLC PAM3244/62, *1962, Preliminary results of research on raw sewage stabilisation ponds, Report 189*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3245/64, 1964a, *The utilisation of municipal wastes: Report on the processing of urban wastes in a mechanized composting plant, Report 211*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3247/64, 1964b, *A guide to the use of septic tank systems in South Africa, Report 2019*, NIWR, Pretoria.

SAWHAR WLC PAM3249/64, 1964c, *Evaluation of a tannin-base polyelectrolyte as a coagulant for turbid waters. Report 223*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3250/65, 1965, *Experiments to establish the degradability of a new biologically soft synthetic detergent, Report 231*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3263/69, 1969, *A guide to water conservation and water reclamation in industry, CSIR Guide K9*, pp. 1–99, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3265/69, 1969, *Industrial water and effluent management in the textile industry: CSIR Guide K11*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3277/63, 1963a, *WAT 20, Report of the director for 1961*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3283/63, 1963b, *NIWR, Report of the director for 1962*, CSIR, Pretoria.

SAWHAR WLC PAM3289/69, 1968, *WAT32, NIWR 1967/68 Annual report*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3290/65, 1965, *NIWR, WAT 33, Director's report for 1964*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3294/65, 1965, *NIWR, Director's report for 1965 (CSIR Special Report WAT37)*, pp. 1–68, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3298/70, 1970, *NIWR, 1968–1969 annual report (Special Report WAT43)*, NIWR, CSIT, Pretoria.

SAWHAR WLC PAM3299/71, 1971, *NIWR, 1969/70 annual report (CSIR Special report WAT44)*, NIWR, CSIR, Pretoria.

SAWHAR WLC PAM3813/72, 1972, *Planning and advisory council of the prime minister*, Report on pollution, March 1972, Department of Planning, Pretoria.

SAWHAR WLC PAM5364/72, 1972, 'SO Ekland, "The Orange-Fish tunnel"', *Public works roads and transport*, n.p., pp. 3–4.

SAWHAR WLC PAM5547, 1968a, *H Olivier, A report on engineering/economic criteria in water resource development: Vol. I, Summary Report and Conclusions*, BSB Company (Pty) Ltd, Johannesburg.

SAWHAR WLC PAM5548, 1968b, *H Olivier A report on engineering/economic criteria in water resource development: Vol. II*, (B.S.B. Company (Pty) Ltd, Johannesburg.

SAWHAR WLC PAM7779, 1974, *TR58, A Rooseboom, Meting en analise van sediment afvoer in riviere*, pp.1–43, HRI, Pretoria.

SAWHAR WLC PAM7781, 1975, *TR61, A Rooseboom, Sedimentproduksiekaart vir Suid-Afrika*, pp. 1–5, HRI, Pretoria.

SAWHAR WLC W11, 1976, 'DC Midgley, Will there be enough water?', *Paper presented at the 1976 Conference of the Institute of Water Pollution Control (Southern African Branch)*, Durban, South Africa, June 07–11, 1976, pp. 1–14.

SAWHAR WLC W1620, 1980, 'Anonymous, "Usutu-Vaal water scheme on stream"', *Power & Plant in Southern Africa*, January, 1980, pp. 1–7.

SAWHAR WLC W177, 1976, 'Anonymous, "DWA's R24 million balancing act"', *Construction in Southern Africa*, May, 1976, n.p.

SAWHAR WLC W178, 1976a, 'Anonymous, "The day they almost abandoned the Orange Fish Tunnel"', *Construction in Southern Africa* 20(10), 41.

SAWHAR WLC W252, 1976, 'AH Görgens, Mathematical modelling of the mineralisation of river systems', *Water SA* 2(1), 13–19.

SAWHAR WLC W3797, 1982, 'P.E. Odendaal, "Die ontstaan, doelstellings en werkwyses van die Waternavorsingskommissie"', in WNK*, Inligtingsessie met betrekking tot die werksaamhede van die Waternavorsingskommissie*, p. 10, Water Research Commission, Pretoria.

SAWHAR WLC W3798, 1982, 'PJT Roberts, "Hydrology and geohydrology"', in WNK, *Inligtingsessie met betrekking tot die werksaamhede van die Waternavorsingskommissie*, Water Research Commission, Pretoria.

SAWHAR WLC W444, 1976b, 'Anonymous, "Vanderkloof comes on stream"', *Construction in South Africa* 21(9), 17–20.

SAWHAR WLC W522, 1977, 'AG Davies, "A new giant on the Orange River', *Construction in South Africa* 22(7), 22–25, 27, 31–33.

SAWHAR WLC W654, 1977, 'GC Cillie, Current technology and research on re-use of effluents', *SACCAP Action News* 3(2), 10–13.

SAWHAR WLC W678, 1978, 'RN Porter, Ecological investigation of dams in the Umfolozi game reserve', *Public Works, Construction and Transport*, pp. 15–16, n.p.

SAWHAR WLC W679, 1978. 'HM Kok, SJM Blaber and GCB Walley, "The post impoundment Ichteofauna of the JG Strijdom Dam, KwaZulu"', *South African Journal of Science* 74, 140–142.

SAWHAR WLC W680, 1978, 'D Pauw, Ngodwana pulp mill and the environment', *Environment RSA* 5(3), 1–2.

SAWHAR WLC W688, 1976, 'Anonymous, Tapping Ruacana's potential', *Building + Construction* 11, 12–15.

SAWHAR WLC W711, 1978, 'Anonymous, Steenbras: There's light at the end of the tunnel', *Construction in Southern Africa* 23(3), 39.

SAWHAR WLC W765, 1978, 'M Isaacson, "The planning and execution of a programme to monitor the health aspects of direct water re-use"', *Paper Presented at a Conference of the Institute of Water Pollution Control: Southern African Branch*, Port Elizabeth, South Africa, March 13–17, 1978, pp. 1–9.

SAWHAR WLC W785, 1978, 'W Thoms, Berekening van piekvloei in 'n rioolskema met behulp van "n rekenaar"', *IMIESA* (Vol. and no. not disclosed in document), 11–17.

SAWHAR WLC W786, 1978, 'AW Austin and PR Bouwer, Boskrans lewer stabiele slyk', *IMIESA* 25, 27.

SAWHAR WLC W788, 1978, 'J Halliday, Goudkoppies: A process of evolution', *IMIESA* 3(5), 24.

SAWHAR WLC W89, 1975, 'Anonymous, "83 kilometres of risks and unknowns"', *South African tunneling. supplement to construction in South Africa*, n.p., p. 7.

SAWHAR WLC W99, 1974, *GG Cillié and GJ Stander, A case for reclamation*, In Supplement No. 2 to the Municipal Engineer, September/October, pp. 33–37.

SAWHAR ZKC, 1986, *DWA, Management of the water resources of the Republic of South Africa*, Department of Water Affairs, Pretoria.

SAWHAR ZKC, 1986, *Management of the water resources of the Republic of South Africa*, Department of Water Affairs, Pretoria.

SAWHAR, 2017, *DWAF HOD Jaap Kroon*, North-West University, South Africa.

SAWHAR, AHCA7/013, 1993, *Scenario based multicriteria policy planning for water management in South Africa*, Report 296/1/93, Water Research Commission, Pretoria.

SAWHAR, PRC, 1987, 'The birth of a house journal', *Water 1912–1987*, p. 21, Department of Water Affairs, Pretoria.

SAWHAR, *c*. 1950-1952, *DH5/LM5/004 Mackenzie collection*, pp. 1-11, North-West University, South Africa

Schapera, I., 1928, 'Economic changes in South African native life', *Africa* 1(2), 170–188. https://doi.org/10.2307/1155936

Schmidt, J.J., 2017, *Water: Abundance, scarcity and security in the age of humanity*, New York University Press, New York.

Scholtz, J.J.J., 1987, 'Sauer, Paul Olivier', in C.J. Beyers & J.L. Basson (eds.), *Suid-Afrikaanse Biografiese Woordeboek V*, pp. 716–720, Raad vir Geesteswetenskaplike Navorsing (RGN), Pretoria.

