

Water Quality Management Policies and Strategies for South Africa

A Review of Water Quality Management Policies and Strategies in South Africa



**Water Resource Planning Systems
Water Quality Planning**

**WATER QUALITY MANAGEMENT POLICIES AND
STRATEGIES FOR SOUTH AFRICA**

**A REVIEW OF WATER QUALITY
MANAGEMENT POLICIES AND STRATEGIES IN
SOUTH AFRICA**

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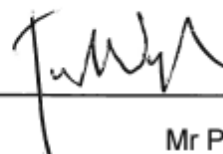
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EXECUTIVE SUMMARY

Introduction

South Africa is often lauded with having one of the most progressive Constitutions and Water Acts. However, this great framework alone cannot guarantee the sustainable and equitable use of the country's most precious resource. Rapid urbanisation, expansion of the mining industry, increasing use of chemicals in agriculture and destruction of our natural/green infrastructure has undermined the quality of the country's water resources. Poor water quality impacts negatively on human health, threatens downstream irrigation areas and food security, increases industrial costs and raw water treatment costs arising from removing pollutants, reduces income generated from recreation and ecotourism, destroys ecosystems and affects biodiversity. The deterioration of water quality is therefore an issue that can affect many national priorities and strategies including strategies for economic development, health management and biodiversity conservation (DWS, 2015).

Sustainable development in South Africa is critically dependent on assurances of good quality of the country's limited resources. Development must be balanced by an increased supply of water of an appropriate quality to satisfy the human needs. Demand for water will continue to grow as the country's population increases as well as social and economic conditions improve in South Africa. Consequently, placing increasing pressure on the country's scarce water resources and concurrently, increasing potential threats to water quality (DWAF, 2003). Water quality management has to be conducted within the realities as outlined above. The challenge has always been to clearly articulate water user requirements for specific circumstances and matching them with appropriate measures to ensure on-going beneficial water use. It is recognised that the existing Water Quality Management (WQM) policy is dated (Water Quality Management Policies and Strategies in the RSA in 1991 and the Resource Directed Management of Water Quality in 2006) and whilst innovative at the time of publication, is now in need of revision in order to align with current overarching policy and legislative frameworks. Key amongst these issues is fundamental changes in governance and institutional frameworks and the need to consider more carefully the role of various public and private actors. It is also recognised that there is a range of supporting operational policies, strategies, management instruments and methodologies that have been developed and implemented in recent years. These provide a significant platform for the development of new strategies and policies, based upon the pragmatic experience of implementing these instruments. It should be noted that the integration of the WQM Policy and IWQM Strategy with wider national policies provides the opportunity to align the approaches toward managing water quality with other activities the Department, and in Government as a whole. This will help entrench this project and secure its sustainability going forward.

Therefore, this report, which is the first part of the Literature Review trilogy, aims to understand the evolution of WQM policies and strategies that currently govern South Africa. This literature review also aims to highlight innovative ways in which the key identified water

quality challenges have been addressed internationally, particularly in the context of challenging landscapes/futures by looking at specific case studies.

The Evolution of Policy

1919 to 1956

Water quality problems were experienced in South Africa during the first half of the 20th Century. This coincided with the development of towns and industries and the associated accumulation of wastes in built-up areas. Under the Public Health Act of the Union of South Africa, 1919 (Act No 36 of 1919) all sewage and sewage effluents had to be disposed of on land, by means of irrigation or through evaporation in evaporation ponds mainly due to inadequate technology or high treatment costs.

1956 to 1991

In the pre-1950 to the post-1950 era, South Africa underwent a change from an agriculturally based economy to one in which industry and mining became more dominant. The Water Act, 1956 (Act No 54 of 1956) aimed at control of the industrial use of water and the treatment and disposal of effluent. By 1956 it was becoming apparent that reconciling water supply with water demand would be increasingly difficult and that reuse of effluent would have to play a major role in the management of the country's scarce water resources. After 1956 the earlier requirement of the health authorities that prohibited the disposal of effluent to natural water courses had to fall away due to diminishing water supplies. The 1956 Act required that all effluent be returned to the water body from which the water was originally abstracted. Later amendments, notably the Water Amendment Act, 1984 (Act No 96 of 1984) broadened water quality management and the uniform effluent standards, the General and Special Standards and the Special Effluent Standards for Phosphate were developed to limit eutrophication and associated pollution.

1991 to 1998

The emphasis on the management of effluent quality did not achieve the desired results. Water quality continued to deteriorate, mainly due to other forms of water contamination, not directly covered by effluent quality control, becoming more pronounced. These primarily relate to diffuse sources of contamination and associated land use activities. This necessitated focussing on the water resource to ensure suitable water quality for beneficial water use. This resulted in the Receiving Water Quality Objectives (RWQO's) approach, complemented with a pollution prevention approach. The development of catchment management plans, although not entrenched in law, also started within this period in order to facilitate the implementation of the RWQO's approach.

1998 to present

The National Water Policy and subsequent National Water Act of 1998 entrenched the concept of catchment management and associated resource quality objectives by direct management effort. Moreover, the concept of the Reserve as part of the resource base was

also established. The concept of sustainable water use as introduced by the National Water Policy and the National Water Act, 1998, not only embraces the concept of aquatic ecosystem integrity as reflected by the Reserve, but also emphasises that water use must 'benefit' human society. This is in line with the current national effort to enhance the social and economic situation of South Africa. South Africa is currently in a policy review phase, with the amendment of the NWA, the amalgamation of the WSA and the NWA, the review of the WQM policies and strategies for South Africa.