Schoonees, P.C., 1939, *Die prosa van die tweede Afrikaanse beweging*, third print edn., Hollandsch-Afrikaansche Uitgevers Maatschappij, Cape Town.

Schreiner, B., n.d., *Abbreviated CV as board member of the International Water management Institute (IWMI)*, viewed n.d., from http://bit.ly/2vd5uzO.

Schrenk, D., 1982, 'The water system of SASOL II', *SA Water Bulletin*, 1982, pp. 24–25.

Schumpeter, J.A., 1975, *Capitalism, socialism and democracy*, Harper, New York.

Schutz, R.W., 1967, 'Application of land conservation methods to engineering projects', *Civil Engineering*, 271–272.

Schwab, K. 2017. *The Fourth Industrial Revolution*, Penguin Books Ltd., London.

Schwarz, E.H.L., 1920, 'The Kalahari and its possibilities', *Journal of the Royal African Society* 20(77), 1–12.

Schwarz, E.H.L., *c*. 1920, *The Kalahari or thirstland redemption*, T. Maskew Miller, Cape Town.

Scoones, I., 1999, 'New ecology and the social sciences: What prospects for a fruitful engagement?', *Annual Review of Anthropology* 28, 479–507. https://doi.org/10.1146/annurev.anthro.28.1.479

Secretary-General, 2001, *Road map towards the implementation of the United Nations Millennium Declaration*, United Nations Organisation, New York.

Sedlack, D., 2014, *Water 4.0: The past present and future of the world's most vital resource*, Yale University Press, New Haven, CT.

Seekings, J., 2007, '"Not a single white person should be allowed to go under": Swartgevaar and the origins of South Africa's welfare state, 1924–1929', *Journal of African History* 48(3), 375–394.

Seleka, N., 2009, 'Vaal service delivery protest turns ugly', Sowetan, 11 September, n.p.

Senchuk, D.M., 1999, 'Whitehead, Alfred North (1861–1947)', in R. Audi (ed.), *The Cambridge dictionary of philosophy*, pp. 971–974, Cambridge University Press, Cambridge.

Showers, K.B., 2009, 'Congo River's Grand Inga hydroelectricity scheme: Linking environmental history, policy and impact', *Water History* 1(1), 31–58. https://doi.org/10.1007/s12685-009-0001-8

Singer, M., 2011, *Facing coal: Changing conceptions of South African coal-based pollution, with special reference to the Witbank coalfield, 1906–1978*, vol. 31, African Studies Collection, African Studies Centre, Ipskamp Drukkers, Enschede.

Sjölander-Holland, A.-C., 2005, *The water business: Corporations versus people*, Zed Books, London.

Slaughter, R.A., 1996, 'Long-term thinking and the politics of reconceptualization', *Futures* 28(1), 75–86. https://doi.org/10.1016/0016-3287(95)00074-7

Smil, V., 2004, *Enriching the earth: Fritz Haber, Carl Bosch, and the transformation of world food production*, MIT Press, Cambridge.

Smit, F., 2009, 'Arm ken nie ras of geslag', Beeld, 16 Oktober, n.p.

Smith, A.D., 2009a, 'Zuma pleads as protests sweep the townships', Guardian, 26 July, n.p.

Smith, C., 2009b, 'Economy trumps politics: Sexwale', Fin24, 23 September, n.p.

Smith, C., 2013, *City water, city life: Water and the infrastructure of ideas in urbanizing Philadelphia, Boston, and Chicago*, University of Chicago Press, Chicago.

Smith, D., 2009c, 'Anger at ANC record boils over in South African townships', Guardian, 22 July.

Smith, G., 2008, 'South Africa's water woes echo global problems', *Earth Island Journal* 23(3), 17.

Smith, H., 1993, 'Apartheid, Sharpeville and "Impartiality": The reporting of South Africa on BBC television 1948–1961', *Historical Journal of Film, Radio and Television* 13(3), 251–298. https://doi.org/10.1080/01439689300260261

Smith, L., 2005, 'South Africa: Testing the waters of public-public partnerships', in B. Balanyá, B. Brennan, O. Hoedeman, S. Kashimito & P. Terhorst (eds.), *Reclaiming public water: Achievements, struggles and visions from around the world*, pp. 159-169, Transnational Institute, Amsterdam.

Snaddon, C.D., Wishart, M.J. & Davies, B.R., 1998, 'Some implications of inter-basin water transfers for river ecosystem functioning and water resources management in southern Africa', *Aquatic Ecosystem Health and Management* 1(2), 159–182. https://doi.org/10.1016/S1463-4988(98)00021-9

Snellen, IThM., 1967, 'Apartheid: Checks and changes', *International Affairs (Royal Institute of International Affairs 1944-)* 43(2), 293–306. https://doi.org/10.2307/2614328

Snow Report, n.d., 'History of Snow in South Africa: 1853–2016', *Snow Report*, viewed n.d., from http://snowreport.co.za/history-of-snow-in-south-africa-1853-2014/.

Sojamo, S., 2015,'Unlocking the "Prisoner's Dilemma" of corporate water stewardship in South Africa – Exploring corporate power and legitimacy of engagement in water management and governance', *Sustainability* 7(6), 6893–6918. https://doi.org/10.3390/su7066893

Solomon, R., 1911, 'The resources and problems of the Union of South Africa', *Journal of the Royal Society of Arts* 59(3042), 420–433.

Solomon, S., 2010, *Water: The epic struggle for wealth, power and civilization [e-book]*, Harper Collins, New York.

Sommer, H., 1996, 'From apartheid to democracy: Patterns of violent and nonviolent direct action in South Africa, 1984–1994', *Africa Today* 43(1), 53–76.

Sorokin, P.A., 1927, 'A survey of the cyclical conceptions of social and historical process', *Social Forces* 6(1), 28–40. https://doi.org/10.1093/sf/6.1.28

South African Government, 1995, *National sanitation water policy white paper*, viewed n.d., from http://www.gov.za/documents/national-sanitation-policy-white-paper-draft%20#secD.

South African Government, 2007, *S Mufamadi on launch of Project Consolidate Publications*, viewed n.d., from http://bit.ly/2hMvfPZ.

South African History Online, 1998, 'Speech by President Nelson Mandela at the opening of the Lesotho Highlands Water Project', 22 January, 1998, viewed n.d., from http://bit.ly/2h5k8iv.

Spalding-Fecher, R., Williams, A. & Van Horen, C., 2000, 'Energy and environment in South Africa: Charting a course to sustainability', *Energy for Sustainable Development* 4(4), 8–17. https://doi.org/10.1016/S0973-0826(08)60259-8

Spengler, O., 1922–1923, *Der Untergang des Abendlandes: Umriss einer Morphologie der Weltgeschichte*, Beck, München.

Spies, S.B., 1993, 'The launching of the Union of South Africa', in B.J. Liebenberg & S.B. Spies (eds.), *South Africa in the 20th century*, pp.72–78, JL van Schaik, Pretoria.

SPROCAS, 1973, *South Africa's political alternatives: Report of the Spro-cas Political Commission*, SPROCAS, Johannesburg.

Stadler, A.W., 1979, 'Birds in the cornfield: Squatter movements in Johannesburg, 1944–1947', *Journal of Southern African Studies* 6(1), 93–123. https://doi.org/10.1080/03057077908708008

Staff Reporter, 2008, 'Public sector: Public service: Pam Yako', *Mail & Guardian*, 07 August, 2008, n.p.

Staff Reporter, 2009, 'Book of South African women: Politics', *Mail & Guardian*, 03 August, 2009, n.p.

Stallebras, J.L., 1963, 'The Orange River Project', *South African Journal of Science* 59, 448–454.