Insights from International Case Studies in repose to key water quality problems in SA

Water Challenges	Quality	Opportunities				Approach			
		Green Economy	Stewardship (Collective Action)	Financing Mechanisms	Restoration & Rehabilitation	Strategic & Planning	Regulation	Contracts & Agreements	Economic (incl. Financial)
Eutrophication									
Municipal sewage		Rhine River				X	X (EU)	X	
Agriculture		EU Nitrates Directive: Danube-Black Sea				X	X	X	X
Acidification and Heavy Metal Contamination									
Acid mine drainage		Australia					X	X	X
Heavy metals & acidification		Canada				X	X		X
Acidic atmospheric deposits			China			X	X		X
Salinisation									
Mining & industrial activities		China				X	X		X
Agriculture (irrigation)		Indus Basin (Pakistan)				X	X	X	
Urban pollution									
Stormwater runoff			Mersey Basin, UK			X		X	X
Infrastructure & water treatment		Porto Alegre, Brazil				X	X		X
Sedimentation									
Agriculture		Agriculture Sector (Private Corporations)				X		X	X
Land management		Catchments in Western Australia				X	X	X	X
Water Quality Management Challenges									
Political Will		Ganga Basin, India				X	X	X	X
Institutional Environment		USA				X	X	X	X
Financial Sustainability		Various				X	X		X

Recommendations for South Africa

This review provided a brief overview of various water quality management approaches that are implemented globally. A key outcome of this review is insight into the changing nature of water quality problems and their management, both locally and internationally. These insights can be described as:

- WQ challenges have shifted from predominantly point source to nonpoint sources. This is a consequence of inadequate land-use planning and development and

operation and maintenance of waste infrastructure (predominantly urban challenge). Traditional WQ challenges however, still exist, such as traditional agricultural nonpoint sources. As seen in the USA and the Mersey Basin (UK), the changing development landscape presents changes to the WQ challenge, thus requiring adaptive WQM.

- WQM challenges are inherently institutional, financial, economic and social/behavioural, rather than technical. Technical solutions are constantly improving, and therefore require the enabling environment and political will to implement sustainably. As illustrated in the Indus Basin, technical solutions that are financially sustainable require institutions and enabling environments in order to be implemented sustainably. The Ganga Basin study also illustrates that buy-in from all stakeholders is key for effective and sustainable WQM.
- Good WQ monitoring enables enforcement and compliance. Added to this, the timely sharing of data and information allows the development of relevant and applicable WQM interventions, which have a high likelihood to succeed. As illustrated in China, the USA, and in the EU, updating of the monitoring network and monitoring services (such as online monitoring) enables effective enforcement and compliance of laws and regulation.
- Clean tech supported by green economy initiatives and financing mechanisms provides targeted ways of reducing pollution at source. The private sector has a crucial role to play in minimising its impacts on water resources. Collaborative efforts by the private sector and international funding organisations (such as the World Bank) and/or NGOs (such as WWF) illustrate that by sharing water risks, benefits can also be shared. There is therefore a recognition that business risk associated with physical, reputational and/or regulatory impacts has contributed to collective action initiatives associated with new emerging partnerships. This, however, requires an enabling environment for R&D and the promotion on the clean tech industry.
- WQM increasingly requires catchment rehabilitation through a range of rural and urban measures, implying an integrated approach that requires cooperation with other sector regulators. Political will and basin institutions that are leading rehabilitation efforts have been illustrated as key to successful rehabilitation of catchments in Western Australia and the Mersey Basin.
- In the presence of a strong institutional and regulatory landscape, alignment and consistency is an emerging challenge that requires cooperative governance and regulatory/strategic approaches that aim for alignment. As in the USA, a centralised unit that aligns legislation and fosters the sharing of knowledge, data and WQM skills is essential for sustainable basin management.
- Regulatory and strategic approaches are increasingly focusing on minimising pollution by being stringent on polluting sectors. As illustrated by China, shifting the regulatory approaches to improving monitoring and compliance, and also enforcing the 'polluter pays' principle, forces polluters to minimise pollution and also provides finances to the regulating entity (through taxes or fines). India is also showing intent

on implementing this strategy, although institutional challenges are delaying implementation. Innovative land-use planning approaches in Porto Alegre illustrate that all sectors have a role to play in minimising pollution.

- Coherent regulatory regimes and strategic institutional approaches are being supported by appropriate financial mechanisms and cooperative actions within these catchments. Improvement in the Environmental Protection Law (EPL) in China enabled the effective implementation of monitoring and compliance, and therefore emission levies. In Porto Alegre, for example, the recently released Resilience Strategy promotes building resilience by collaboration, participatory budgeting and aligning the strategic intent of the various departments.
- Natural (green) infrastructure is recognised as critical aspect of integrated management of water quality in urban and rural settings. The Danube and Rhine Rivers have shifted basin management efforts (including WQM and flood management) to green approaches that meet water management objectives while also preserving ecosystems.
- Addressing WQ problems requires political will at all levels, because sustained financing and attention is required over a long period of time, and can have short term economic impacts (that are balanced by long-term economic benefits). This has two components. Firstly, basin management is long-term process that requires political will to build the required institutional capacity and financial sustainability. Secondly, there are various economic (and financial) approaches that can be implemented to fund the cost of water management, and the selection of the approach should depend on the individual context. This can range from pollution charges for direct discharge of wastewater in Germany, or financial compensation for environmental services in France
- Government needs to play a lead role in driving, coordinating and often financing the remediation of critical water quality problems in the public interest, possibly leveraging innovative sources of finance. The Ganga Basin initiative in India illustrates that government needs to drive efforts to remediate water resources, and also source funding. As in India, political will has increased the willingness of international funding entities to be involved in funding the initiatives, and to also build the required institutional and regulatory mechanisms required to rehabilitate the basin.
- Clean tech supported by green economy initiatives and financing mechanisms provides targeted ways of reducing pollution at source. The private sector has a crucial role to play in minimising its impacts on water resources. Collaborative efforts by the private sector and international funding organisations (such as the World Bank) and/or NGOs (such as WWF) illustrate that by sharing water risks, benefits can also be shared. There is therefore a recognition that business risk associated with physical, reputational and/or regulatory impacts has contributed to collective action initiatives associated with new emerging partnerships.

- The SDG implementation provides a valuable opportunity to tackle WQ problems in a coherent manner. A key success of the EU Nitrates Directive is that the interventions implemented by countries (in order to meet the EU objectives) have multiple benefits, such as improving WQ monitoring, providing electricity through biogas, and improving agricultural efficiency.

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LIST OF ACRONYMS

Abbreviation	Meaning
AAUs	Autoridades Ambientales Urbanas
AMD	Acid Mine Drainage
AWB	Area Water Boards
AWS	Alliance for Water Stewardship
BAPs	Best Agricultural Practices
BOD	Biological Oxygen Demand
CARs	Corporaciones Autónomas Regionales
CBS	Capacity Building Strategy
CCS	CO ₂ capture and storage
CFRI	Commercial Forestry Research Institute
CMA	Catchment Management Agency
CMF	Catchment Management Forum
CMS	Catchment Management Strategy
COD	Chemical Oxygen Demand
COGTA	Department of Cooperative Governance and Traditional Affairs
CoM	Chamber of Commerce
CSIR	Centre for Scientific and Industrial Research
CWA	Clean Water Act
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DEEDI	Department of Employment and Economic Development
DMR	Department of Mineral Resources
DoE	Department of Energy
DPE	Department of Public Enterprises
DPRP	Danube Pollution Reduction Programme
DRP	Danube Regional Project
DTI	Department of Trade and Industry
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EDC	Endocrine Disrupting Chemicals
EPA	Environmental Protection Agency
EPL	Environmental Protection Law
EU	European Union
FO	Farmer Organisations
GDP	Gross Domestic Product
GDP	Gross domestic product

GEF	Global Environmental Facility
GIWP	DEWHA
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HDI	Human Development Index
HWP	Healthy Waterways Partnership
IBIS	Indus Basin Irrigation System
ICPR	International Commission for the Protection of the Rhine
IDB	Inter-American Development Bank
IEA	International Energy Agency
IWQM	Integrated Water Quality Management
IWRM	Integrated Water Resource Management
IWSS	International Water Stewardship Standard
LNKG	The Lake Naivasha Growers' Group
M&E	Monitoring and Evaluation
MAC	Mining Association of Canada
MBBF	Mersey Basin Business Foundation
MCA	Minerals Council of Australia
MCMPR	Ministerial Council on Mineral and Petroleum Resources
MDG	Millennium Development Goals
MMER	Metal Mining Effluent Regulations
n.d.	undated
NBBN	National Business and Biodiversity Network
NBI	Nile Basin Initiative
NBTF	Nile Basin Trust Fund
NGO	Non-Government Organisation
NMCG	National Mission to Clean Ganga
NPS	Non-point Source
NWA	National Water Act (Act 36 of 1998)
NWFP	North-West Frontier Province
NWRS	National Water Resource Strategy
O&M	Operation and Maintenance
PAC	Project Administration Committee
PCT	Professional Counterpart Team
PES	Payment for Ecosystem Services
PMC	Project Management Committee
POP	Persistent Organic Pollutants
PSC	Project Steering Committee
R&D	Research and development
RAP	Rhine Action Program

RDM	Resource Directed Management
RHA	Rivers and Harbors Act
RSA	Republic of South Africa
SAIAE	South African Institution of Agricultural Engineers
SAICE	South African Institution of Civil Engineers
SALGA	South African local Government Association
SAWI	South Asia Water Initiative
SCARP	Salinity Control and Reclamation Projects
SDG	Sustainable Development Goals
SEQ	South-East Queensland
SEQTOA	SEQ Traditional Owners Alliance
SIDA	Sindh Irrigation and Drainage Authority
SMEs	Small and medium-sized enterprises
SO ₂	sulphur dioxide
SWPN	Strategic Water Partners Network
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
UK	United Kingdom
UNEP	United Nations Environment Programme
USA	United States of America
USGS	U.S. Geological Survey
UWWT	Urban Wastewater Treatment Directive
WCAP	Water Sector Capacity Building and Advisory Services Project
WDCS	Waste Discharge Charge System
WFD	Water Framework Directive
WQ	Water Quality
WQM	Water Quality Management
WQM	Water Quality Management
WRM	Water Resource Management
WRUAs	Water Resource Users' Associations
WSA	Water Services Act (Act 108 of 1997)
WUA	Water User Association
WWF	World Wide Fund for Nature
WWTW	Waste Water Treatment Works

1. INTRODUCTION

1.1 Background to the Project

South Africa is often lauded with having one of the most progressive Constitutions and Water Acts. However, this great framework alone cannot guarantee the sustainable and equitable use of the country's most precious resource. Rapid urbanisation, expansion of the mining industry, increasing use of chemicals in agriculture and destruction of our natural/green infrastructure has undermined the quality of the country's water resources. Poor water quality impacts negatively on human health, threatens downstream irrigation areas and food security, increases industrial costs and raw water treatment costs arising from removing pollutants, reduces income generated from recreation and ecotourism, destroys ecosystems and affects biodiversity. The deterioration of water quality is therefore an issue that can affect many national priorities and strategies including strategies for economic development, health management and biodiversity conservation (DWS, 2015).

Sustainable development in South Africa is critically dependent on assurances of good quality of the country's limited resources. Development must be balanced by an increased supply of water of an appropriate quality to satisfy the human needs. Demand for water will continue to grow as the country's population increases as well as social and economic conditions improve in South Africa. Consequently, placing increasing pressure on the country's scarce water resources and concurrently, increasing potential threats to water quality (DWAF, 2003).