Stander, G.J., Henzen, M.R. & Funke, J.W., 1970, 'The disposal of polluted effluents from mining, metallurgical and metal finishing industries, their effects on receiving water and remedial measures', *Journal of the South African Institute of Mining* 71(5), 95–103.

Steenveld. C., Barclay, S.J. & Buckley, C., 1995, 'Waste minimisation clubs: Introducing the concept to South African industries', *WISA 98, Biennial Conference and Exhibition of the Water Institute of Southern Africa (WISA)*, n.p., May 04–07, pp. 1–7.

Stein, R., 2005, 'Water law in a democratic South Africa: A country case study examining the introduction of a public rights system', *Texas Law Review* 83(7), 2167–2183.

Stephenson, D.B., 1971, 'Integrated development of the Orange-Vaal & Tugela Basins', *South African Journal of Science* 67(9), 457–463.

Stewart, C.M., 1910, 'Rainfall, from an agricultural standpoint, particularly in relation to dry farming', *Agricultural Journal of the Union of South Africa* 35(5), 552–554.

Steyn, P. & Wessels, A., 1999, 'The roots of contemporary governmental and non-governmental environmental awareness in South Africa, 1654–1972', *New Contree* 45, 61–81.

Steyn, P., 2001, 'Environmental management in South Africa: Twenty years of governmental response to the global challenge, 1972–1992', *Historia* 46(1), 25–53.

Steyn, P.J., 1994, 'Streke in Suid-Afrika-Verlede vs teorie vs toekoms', *Stads-en Streeksbeplanning = Town and Regional Planning* 1994(37), 7–19.

Stockholm International Water Institute, n.d., *Stockholm Water Prize Laureates: Kadar Asmal, South Africa*, viewed n.d., from http://1clickurls.com/LxGpuWj.

Struben, A.M.A., 1906, 'Some problems in Transvaal irrigation', *Transvaal Agricultural Journal* 4(14), 299-307.

Stultz, N.M., 1969, 'The politics of security: South Africa under Verwoerd, 1961–6', *The Journal of Modern African Studies* 7(1), 3–20.

Supplement to Financial Mail, 1969a, 'A desert into an Eden?' *Supplement to Financial Mail*, 26 April, pp. 9–11.

Supplement to Financial Mail, 1969b,'Nine thousand new farms', *Supplement to Financial Mail*, 26 April, p. 13, 15.

Supplement to Financial Mail, 1969c, 'State in the saddle', *Supplement to Financial Mail*, 26 April, p. 19, 21.

Supplement to Financial Mail, 1969d, 'Victim of the credit squeeze', *Supplement to Financial Mail*, 26 April, p. 21, 23.

Suttner, R., 2009, 'The challenge to African National Congress dominance', *Representation* 45(2), 109–123. https://doi.org/10.1080/00344890902944346

Swanson, M.W., 1977, 'The sanitation syndrome: Bubonic plague and urban native policy in the Cape Colony, 1900–1909', *The Journal of African History* 18(3), 387–410. https://doi.org/10.1017/S0021853700027328

Swartz, D., 2006, 'New pathways to sustainability: African universities in a globalising world', in M. Nkomo, D. Swartz & B. Maja (eds.), *Within the realm of possibility: From disadvantage to development at the University of Fort Hare and the University of the North*, pp. 127–166, Human Sciences Research Council, Cape Town.

Swatuk, L., 2005, 'Political challenges to sustainably managing intra-basin water resources in southern Africa: Drawing lessons from cases', *Paper presented at the Workshop on Water, Development and Cooperation – Comparative Perspective: Euphrates-Tigris and Southern Africa*, Bonn, Germany, March 01–02, 2004, pp. 157-183.

Swatuk, L., 2010, 'The state and water resources development: A tale of two South Africas', *Water Alternatives* 3(3), 521–536.

Swatuk, L.A. & Cash, C., 2018, 'Perspectives on the Nexus: Water, Energy and Food Security in an era of climate change', in L.A. Swatuk & C. Cash (eds.), *Water, Energy, Food and People Across the Global South*, pp. 1–13, Springer Nature, Switzerland.

Swilling, M., 1987, 'The United Democratic Front and township revolt in South Africa', University of the Witwatersrand, History Workshop, Johannesburg, p. 23.

Swilling, M., 1990, 'Political transition, development and the role of civil society', *Africa Insight* 20(3), 151–160.

Swyngedouw, E., 1999, 'Modernity and hybridity: Nature, regeneracionismo, and the production of the Spanish waterscape, 1890–1930', *Annals of the Association of American Geographers* 89(3), 443–465. https://doi.org/10.1111/0004-5608.00157

Tapela, B.N., 2008, 'Livelihoods in the wake of agricultural commercialisation in South Africa's poverty nodes: Insights from small-scale irrigation schemes in Limpopo Province'. *Development Southern Africa* 25(2), 181–192. https://doi.org/10.1080/03768350802090584

Tatlow, A.H., 1924, 'The Union of South Africa', *Journal of the Royal African Society* 23(92), 278–284.

TCTA, 2004, *2004 Annual report*, p. 123, TCTA, Centurion.

TCTA, 2005, *Annual report 2005*, n.p. p. 154.

TCTA, 2006, *Annual report 2006: Rejuvenation, revival, renaissance, transformation*, p. 112, Trans Caledon Tunnel Authority, Centurion.

Tempelhoff, J., 2016a, 'Exploring panarchy and social-ecological resilience: Towards understanding water history in precolonial southern Africa', *Historia* 61(1), 92–112. https://doi.org/10.17159/2309-8392/2016/v61n1a8

Tempelhoff, J.W.N. & All Rand Water Portfolios, 2015*, In pursuit of excellence: Rand Water 2003–2013*, Kleio, Vanderbijlpark.

Tempelhoff, J.W.N. & Stopforth, G., 2014, *The South African Water History Archival Repository (SAWHAR) project at North-West University (Vaal) and a historical overview of the Waterlit Collection*, Water Research Commission, Gezina.

Tempelhoff, J.W.N. & Winde, F., 2013, 'Acid mine water drainage in South Africa: Policy, economic issues and public concerns', in T.S. Katko, P.S. Juuti & K. Schwartz (eds.), *Water services management and governance lessons for a sustainable future*, IWA Publishers, London.

Tempelhoff, J.W.N., 2003, *The substance of ubiquity: Rand Water 1903–2003*, Kleio Publishers, Vanderbijlpark.

Tempelhoff, J.W.N., 2006, 'Omgewingslagoffers of armblankes? Water en welvaartskepping in die era van Hertzog (1924–1939)', in S.A. Akademie vir Wetenskap en Kuns (ed.), *Genl. J.B.M. Hertzoggedenklesing XXXV*, pp. 1–31, S.A. Akademie vir Wetenskap en Kuns, Pretoria.

Tempelhoff, J.W.N., 2008, 'Historical perspectives on pre-colonial irrigation in Southern Africa', *African Historical Review* 40(1), 121–160.

Tempelhoff, J.W.N., 2009a, 'Service delivery conflict in South Africa's water sector', *Quarterly Bulletin of Third World Studies* 49(1), 30–53.

Tempelhoff, J.W.N., 2009b, 'Bloot ń vrees vir verval? ń Mentaliteitsgeskiedenis van die kragonderbrekings in Suid-Afrika, Januarie-April 2008', *TD: The Journal for Transdisciplinary Research in Southern Africa* 5(2), 262–292. https://doi.org/10.4102/td.v5i2.140

Tempelhoff, J.W.N., 2016b, 'Water, migration and settlement in the Southern African Iron age', in T. Tvedt & T. Østigard (eds.), *A history of water: Water and food: From Hunter-Gatherers to global production in Africa*, pp. 121–159, IB Taurus, London.

Terblanche, D.E., Pegram, C.G.S. & Mittermaier, M.P., 2001, 'The development of weather radar as a research and operational tool for hydrology in South Africa', *Journal of Hydrology* 241(1–2), 3-25.