Water quality management has to be conducted within the realities as outlined above. The challenge has always been to clearly articulate water user requirements for specific circumstances and matching them with appropriate measures to ensure on-going beneficial water use. It is recognised that the existing Water Quality Management (WQM) policy is dated (Water Quality Management Policies and Strategies in the RSA in 1991 and the Resource Directed Management of Water Quality in 2006) and whilst innovative at the time of publication, is now in need of revision in order to align with current overarching policy and legislative frameworks. Key amongst these issues is fundamental changes in governance and institutional frameworks and the need to consider more carefully the role of various public and private actors. It is also recognised that there is a range of supporting operational policies, strategies, management instruments and methodologies that have been developed and implemented in recent years. These provide a significant platform for the development of new strategies and policies, based upon the pragmatic experience of implementing these instruments. It should be noted that the integration of the WQM Policy and IWQM Strategy with wider national policies provides the opportunity to align the approaches toward managing water quality with other activities the Department, and in Government as a whole. This will help entrench this project and secure its sustainability going forward.

1.2 Context of the Report

This literature review, together with the glossary and water quality and management challenges contribute to the assessment phase, as outlined in the project programme below (Figure 1).

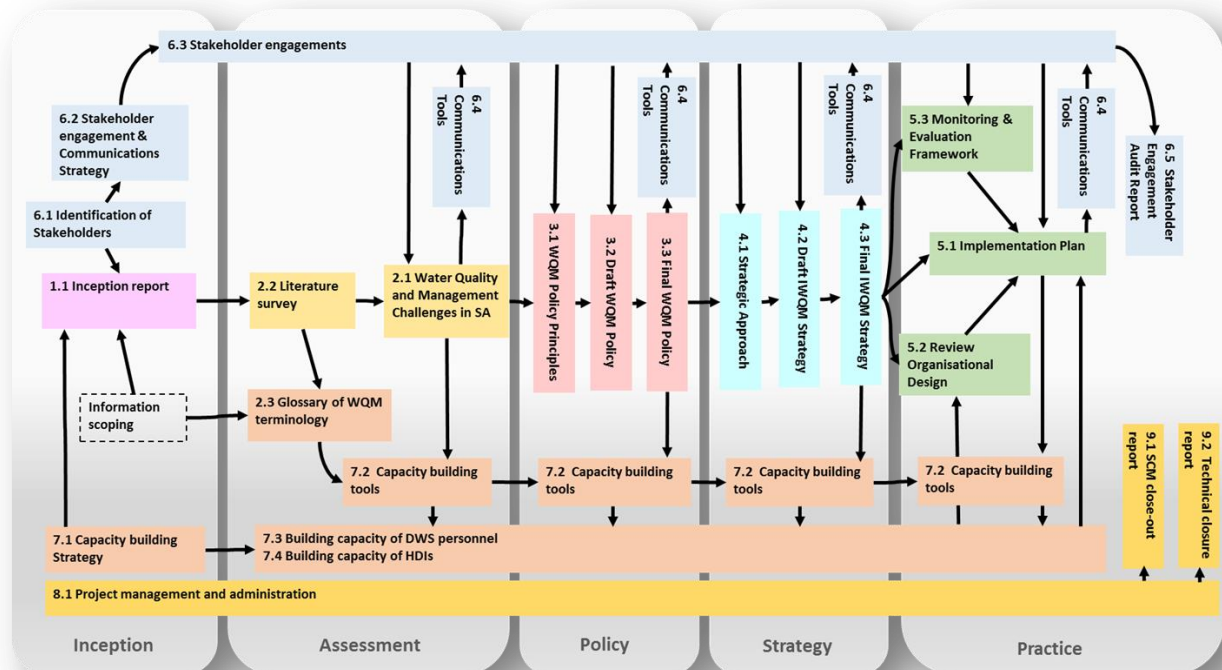


Figure 1: Project Components

In the assessment phase of the project, Component 2 consists of two tasks that feed into the overall situation assessment and gaps analysis for water quality and water quality management challenges for South Africa. The first task is a high-level situation assessment to understand the impacts, topography and root causes of the water quality challenges facing the country. In order to meet the South Africa's development objectives, an approach to WQM should consider the importance of proactively planning in order to be prepared for the range of socio-economic and developmental requirements of the country. This requires a more informed understanding of the range of impacts, and provides the opportunity to fully understand the management regimes required (DWS, 2015). Similarly, an understanding of the water quality challenges in the country provides a good starting point for research, planning and management interventions. These water quality challenges affect the country in different ways, and therefore have different characteristics such as:

- the geographical extent of their impacts;
- the integrated severity of their impacts on the fitness-for-use of the resource, on water users' health, on the local and regional economy, and on local and downstream ecosystems;
- the extent to which they have been / are being monitored; and
- levels of knowledge and understanding of the above impacts, their temporal patterns and geographic prevalence.

In addition, an assessment of future trends as it relates to the expansion or contraction of dense settlements, the coal mining roadmap and its direction and shifts towards urbanisation, amongst others, will be used to further inform potential future water quality threats to SA's water resources. A SWOT analysis will also form part of the report to identify in particular areas for improvement.

Some of the salient results from the first task are presented here. **Figure 2** depicts a graphical representation of the various water quality challenges in South Africa. These water quality 'impacts' of each of these challenges is mapped against the 'knowledge and understanding' of the challenge. It can be seen that five water quality issues occupy the High Impacts/High Knowledge area on the diagram, namely Eutrophication, Salinisation, Sedimentation, Acidification and Urban Pollution. This signifies that they should receive high priority management attention (DWS, 2016).

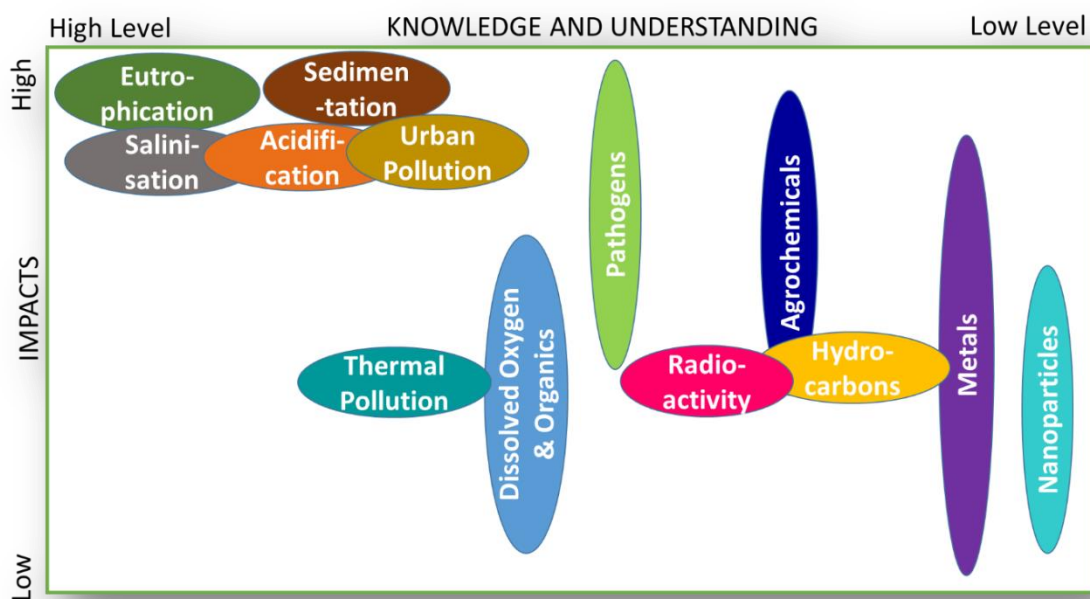


Figure 2: Mapping of water quality issues against Impacts and Knowledge/Understanding
(Source: DWS, 2016)

Understanding the root causes of these water quality challenges enables the implementation of effective WQM strategies and interventions. In addition, as these challenges are exacerbated by climate change, incorporating a climate change lens enables the development of robust water quality management policy, strategy and implementation plans, which are adaptable and effective under changing environments. This, however, does not come easy, as the development of new ideas and thinking requires considerable political and strategic support in order to see these ideas becoming part of policy and strategy (DWS, 2015).

Although South Africa's existing policies and strategies have an array of strengths and weaknesses, these need to be further explored in both the current and future context (particularly the climate, development, socio-economic context). Here-in lies the opportunities offered by innovative WQM interventions, as enables countries to not only address water

quality challenges, but to also meet other country objectives. Such opportunities can be described as:

- Aiming for **sustainable development** and promoting the **green economy**.
- Forming **stewardships efforts and partnerships** that promote collaboration to manage shared risks.
- Alternative and innovative **financing mechanisms** that provide opportunities to support improved WQM (DWS, 2015).
- The **restoration and rehabilitation** of natural systems (including water resources) to their natural state and thus ensuring equitable access to water resources for all water users (which include the ecosystems).

There is, therefore, an opportunity for South Africa to review, revise and refine WQM policies and strategies to address the above-listed opportunities offered by innovative solutions. This necessitates an evaluation of the current states of WQM in South Africa, and most importantly the challenges and gaps in the countries current WQM approach. This will enable the country to implement solutions that will resolve current water quality challenges by resolving the barriers to progress. This forms the basis of the second part of Component 2: the Literature Review.

1.3 Purpose of the Report

The Literature Review consists of three parts: WQM Policies and Strategies, WQM Institutional Arrangements and WQM instruments for South Africa (**Figure 3**).

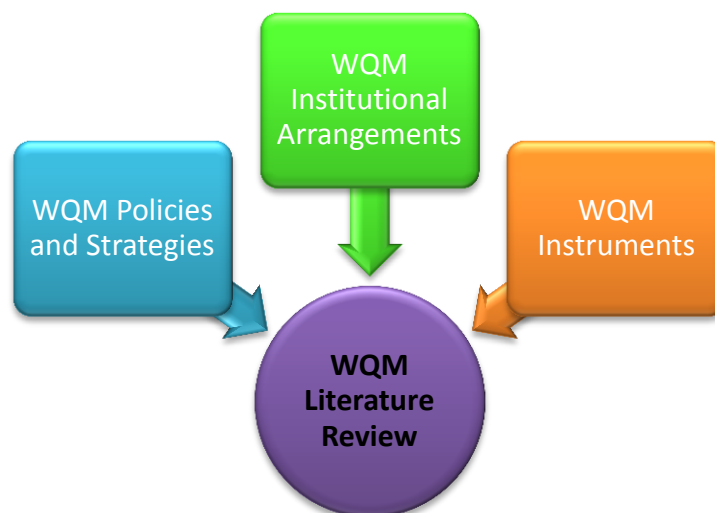


Figure 3: Components of the WQM Literature Review

This report, the first of the series, includes understanding the policies and strategies that govern WQM in South Africa, whilst ensuring that the country meets their international obligations basin management. This literature review also aims to highlight innovative ways in which the key identified water quality challenges have been addressed internationally, particularly in the context of challenging landscapes/futures by looking at specific case

studies. For the case studies, it was crucial to get a combination of different experiences and practices from countries that are comparable to South Africa i.e. have similar GDPs, economic sectors, climate, policies, WQ challenges and socio-economic challenges from both developing and first world countries. Thus, the second portion of the report, aims to provide a comprehensive review of water quality management (WQM) in various countries. It draws on international best practice guidelines and interventions of numerous countries that have a similar context to South Africa.