Tewari, D.D., n.d., 'An analysis of evolution of water rights in South African Society: An account of three hundred years', *International Water History Association Conference*, Bergen, Norway, n.d., p. 37.

The Engineer, 1924 , 'Illustration of recently completed "Lake Mentz"', *The Engineer*, 01 February, 1924, n.p.

The International Commission on Large Dams, n.d., *History*, viewed n.d., from http://bit.ly/2dfnPTP.

The Right to Water and Sanitation, n.d., 'The Millennium Development Goals', viewed 17 December 2016, from http://bit.ly/2gUVCnr.

Thompson, H., 2006, *Water law: A practical approach to resource management and the provision of services*, Second impression edn., Juta & Co Ltd, Cape Town.

Thorelli, H.B., 1968, 'South Africa: Its multi-cultural marketing system', *Journal of Marketing* 32(2), 40–48. https://doi.org/10.2307/1248927

Thorp, W.L. & Thorp, H.E., 1926, 'The annals of South Africa', in W.L. Thorp (ed.), *Business annals*, pp. 308–318, National Bureau of Economic Research, Cambridge.

Thwaites, R., 1982, 'The hydrological cycle (modified)', *Waboom*, December, 1982, p. 19.

Tissington, K., 2011, *Basic sanitation in South Africa: A guide to legislation, policy and practice*, Socio-economic Rights Institute of South Africa, Johannesburg.

Tissington, K., Dettmann, D., Langford, M., Dugard, J. & Conteh, S., 2008, *Water services faultlines: An assessment of South Africa's water and sanitation provision across 15 municipalities*, CALS, COHRE and NCHR, Johannesburg.

Tobias, P.V., 1958, 'Kariba re-settlement: An experiment in human ecology', *South African Journal of Science* 54(6), 148–150.

Toynbee, A., 1959, 'My view of history', in P. Gardiner (ed.), *Theories of history*, pp. 205–210, The Free Press, New York.

Toynbee, A.J., 1958, 'Book review: Oriental Dcspotism: A comparative study of total power'. Review of oriental despotism: A comparative study of total power, Karl A. Wittfogel', *The American Political Science Review* 52(1), 195–198. https://doi.org/10.2307/1953021

Transparency International, 2003, *Global corruption report 2003*, Transparency International, Berlin.

Trawick, P., 2003, 'Against the privatization of water: An indigenous model for improving existing laws and successfully governing the commons', *World Development* 31(6), 977–996. https://doi.org/10.1016/S0305-750X(03)00049-4

Trends Reporter, 1991, 'SA thirst still far from being quenched', *The Star*, 21 September, 1991, p. 12.

Triebel, C. & Van Niekerk, P.H., 1994, 'The water supply systems in South Africa', in J.M. Jordaan (ed.), *Large dams and water systems in South Africa*, SANCOLD, Pretoria, pp 30–43.

Turton, A. & Funke, N., 2008, 'Hydro-hegemony in the context of the Orange River Basin', CSIR, Pretoria.

Turton, A. & Henwood, R., 2002, *Hydropolitics in the developing world: A Southern African perspective*, IWMI, University of Pretoria, Pretoria.

Turton, A. & Meissner, R., 2002,'The hydrosocial contract and its manifestation in society: A South African case study', in A. Turton & R. Henwood (eds.), *Hydropolitics in the Developing World: A Southern African Perspective,* pp. 37–60, University of Pretoria, Pretoria.

Turton, A., 1999, 'Water scarcity and social adaptive capacity: Towards an understanding of the social dynamics of water demand management in developing countries', *MEWREW Occasional Paper No. 9*, School of Oriental and African Studies, University of London, London.

Turton, A., 2000, *Water and sustainable development: A southern perspective*, African Water Issues Research Unit, University of Pretoria, Pretoria.

Turton, A., 2010, 'The politics of water and mining in South Africa', in K. Wegerich & J. Warner (eds.), *The Politics of water: A survey*, pp. 142-160, Routledge, London.

Turton, A.R. & Warner, J.F., 2002, 'Exploring the population/water resources nexus in the developing world', *Finding the Source: The Linkages between Population and Water*, pp. 52–81, n.p.

Turton, A.R., 2001, 'Hydropolitics and security complex theory: An African perspective', *4th Pan-European International Relations Conference*, University of Kent, Canterbury, United Kingdom, n.d., pp. 11–26.

Turton, A.R., 2003, *The political aspects of institutional developments in the water sector: South Africa and its international river basins*, Political Science, University of Pretoria, Pretoria.

Turton, A.R., Meissner R., Mampane P.M. & Seremo, O., 2004, *A hydropolitical history of South Africa's international river basins*, Water Research Commission, Pretoria.

Turton, A.R., Meissner, R., Mampane, P.M. & Seremo, O., 2004, *A hydropolitical history of South Africa's international river basins*, p. 454, Water Research Commission, Pretoria.

Turton, A.R., Patrick, M.J. & Rascher, J., 2008, 'Editorial: Setting the scene – Hydropolitics and the Development of the South African Economy', *International Journal of Water Resources Development* 24(3), 323–327. https://doi.org/10.1080/07900620802127309

UG10/1932, 1932, *Report of the director of irrigation for the period 1st April, to 31st march, 1931*, Government Printer, Pretoria.

UG10/1940, 1940, *Annual report of the director of irrigation for the period 1st April, 1938, to 31st March, 1939*, Government Printer, Pretoria.

UG11/1941, 1941, *Annual report of the director of irrigation for the period 1st April, 1939, to 31st March, 1940*, Government Printer, Pretoria.

UG12/1914, 1914, *Rapport van de direkteur van besproeiïng over het tijdperk 1 Januarie 1912 tot 31 Maart 1913*, Government Printer, Cape Town.

UG12/1933, 1933, *Report of the director of irrigation for the period 1st April, 1931 to 31st March 1932*, Government Printer, Pretoria.

UG12/1939, 1939, *Annual report of the director of irrigation for the period 1st April, 1937, to 31st March, 1938*, Government Printer, Pretoria.

UG14/1925, 1925, *Report of the director of irrigation for the period 1st April, 1923, to 31st March, 1924*, Government Printers, Cape Town.

UG14/1937, 1937, *Annual report of the irrigation commission for the year ending 31st March, 1936*, Government Printer, Pretoria.

UG14/1940, 1940, *Annual report of the irrigation commission for the year ending 31st March, 1939*, Government Printer, Pretoria.

UG14/1947, 1947, *Report of the Native Affairs Commission for the year 1945–46*, Government Printer, Cape Town.

UG15/1936, 1936, *Annual report of the director of irrigation for the period 1st April, 1934, to 31st March, 1935*, Government Printer, Pretoria.

UG15/1949, n.d., *Report of the Native Affairs Commission for the period 1April, 1946, to 31 December 1947*, Cape Times Limited, Cape Town.

UG16/1927, 1927, *Rapport van die direkteur van besproeiing vir die tydperk 1 April, 1925, tot 31 Maart, 1926*, Government Printer, Cape Town.

UG16/1928, 1928, *Rapport van die direkteur van besproeiing vir die tydperk 1 April 1926 tot 31 Maart 1927*, Government Printer, Pretoria.

UG19/1918, 1918, *Report of the director of irrigation for the period 1st April, 1913, to 31st March, 1917*, Government Printers, Cape Town.

UG2/1914, 1914, *Report of the director of irrigation for the period 1st January, 1912, to 31st March, 1913*, Government Printer, Cape Town.

UG24/1956, 1956, *Report of the director of irrigation for the period 1st April to 31st March 1955*, Government Printer, n.p.

UG25/1926, 1926, *Rapport van die direkteur van besproeiing vir die tydperk 1 April, 1924, tot 31 Maart, 1925*, Government Printer, Cape Town.

UG26/1911, 1911, *Report of the Director of Irrigation for the year 1910*, Government Printer, Pretoria.

UG27/1953, 1953, *Verslag van die direkteur van besproeiing vir die tydperk 1 April tot 31 Maart 1952 1953)*, Staatsdrukkery, Pretoria.