2. THE GLOBAL CONTEXT

Globally, freshwater ecosystems are in serious decline due largely to rapid population and economic growth. Climate change will add further pressure on shared water systems resulting in major impacts by aggravating significantly the challenge of establishing and sustaining cooperation between the states that share watercourses. Therefore, the equitable and sustainable allocation, and management of water across international borders is a crucial requisite for sustaining aquatic ecosystems and maintaining their ecological functions and services such as clean water, food and flood control in support of human well-being and the environment. To this end, South Africa shares transboundary basins with other Member States where WQM is an international priority for many countries. South Africa is a signatory to a number of international conventions, treaties and protocols. Some of these have been ratified. The ratification of conventions, treaties and protocols involves all organs of state and thereby, constitutes government policy. Some of the key global and regional protocols and agreements relevant to South Africa and water quality management are briefly outlined below.

2.1 International Protocols and Obligations

2.1.1 The Sustainable Development Goals (SDGs)

The 17 UN Sustainable Development Goals (SDGs), which replaced the Millennium Development Goals (MDGs) are a new, universal set of goals, with targets and indicators that UN Member States will be expected to use to frame and guide their agendas and political policies over the next 15 years (**Figure 4**).



Figure 4: The Sustainable Development Goals

Goal 6 relates directly to the water sector and seeks to “*ensure availability and sustainable management of water and sanitation for all.*” The achievement of this and other SDGs (such as Goals 3; 9; 12; and 14) can be constrained by poorly managed water including lack of cooperation in flood and droughts management, lack of adequate water supplies and sanitation provision all of which can be linked to weak institutions, lack of information and inadequate infrastructure. The strive towards attainment of these goals is binding for South Africa especially given the links between water quality management and ensuring high quality potable water for fulfilling Goal 6.

2.1.2 The ‘Helsinki Rules on the Uses of the Waters of International Rivers’

The framework for the management of international shared water resources remains the Helsinki Rules. These state that each country which shares any river (basin state) has the right to a reasonable and equitable share of the water in the basin, and that the greatest benefit should be achieved with the least disadvantage to other states (National Water Policy, 1997).

Although the title of the Rules refers to international rivers only, Article I states that the Rules are applicable to the use of the waters of an international drainage basin. Such a drainage basin is defined as “a geographical area extending over two or more States determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus” (Salman, 2007¹). As such, the Helsinki Rules also apply to groundwater connected to surface water.

Article V of the Helsinki Rules states that the relevant factors to be considered include: i) the avoidance of unnecessary waste in the utilization of waters of the basin; ii) the practicability of compensation to one or more of the co-basin states as a means of adjusting conflicts among uses; and iii) the degree to which the needs of a basin state may be satisfied, without causing substantial injury to a co-basin state (see Salman, 2007; ILA, 1966). The Rules devote a separate chapter to each of pollution, navigation and timber floating. Some of the bilateral treaties in South Africa also made specific reference to the Helsinki Rules such as the 1992 Agreement between Namibia and South Africa on the Establishment of a Permanent Water Commission (Salman, 2007).

2.1.3 UN-Convention on the Law of the Non-Navigational Uses of International Watercourses (UN, 1997)

UN-Convention on the Law of the Non-Navigational Uses of International Watercourses (UN, 1997). The UN Convention provides general principles and rules to guide states in negotiating future agreements on specific watercourses. It looks at management of a river

¹ Salman, S, M, A. 2007 The Helsinki Rules, the UN Watercourses Convention and the Berlin Rules: Perspectives on International Water Law. Water Resources Development, Vol. 23, No. 4, 625–640

system as a whole and addresses issues such as flood control, water quality, erosion, sedimentation, salt-water intrusion and living resources (UN, 1997; Salman, 2007). It is the only global legal instrument codifying, clarifying and developing minimum substantive and procedural standards for transboundary water cooperation.

Other international obligations that South Africa has ratified include:

- **Wetlands of International Importance** - The Convention of wetlands of International Importance, Especially as Waterfowl Habitat (RAMSAR) dated 2 February 1971 was signed and ratified by South Africa on 12 March 1975. The Convention was amended on 3 December 1982.
- **Transboundary movement of hazardous wastes** - The Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal dated 1989 (Basel Convention) came into force in South Africa on 5 August 1994. The principles encompassed in the Convention entail the recognition that i) transboundary movement of hazardous and other wastes poses an increasing threat to human health and the environment; ii) States should regulate waste disposal and its movement in a manner designed to protect human health and the environment; iii) hazardous wastes should preferably be disposed in the state it is generated in and states should cooperate in this regard. However, transboundary movement of hazardous waste is allowed if the wastes are inputs to reuse. Parties are prohibited from exporting hazardous wastes if the state receiving the import has not agreed to this import in writing; and from transporting and disposing of hazardous waste if not authorised to conduct these operations.
- **Biological diversity** - The Convention on Biological Diversity opened for signature on 5 June 1992. This convention was signed and ratified by South Africa on 4 June 1993 and 2 November 1995 respectively. The convention aims to achieve international cooperation on the conservation of biological diversity and sustainable use of living natural resources worldwide.
- **Climate change** - The United Nations Framework Convention on Climate Change dated 9 May 1992 was signed and ratified by South Africa on 15 June 1993 and 29 August 1997 respectively. The Convention aims to regulate the greenhouse gas concentration in the atmosphere, which could result in climate change of a nature impeding sustainable economic development or food production. This also includes greenhouse gases such as carbon dioxide and/or methane inter alia produced within sewage treatment processes and subsequent handling and disposal of sewage sludge by means of waste incinerators.