UG28/1946, 1946, *Report on the Kalahari expedition 1945 (being a further investigation into the water resources of the kalahari and their relationship to the climate of South Africa)*, Government Printer, Pretoria.

UG29/1925, 1925, *Eerste verslag van die finansiële besproeiïngskommissie,* Government Printer, Cape Town.

UG3/1931, 1931, *Annual report of the irrigation commission for the year ending 31st March, 1930*, Government Printer, Pretoria.

UG3/1938, 1937, *Annual report of the director of irrigation for the period 1st April, 1936, to 31st March, 1937*, Government Printer, Pretoria.

UG32/1912, 1912, *Census 1911, Report and annexures*, Government Printer, Pretoria.

UG32/1921, 1921, *Rapport van die direkteur van besproeiïng voor het tydperk 1 April 1919 tot 31 Maart 1920*, Government Printer, Cape Town.

UG36/1961, 1961, *Report of the Bantu Affairs Commission for the period 1January, 1957 to 31 December 1960*, Government Printer, Pretoria.

UG37/1958, 1958, *Report of the Native Affairs Commission for the period 1 January 1956, to 31 December 1956*, Government Printer, Pretoria.

UG39/1912, 1912, *Report of the Director of Irrigation for the year 1911*, Government Printer, Cape Town.

UG4/1938, 1938, *Annual report of the Irrigation Commission for the period year ending 31 March 1937*, Government Printer, Pretoria.

UG40/1948, 1948, *Verslag van die kommissie in sake besproeiingsfinansies*, Staatsdrukker, Pretoria.

UG44/1925, 1925, *Second report of the irrigation finance commission*, Government Printers, Cape Town.

UG49/1918, 1918, *Rapport van de direkteur van besproeiingen voor het tijdperk 1 April 1917–31 Maart 1918*, Government Printer, Cape Town.

UG5/1934, 1934, *Jaarverslag van die direkteur van besproeiing vir die tydperk 1 April 1932 tot 31 Maart 1933*, Government Printer, Pretoria.

UG54/1956, 1956, *Report of the Native Affairs Commission for the period 1 January 1955, to 31 December 1955*, Government Printer, Pretoria.

UG55/1947, 1947, *Report of the director of irrigation for the period 1st April, 1940, to 31st March 1946*, Govenment Printer, Pretoria.

UG55/1955, n.d., *Report of the Native Affairs Commission for the period 1 January 1954, to 31 December 1954*, Government Printer, Pretoria.

UG61/1955, 1955, *Summary of the report of the Tomlinson Commission for the socio-economic development of the Bantu areas within the Union of South Africa*, Government Printer, Pretoria.

UG65/1949, 1949, *Report of the director of irrigation for the period 1st April 1947 to 31 March 1948*, Government Printer, Pretoria.

UG65/1950, 1950, *Verslag van die direkteur van besproeiing vir die tydperk 1 April 1948 tot 31 Maart 1949*, Government Printer, Pretoria.

UG7/1929, 1929, *Annual report of the irrigation commission for the year ending 31st March 1928*, Government Printer, Cape Town.

UG74/1960, 1960, *Report of the director of water affairs for the period 1st April, 1956 to 31st March, 1957*, Government Printer, Pretoria.

UG8/1923,1923, *Rapport van de direkteur van besproeiing voor het tijdperk 1 April 1921 to 31 Maart 1922*, Government Printer, Cape Town.

UG8/1929, 1929, *Rapport van die direkteur van besproeiing vir die tydperk 1 April 1927 tot 31 Maart 1928*, Cape Times, Cape Town.

UG9/1930, 1930, *Rapport van die direkteur van besproeiing vir die tydperk 1 April 1928 tot 31 Maart 1929*, Cape Times Beperk, Cape Town.

UG9/1932, 1932, *Annual report of the irrigation commission for the year ending 31st March, 1931*, Government Printer, Pretoria.

UG9/1939, 1939, *Jaarverslag van die besproeiingskommissie vir die tydperk eindigende 31 Maart 1938*, Government Printer, Pretoria.

Union of South Africa, 1952, *Hartebeestpoort irrigation scheme (Crocodile River) Act, 32 of 1914*, Durban: Butterworth & Co., (Africa) Ltd, Durban, pp. 415–417.

Union of South Africa, 1956,'Water Act, 54 of 1956', in Union of South Africa (ed.), *Statutes of the Republic of South Africa,* n.p.

United Nations, 1985, *General Assembly Resolution 35/18 of 1980.11.10; and UN General Assembly Resolution A/RES/40/171*, viewed n.d., from http://bit.ly/2ljELMA.

United Nations, 2000, We the peoples: The role of the United Nations in the 21st century (Millennium Report of the Secretary General), Press Release GA/9704, 03 April 2000, viewed 17 December 2016, from http://bit.ly/2htJUim.

United Nations, 2001, *Road map towards the implementation of the United Nations Millennium Declaration (Report of the Secretary-General), General Assembly A/56/326*, 06 Sept. 2001, viewed n.d., from https://bit.ly/2URU5yQ.

United Nations, 2002, *World Summit on Sustainable Development*, A/conf.199/L.4 agenda Item 8, partnership events. Water, energy, health, agriculture and biodiversity: Synthesis of the framework paper of the working group, Distribution: 22 August 2002, pp. 3–5, United Nations, Digital Archive.

Uys, M. 2008, *Water law of South Africa 1912-1998*, Water Research Commission, Pretoria.

Uys, M., 1996, *A structural analysis of the water allocation mechanism of the Water Act 54 of 1956 in the light of the requirements of competing water user sectors with special reference to the allocation of water rights for ecobiotic requirements and the historical development of the South African water law*, Water Research Commission, Pretoria, p. 468.

Van Robbroeck, T.P.C., c. 2016a, *Water boards'. Water engineering: Memories of a career in water engineering and management*, viewed n.d., from http://lieberheim.blogspot.com/p/blog-page_8.html.

Van Averbeke, W., Denison, J. & Mnkeni, P.N.S., 2011, 'Smallholder irrigation schemes in South Africa: A review of knowledge generated by the Water Research Commission', *Water SA* 37(5), 797-808. https://doi.org/10.4314/wsa.v37i5.17

Van Averbeke, W., Denison, J. & Mnkeni, P.N.S., 2011, 'Smallholder irrigation schemes in South Africa: A review of knowledge generated by the Water Research Commission', *Water SA* 37(5), 797–808. https://doi.org/10.4314/wsa.v37i5.17

Van der Bank, D.A., 1989, 'Die Vrystaatse Eeufees (1954): beplanning en reelingskomitees', *Navorsinge van die Nasionale Museum: Researches of the National Museum* 6(9), 324–333.

Van der Horst, S.T., 1955, 'The Union of South Africa: Economic problems in a multiracial situation', *The Annals of the American Academy of Political and Social Science* 298, 71–83. https://doi.org/10.1177/000271625529800109

Van der Merwe, C., 1965, 'Agriculture: Trends and Prospects, 1963/64 and 1964/65', *Agrekon* 4(1), 5–7. https://doi.org/10.1080/03031853.1965.9524478

Van der Merwe, N., 2004, 'Managing the quality of drinking water: Insight', *IMIESA* 29(9), 6–11.

Van Huyssteen, J.F., 1962, 'The sheep and wool industry in South Africa', *Agrekon* 1(2), 28–34. https://doi.org/10.1080/03031853.1962.9524601

Van Jaarsveld, A.Z.A., 1982, *Kroniek van eeu-ou Prieska 1882–1982*, N.G. Sendingpers, Bloemfontein.

Van Koppen, B. & Schreiner, B., 2014, 'Moving beyond integrated water resource management: Developmental water management in South Africa', *International Journal of Water Resources Development* 30(3), 543–558. https://doi.org/10.1080/07900627.2014.912111

Van Koppen, B., 2008, 'Redressing inequities of the past from a historical perspective: The case of the Olifants basin, South Africa', *Water SA* 34(4), 432–438.

Van Reenen, J.R., 1925, 'Development of irrigation in the Union of South Africa', *South African Journal of Science* 22, 22–41.

Van Reenen, R.J., 1935, *Resisting drought*, Government Printer, Pretoria.

Van Rensburg, A.P.J., 1977, 'Strijdom, Johannes Gerhardus', in D.W. Krüger & C.J. Beyers (eds.), *Suid-Afrikaanse Biografiese woordeboek III*, pp. 785–793, Tafelberg Uitgewers, Cape Town.

Van Rensburg, W.C.J., 1974, 'South Africa's future role as a supplier of raw materials to the world', *Africa Insight* 4(2), 33–39.

Van Riet & Louw Landscape Architects, 2003, *Sustainable utilisation plan for the Nandoni Dam in the Thoyandou district of the Limpopo Province*, p. 176, Department of Water Affairs and Forestry, Pretoria.

Van Robbroeck, T.P.C., 1979, 'Inter-basin water transfers in South Africa', *Civil Engineer in South Africa* 21(2), 29–35.

Van Robbroeck, T.P.C., 1985, 'Wateroordrag tussen rivierbekkens', *SA Tydskrif vir Natuurwetenskap en Tegnologie* 4(3), 93–98. https://doi.org/10.4102/satnt.v4i3.1036

Van Robbroeck, T.P.C., 1990, 'International and South African interaction on large dams', *Civil Engineering* 2(8), 200, 203.

Van Robbroeck, T.P.C., 1996, *Conservation of the water environment – Is it attainable?*, Ninth Biennial British Dam Society Conference, York.

Van Robbroeck, T.P.C., c. 2016c, Hydroconsult'. W*ater engineering: Memories of a career in water engineering and management*, viewed n.d., from http://lieberheim.blogspot.com/p/blog-page_52.html.

Van Robbroeck, T.P.C., *c*. 2016b, *Tugela-Vaal. Water engineering: Memories of a career in water engineering and management*, viewed n.d., from http://lieberheim.blogspot.com/p/blog-page_24.html.

Van Robbroeck, T.P.C., *c*. 2016d, *Ebenezer Dam. Water engineering: Memories of a career in water engineering and management*, viewed n.d., from http://lieberheim.blogspot.com/p/v-behaviorurldefaultvmlo.html.

Van Rooyen, C. & Hall, D., 2007, *Public is as private does: The confused case of Rand Water in South Africa*, Occasional Papers Series, Municipal Services Project, Johannesburg.

Van Schoor, M.C.E. &Oberholster, J.J., 1960, 'Die fontein van Bloemfontein – voorstelle vir 'n monument: Die fontein van Bloemfontein – voorstelle vir 'n monument', *Historia* 5(3), 169–178.

Van Sittert, L., 2004, 'The supernatural state: Water divining and the Cape underground water rush, 1891–1910', *Journal of Social history* 37(4), 915–937. https://doi.org/10.1353/jsh.2004.0067

Van Tonder, D., 1990, 'Gangs, councillors and the apartheid state: The Newclare Squatters' Movement of 1952', *South African Historical Journal* 22(1), 82–107.

Van Vuuren, L., 2006, 'Cholera – The threat is not over', *The Water Wheel* 5(5), 16–18.

Van Vuuren, L., 2008, 'Taming the poort: SA's water history', *Water Wheel* 7(3), 19–21.

Van Vuuren, L., 2009, 'Darlington Dam – SA's troubled lake: Water history', *Water Wheel* 8(4), 24–28.

Van Vuuren, L., 2012, *In the foosteps of giants – Exploring the history of South Africa's large dams*, Water Research Commission, Gezina.

Van Vuuren, L., 2013, 'Together we can do more – Environmental consciousness in the South African dam construction sector (1945–1980)', *TD: The Journal for Transdisciplinary Research in Southern Africa* 9(1), 51–80. https://doi.org/10.4102/td.v9i1.218

Van Vuuren, L., 2017, 'Kruger National Park river research: A history of conservation and the "reserve" legislation in South Africa (1988–2000)', MA thesis, North-West University.

Van Vuuren, L., n.d., *The department of water affairs (DWA) celebrates 100th anniversary in July*, viewed n.d, from http://goo.gl/n6MUrz.

Van Vuuren, L.R.J., 1975, 'Water reclamation – Quality targets and economic considerations', *Water SA* 1(3), 133–143.

Van Waasdijk, T., 1963, 'Some secondary economic effects of the execution of the Orange River Project', *South African Journal of Science* 59(10), 468–472.

Van Wyk, E., Breen, C.M., Roux, D.J., Rogers, K.H., Sherwill, T. & Van Wilgen, B.W., 2006, 'The ecological reserve: Towards a common understanding for river management in South Africa', *Water SA* 32(3), 403–409.

Van Wyk, E., Van Wilgen, B.W. & Roux, D.J., 2001, 'How well has biophysical research served the needs of water resource management? Lessons from the Sabie-Sand catchment: Commentary', *South African Journal of Science* 97(9–10), 349–356.

Van Wyk, J., 2017, 'As die wolprys styg', *Beeld*, 30 Augustus 2017, Digitally accessed 2017.2008.2030.

Van Zyl, C., 1914, 'Irrigation by Zaaidams', *Agricultural Journal of the Union of South Africa* 7(4), 493–495.

Van Zyl, L., 2007, *Boegoeberg se mense: 'n flukse draai van die wiel*, Lokkie van Zyl, Groblershoop.

Venter, F.A., 1970a, 'Die wêreld is hul woning', in F.A. Venter (ed.), *Water*, pp. 291–296, Afrikaanse Pers-boekhandel, Cape Town.

Venter, F.A., 1970b, *Water*, 1st edn., Afrikaanse Pers-Boekhandel vir die Ministerie van waterwese, Cape Town.

Venter, I., 2005, 'SA in danger of losing water excellence', *Engineering News*, 21 October, 2005, n.p.

Venturi, F., 1963, 'Oriental despotism', *Journal of the History of Ideas* 24(1), 133–142. https://doi.org/10.2307/2707864

Verbeek, A.W., 1966, 'Toekomstige vleisproduksie in verband met droogtevraagstukke', *Journal of the South African Veterinary Association* 37(4), 387–393.

Visser, C.G., 2015, *Van armoedeverligtingsprojek tot volhoubare landbougemeenskap: die vestiging en ontwikkeling van die Skanskopeilandbesproeiings nedersetting*, North-West University, Potchefstroom.

Visser, D. & Nyanchaga, E., 2012, 'The South African Engineer Corp's water supply operations in Kenya during the Second World War: Its wartime impact and postwar legacy', *Journal for Contemporary History* 37(2), 32–51.

Visser, D., Jacobs, A. & Smit, A., 2008, 'Water for Saldanha: War as an agent of change', *Historia* 53(1), 130–161.

Visser, W.P., 2013, 'White settlement and irrigation schemes: C.F. Rigg and the founding of Bonnievale in the Breede River Valley, 1900–*c*.1953', *New Contree* 68, 1–28.

Vogel, C., 1994a, '(Mis)management of droughts in South Africa: Past, present and future', *South African Journal of Science* 90, 4–6.

Vogel, C., 1998, 'Disaster management in South Africa', *South African Journal of Science* 94(3), 98–100.

Vogel, C.H., 1994b, *Consequences of drought in Southern Africa (1960–1992)*, University of the Witwatersrand, Johannesburg.

W177, SAWHAR WLC, 1976, 'Anonymous, DWA's R24 million balancing act', *Construction in Southern Africa*, p. 49, n.p.

W673, SAWHAR WLC, 1976, 'GJ Stander, "Die WNK en plaaslike owerhede"', *IMIESA* 1(6),21, 23.

Wallace, R., 1896, *Farming industries of the Cape Colony*, C. Juta and Co., Cape Town.