2.2 Regional Protocols and Agreements



Figure 5: Shared river basins

2.2.1 Revised SADC Protocol on Shared Water Courses

The Revised SADC Protocol is the key instrument for transboundary water management in the SADC region that establishes a legally binding framework for transboundary water management. The generic provisions of the Revised SADC Protocol are drafted in line with the provisions of the UN Watercourse Convention, thus reflecting contemporary international water law (SADC, 2000; Aurecon et al, 2013²). With signing (and ratifying) the Revised SADC Protocol the SADC Member States have expressly undertaken to adhere to the rules of international water law shared by most states in the world relating to the utilisation and management of the resources of shared watercourses (Article 3 (3)). In line with these rules of international water law the Revised SADC Protocol contains the principles of “equitable and reasonable utilisation” (Article 3 (7)) and the “duty to prevent significant harm” (Article 3 (8)) (SADC, 2000). It furthermore, among others, contains provisions dealing with notification and consultation requirements regarding planned measures and rules on pollution prevention, reduction and control. Significantly, the Revised SADC Protocol establishes an institutional framework at the regional level for the implementation of the instrument. In

² Aurecon et al, 2013 Limpopo River Basin Monograph (LRBMS-81137945) Legal and Policy Review. GIZ.

Article 5 it establishes the SADC Water Sector Organs and mandates them as well as Shared Watercourse Institutions with the implementation of the Protocol.

Through the Protocol, the SADC Water Division works together with SADC Member States in supporting, facilitating and coordinating the implementation of regional water related activities. This is done at regional, transboundary basin and national levels. The SADC has an advocacy objective to ensure that the shared water resources of the region are managed, protected, and used in a sustainable manner. This is encapsulated in a range of policy documents (SADC, 2010; AURECON *et al*, 2013).

The SADC Water Division has a number of work programmes which are all part of the Regional Strategic Action Plan. Launched in 2011, Regional Strategic Action Plan III has the focus of strengthening the enabling environment for regional water resources governance, management and development through the application of IWRM at the regional, river basin, Member State and community levels. As such the key challenges being faced within the transboundary basins (such as Limpopo basin, Orange-Senqu, and Inkomati among others) where South Africa is a riparian include water allocation, water quality management and disaster management. These challenges can be seen within the various support activities of the SADC Water Division.

2.2.2 Regional Strategic Action Plans (RSAP)

Over the years SADC has embarked on a number of approaches to improving water security and these have been informed by practices elsewhere in the world. A number of these began with the 1st Regional Strategic Action Plan on Integrated Water Resources Management (RSAP – IWRM) in 1999 to 2004, as well as the subsequent RSAPII; III and now RSAP IV; have been improved over the years. The fundamental basis was to first develop and sustain a sound enabling environment, consisting of building resilient and effective policies and institutional frameworks and capacity building. The sound enabling environment help build a solid foundation for infrastructure development which will also help to improve resilience to the impacts of climate change and variation. Infrastructure development in turn creates a platform for economic development including industrialisation which creates jobs and alleviate poverty. These approaches form the foundation of the options dealt with in the appraisal case.

2.2.3 Bilateral Agreements

Some key bilateral agreements to which South Africa is a party/member include:

- **Rivers of mutual interest** - The agreement between Portugal (Mozambique), Swaziland and the Republic of South Africa dated 13 October 1964, concerning rivers of mutual interest, was signed and ratified by South Africa.
- **Republic of South Africa and the Republic of Botswana, 2008** - Agreement between the Government of the Republic of South Africa and the Government of the

Republic of Botswana on water supply across the border between Botswana and South Africa.

- **Republic of South Africa and the Republic of Botswana, 1997** - Agreement between the Government of the Republic of South Africa and the Government of the Republic of Botswana for the Establishment of a Joint Permanent Commission for Cooperation.
- **Republic of South Africa and the Republic of Moçambique, 1996** - Agreement between the Government of the Republic of South Africa and the Government of the Republic of Moçambique on the Establishment and Functioning of the Joint Water Commission.
- **Republic of South Africa and the Republic of Moçambique, 1994** - Agreement between the Government of the Republic of South Africa and the Government of the Republic of Moçambique for the Establishment of a Joint Permanent Commission for Co-operation.
- **Republic of South Africa and the Republic of Botswana, 1988** - Agreement relating to the supply of water from the Molatedi Dam on the Marico River made and entered into by and between the Department of Water Affairs of the Republic of Bophuthatswana and the Water Utilities Corporation in the Republic of Botswana and the Department of Water Affairs of the Republic of South Africa.
- **Republic of South Africa and the Republic of Botswana, 1983** - Joint Permanent Technical Committee (JPTC) established by the Government of the Republic of South Africa and the Government of the Republic of Botswana concerning water matters of common interest.
- **Republic of South Africa and the Republic of Portugal, 1971** - Agreement between the Government of the Republic of South Africa and the Government of the Republic of Portugal in regard to rivers of mutual interest, 1964- Massingir dam.
- **Republic of South Africa and the Republic of Portugal, 1964** - Agreement between the Government of the Republic of South Africa and the Government of the Republic of Portugal in regard to rivers of mutual interest and the Cunene River Scheme.

South Africa sits in a position of relative privilege (compared to its neighbours) when it comes to the shared water basins, mainly being positioned upstream. However; South Africa is not an island upon itself, and as such, needs to adhere to international and bilateral agreements it has entered into especially when it relates to the management of water quality of its water resources that could potentially affect downstream users for the shared basins.

3. THE EVOLUTION OF POLICY AND STRATEGY FOR WQM IN SA

3.1 The Mandate of the Department of Water and Sanitation

Everyone has the right to have access to sufficient water.
(Bill of Rights, Constitution of South Africa, Section 27 (1) (b))

The Department of Water and Sanitation has been mandated to **manage** the country's water resources. This means that the Department must not only **ensure the equitable distribution of water** to all South Africans, but must also **protect the water resource for future generations**. This **cannot be achieved** without the Department **managing the water quality** of the resource. Whilst it is impractical to maintain a pristine resource, socio-economic development and long-term should not result in unsustainable mis-use of the resource (DWAF, 1991).