Wallingford, H.R. & Wallingford G.W.P.S, 1999, 'Facilitating remedies for water scarcity', *Framework for action: Achieving the vision*, Global Water Partnership, n.p.

Walton, J., 1974, *Water-mills, windmills and horse-mills of South Africa*, p. 155, C Struik Publishers, Cape Town,.

Water Law Commission, 1952, R*eport of the commission of enquiry concerning the water laws of the Union*, Government Printer, Pretoria.

Water Research Commission, 1974, *Annual report: 1 April 1973 to 31 March 1974*, Wallachs Printing Co. (Pty.) Ltd, Pretoria.

Water Research Commission, 1976, *Annual report: 1 January 1975 to 31 December 1975*, vol. 65, Water Research Commission, Pretoria.

Water Research Commission, 1977, *Annual report: 1 January 1976 to 31 December 1976*, Wallachs Printing Co (Pty) Ltd, Pretoria.

Water Research Commission, 1978, *Annual report: 1 January 1977 to 31 December 1977*, p. 85, Water research Commission, Pretoria.

Water Wheel, 2011. "Water Research Commission - celebrating 40 years of research excellence: Special anniversary issue," *Water Wheel* 10(5), 6–10.

Waterbury, J., 1979, *The hydropolitics of the Nile Valley*, Syracusse University Press, Syracusse.

Waterbury, J., 2002, *The Nile Basin: National determinants of collective action*, Yale University Press, New Haven.

Waters, C.N., Zalasiewicz, J., Summerhayes, C., Barnosky, A.D., Poirier, C., Gałuszka, A., 2016, 'The anthropocene is functionally and stratigraphically distinct from the Holocene ', *Science* 351(6269). https://doi.org/10.1126/science.aad2622

Webber, A.J., 1916, 'Fruit farming in the Eastern Cape', *The Agricultural Journal and Small-holder of South Africa* 3(14), 48–50.

Weeks, B., Rodriguez, MA. & Blakeslee, J.H., 2004, 'Panarchy: Complexity and regime change in human societies', *Proceedings of Complex Systems Summer School*, Santa Fe, United States of America, n.d., 2004, n.p.

Weisfelder, R.F., 1997, 'Why Lesotho needs a distinctive diplomatic strategy but hasn't found an appropriate format', *Africa Insight* 27(1), 32–43.

Welsh, D., 1984, 'Constitutional changes in South Africa', *African Affairs* 83(331), 147–162. https://doi.org/10.1093/oxfordjournals.afraf.a097603

West, G., 2017, *Scale: The universal laws of growth, innovation, sustainability, and the pace of life, in organisms, cities, economies, and companies*, Penguin Press, New York.

Whelan, D., 2015, 'Diluted by history: The extraordinary endeavour of the Winterton irrigation settlement', *South African Historical Society Biennial Conference*, University of Stellenbosch, Stellenbosch, South Africa, n.d., 2015, n.p.

White, E., 1965, 'Last steps towards independence: The three African Protectorates', *African Affairs* 64(257), 261–270. https://doi.org/10.1093/oxfordjournals.afraf.a095428

Whitmore, J.S., n.d., *The founding of the Hydrological Research Institute: Recollections and reflections Speech delivered on the occasion of the institute's 21st anniversary by Joan Whitemore 1922–2002, the first director of the institute (1970–1977)*, viewed n.d., from https://goo.gl/Kx7UGF.

Whittington, G., 1963, 'Developments in southern African diamond production', *Geography* 48(2), 194–196.

Whysal, G., 1944, 'Vaalharz Irrigation Scheme', *Vaalhartz Hoërskool Jaarblad*, n.p.

Wickens, P.L., 1983, 'Agriculture', in F.L. Coleman (ed.), *Economic history of South Africa*, pp. 37–88, HAUM, Pretoria.

Wilcocks, R.W., 1932, *Psychological report*, 5 vols, vol. 2, Pro Ecclesia, Stellenbosch.

Wilson, F. & Ramphele, M. (eds.), 1989, *Uprooting poverty: The South African challenge: Report for the second Carnegie inquiry into poverty in Southern Africa*, Norton, New York.

Wilson, T.D., 1984, 'Health services within Soweto', in Anonymous (ed.), *Second Carnegie Report into Poverty and Development in Southern Africa Conference*, pp. 1–32, SALDRU, Cape Town.

Wittfogel, K.A., 1957, *Oriental despotism: A comparative study of total power*, Yale University Press, New Haven.

Wolff, G. & Gleick, P., 2002, 'The soft path for water', in P.H. Gleick (ed.), *The world's water 2002–2003*, pp. 1–29, Island Press, Washington DC.

Wolpe, H., 1995, 'The uneven transition from apartheid in South Africa', *Transformation* 27, 88–102.

Wolski, P., 2017, 'How severe is this drought, really?' in CSAG (ed.), *CSAG Blogpost*, Climate System Analysis Group, University of Cape Town, Cape Town.

World Bank, n.d. *Kingdom of Lesotho, Lesotho Highlands Water Project, Phase B: Environmental impact assessment: Executive summary*, May, World Bank documents, viewed n.d., from http://documents.worldbank.org/curated/en/503161468772479396/Lesotho-Highlands-Water-Project-Phase-B-environmental-impact-assessment.

World Commission on Dams, 2000, *Dams and development: A new framework for decision-making*, Earthscan Publications Ltd, London.

Worster, D., 1985, *Rivers of empire: Water, aridity and the growth of the American West*, Pantheon Books, New York.

WP A90, 1990, *Eighth supplementary report on the Orange River development project (Lower Sundays River government water scheme: Extension to supply Port Elizabeth)*, Government Printer, Pretoria.

WP AA64, 1964, *Supplementary report on the Orange River development project,* Department of water affairs, Pretoria.

WP C86, 1986, *Seventh supplementary report on the Orange River development project (Lower Sundays River Government water scheme, Lower Fish River government water scheme and Orange-Douglas government water scheme)*, Government Printer, Pretoria.

WP C90, 1990, *Report on the Ladysmith flood control scheme (Mount Pleasant Dam)*, Government Printer, Cape Town.

WP D57, 1957/1958, *The proposed Upper Komati River government water scheme, District Carolina*, Government Printer, Pretoria.

WP E63, 1963, *Report on the proposed Northern Free State water board scheme*, Government Printer, Pretoria.

WP E82, 1982, *Sixth supplementary report on the Tugela Vaal government water project*, Department of Environmental Affairs, Pretoria.

WP E87, 1987, *Report on the proposed water pollution control works at abandoned mines in Northern Natal*, Government Printer, Pretoria.

WP F57, 1957, *Report of the director of water affairs on the Kougha River government water scheme, district Humansdorp*, Department of Water Affairs, Pretoria.

WP F70, 1970, *Report on the proposed Elands River government work,* Government Printer, Pretoria.

WP F81, 1981, *Report on the proposed Usutu-Vaal river government water scheme second phase (Heyshope Dam, pumping stations and aquaducts)*, Government Printer, Cape Town.

WP F84, 1984, *First supplementary report on the Grootdraai Dam emergency augmentation scheme*, Government Printer, Pretoria.

WP F92, 1992, *Report on the proposed water pollution control works at abandoned coal mines in the Witbank and Ermelo districts*, Government Printer, Pretoria.

WP G63, 1963, *Report on the proposed Usutu government water work (Jericho Dam)*, Government Printer, Pretoria.

WP G68, 1968, *Report on the third phase of the Usutu River government water scheme*, Government Printer, Pretoria.

WP H80, 1980, *Fifth supplementary report on the Tugela-Vaal government water project (Increased cost of second phase, and proposed raising of Sterkfontein Dam)*, Government Printer, Pretoria.

WP H84, 1984–1985, *Sixth supplementary report on the first phase of the Orange River development project*, Government Printer, Pretoria.

WP I65, 1965, *Report of the second phase of the proposed Usutu government water scheme*, Government Printer, Pretoria.

WP J1994, 1994, *White paper on reconstruction and development. Notice 1954 of 1994*, Government Gazette, pp. 1–81, Government Printer, Pretoria.

WP J64, 1964, *Report on the proposed Usutu River government water work (Camden pipeline)*, Government Printer, Pretoria.

WP J84, 1984, *Seventh supplementary report on the Tugela-Vaal government water project (Extension phase II)*, Government Printer, Pretoria.

WP K83, 1983, *Report on the proposed Grootdraai Dam emergency augmentation scheme*, Government Printer, Pretoria.

WP L68, 1968, *Second supplementary report on the Orange River development project 1968–1969*, Government Printer, Pretoria.

WP L82, 1982, *Report on the proposed Elands River government water scheme (Vaal augmentation)*, Government Printer, Pretoria.

WP M83, 1983, *Report on the Ngagane River government water scheme (Buffalo River)*, Government Printer, Pretoria.

WP N71, 1971–1972, *Third supplementary report on the first phase of the Orange River Development Project*, Government Printer, Pretoria.

WP N71, 1971–1972, *Third supplementary report on the first phase of the Orange River Development Project*, Government Printer, Pretoria.

WP N83, 1983, *Report on the proposed Mooi-Mgeni water scheme (Emergency augmentation of the Mgeni River)*, Government Printer, Pretoria.

WP Q64, 1964, *Department of water affairs, The proposed water scheme of the Phalaborwa Water Board*, Government Printer, Pretoria.

WP R67, 1967, *Supplement report on the second phase of the Usutu government water scheme*, Government Printer, Pretoria.

WP T65, 1965, *Supplementary report on the proposed water scheme of the Phalaborwa water board*, Government Printer, Pretoria.

WP V66, 1966, *Second supplementary report on the first phase of the Usutu River government water work (Jericho Dam and Camden Pipeline)*, Government Printer, Pretoria.

WP W70, 1970, *Supplementary report on the proposed Tugela-Vaal water project*, Department of Water Affairs (ed.), Government Printer, Pretoria.

WP X62, 1962, *Report on the proposed Orange River development project*, Government Printer, Pretoria.

WP Z64, 1964, *Report on the proposed Palala river weirs*, edited by Department of Water Affairs, Government Printer, Cape Town.

Wuetrich, B., 2002, *Synopsis: Panarchy*, Island Press, Washington DC.

WWF-SA, 2016, *Water: Facts & futures*, WWF-SA, Cape Town.

Young, L.L., 1964, *Summary of developed and potential waterpower of the United States and other countries of the world, 1955–62*, vol. 483, US Government Printing Office, Washington DC.

Zangel, V.A., 2004, 'The seething masses: Housing, water and sanitation in the lives of Johannesburg's poor, 1886–1906', MA dissertation, North-West University.

Zonzolo, A., 1966, 'Drought, water and politics in South Africa', *The African Communist* 27(4), 28–33.

Glossary

α	Used in panarchy theory: The first letter of the alphabet (Alpha) associated with the beginning.
Ω	Used in panarchy theory: The last letter (Omega) of the Greek alphabet that is associated with the end.
K	Used in panarchy theory: The tenth letter (Kappa) of the Greek alphabet. In mathematics it is an ordinal number that is a generalisation for a natural number that is used to describe or arrange a way of a collection of objects.
kL	Kiloliter
r	Used in Panarchy theory: The third letter (Gamma) of the Greek alphabet. In mathematics and science it has a bearing on a chromatic number in graph theory.
Back loop	In panarchy the back loop of the infinity cycle is deemed unpredictable and constantly uncertain, for as long as there is no clear indication of recovery in the cycle.
Creative destruction	An economic theory that holds that amid processes of collapse, the outcome is not always merely negative. Instead there are inherent benefits to be reaped, depending on the way in which the collapse is perceived.
Front loop	In panarchy theory the front loop, as a rule leads in the direction of the conservation of resources and steady growth, for as long as it is possible for the system to exploit the available resources in a sustainable manner.
Heuristic	The process of collecting information that can, but may in future, not be of relevance in the process of interpreting the past or present.
Hermeneutics	The practice of qualitatively interpreting information in a manner so that the meaning of words and ideas can be understood in a past-present context.
Hydraulic mission	The planning and management of a system of water governance by a governance authority over an extended period of time.
L	Litre
ML	Mega litres
Panarchy	A theory of resilience in environmental studies in which infinity is studied as key to processes of adaptive change in ecosystems. As a result of complexity the process may have contradictory characteristics in sequences of change in temporal and spatial contexts.
Resilience	The ability to recover from setbacks and often even flourish better than before as a result of appropriate adaptations.
SES	Social ecological system. The natural ecology of biological and geophysical components are integrated with primarily human social entities in the form of human society and its institutions with an awareness of the complexity and adaptive ability of the system of engagement.

Source criticism	The critical interrogation of texts to determine their truthfulness and usefulness in our understanding of the past.
System	An apparent orderly manner of engagement between humans and nature in what may appear to be ecosystems, human institutions related to social, economic, political and environmental in character.
WEF nexus	Water–energy–food nexus. The nexus resources are currently singled out as crucial for governance and management planning in the era of climate change.

Index

Q

R

S

In this scholarly work, Johann Tempelhoff takes the reader on a comprehensive tour of the key moments that have shaped South Africa's water sector. He pays special attention, not only to influential individuals but also to the role of institutions, world and regional events and to relevant scholarship across the globe and across disciplines. By considering the nation's 'hydraulic mission', the book's organising principle, through the lens of the Water-Energy-Food nexus, the author situates his analysis within a current mode of thinking about water management and governance. The chronological organisation of the book is well thought-out and logical. Its sections and chapters move breezily through the nation's major phases in the 20th and early 21st century. Sensitive to sociocultural issues, which in this instance arise from South Africa's colonial and then past, Johann Tempelhoff is consistently on the lookout for issues relating to social justice. In the course of reporting on how water has been viewed by the various governments, he demonstrates an excellent grasp of the technological aspects of the water development sector. Most impressive is the author's mastery of the relevant sources (including nearly 2200 footnotes); he has thoroughly and competently milked official documents and archival materials and complemented that with a comprehensive familiarity with and handling of modern global scholarship on the multiple aspects of water management and governance (by geographers, political scientists, anthropologists, hydrologists and engineers).

Prof. Robert Varady, Environmental Policy, Udall Centre for Studies in Public Policy, University of Arizona, United States of America

South Africa has a rich history of water. The frontier between the cultures of Europe and southern Africa opened at a small place called Camissa, a series of short rivers flowing from 36 springs fed from an aquifer at the base of Table Mountain. Camissa means 'Place of Sweet Waters' in the Khoi language. Those rivers sustained a vibrant community of pastoralists, whose culture was eventually destroyed by European intrusion. Today, the City of Cape Town is in deep crisis. Water resource management has brought the city to its knees as the world watches in horror. Yet, the Camissa streams still flow, steadily, now polluted and trapped in the sewers of the city, discarded and forgotten. Cape Town is the canary in the cage down the mine shaft, as many parts of the planet are experiencing similar water-related crisis. The circularity of the Cape Town story is a perfect example of our need to map a better future by understanding what has happened in the past. This book is of vital importance to the citizens, government and business leaders of South Africa, who are slowly starting to comprehend the harsh reality of systemic failure across the entire water sector. Our sewage management systems are mostly dysfunctional, so we are polluting our rivers and dams with pathogens and partially metabolised medication. Major cities are gripped in the throes of various crises that can only be understood in the context of their respective history. How we deal with this will determine the kind of future our children will have. Facts are our friend, and history is the collective wisdom needed to manage this resource in a way that takes us from merely surviving, to a better future in which we are thriving.

Dr Anthony Turton, Centre for Environmental Management, University of the Free State, South Africa

AOSIS
www.aosis.co.za

Open access at https://doi.org/10.4102/aosis.2018.BK75

9 781928 396727
ISBN: 978-1-928396-72-7