Consequently, WQM requires balancing protection of the water resource with the need for development and growth in South Africa. Key criteria for the balance can be found given active public participation in water quality management and strong governance and institutional structures. The water box ((Pegram *et al.*, 2013) shows the complexity and diverseness that is the water sector (Figure 6).

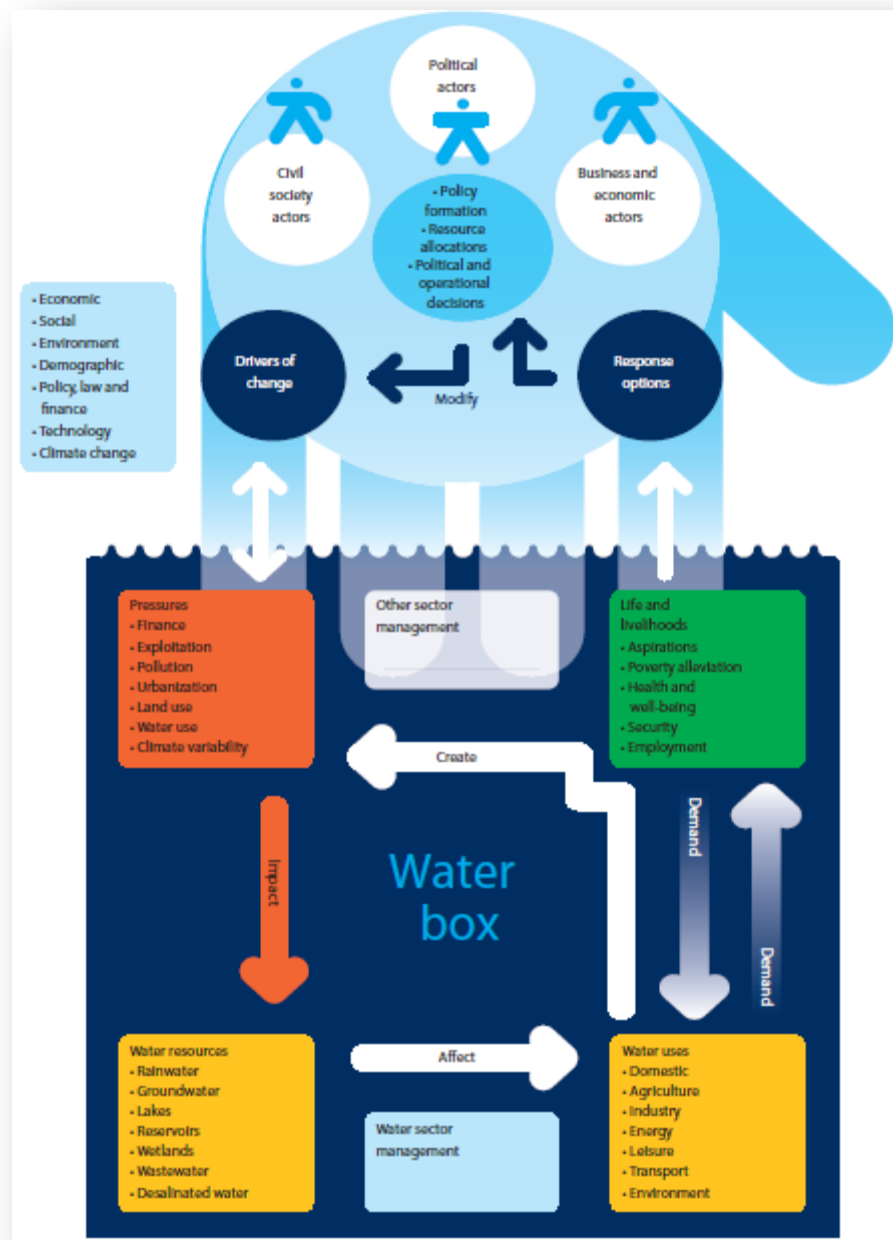


Figure 6: The Water Box

3.2 The Evolution of Water Quality Management

Issues around water quality were evident as far back as the 17th century which spear-headed the need for water quality management. However; a more formalised approach to water quality management was established in the 20th century. Water quality management in South Africa has come a long way, from the Public Health Act of the Union of South Africa in 1919, to the National Water Act of 1998 to the current amalgamation of the NWA and WSA. As society evolved with the expansion of agriculture, mining and industry, with population increase and urbanisation, with technology development and conceptual enhancement, so did water quality management (DWA, 2003). This section provides a high-level overview of water quality management, showing the path of evolution, dictated by needs but also guided by technology development and conceptual enhancement.

3.2.1 The Era of Mineral Revolution

In the late 19th Century, South Africa shifted from a primarily agricultural society, where most people lived off the land, to an industrial society. This took place largely as a result of the discovery of large diamond deposits in Kimberley in 1867 followed in 1886 by the discovery of gold on the Witwatersrand³, and so began the “gold rush”. Together these, discoveries led to the Mineral Revolution. The revolution was largely driven by the need to create a permanent workforce to work in the mining industry and saw South Africa transformed from a patchwork of agrarian states to a unified, industrial nation. This led to a significant migration of workforce from the rural areas, where people tended to cattle or cultivated crops, to the mining areas. These mining operations caused severe environmental damage, whilst the urban growth placed increasing strains on water supplies and led to increasing pollution of rivers. In addition to the pollution caused from the mining and urbanisation in this period, the policies developed during this era had an profoundly negative effect on South Africa and formed the basis of the apartheid system, which dominated South African society for a century (Worden, 1994), where water was supplied to a small group and water quality did not receive the much needed attention it required.

3.2.2 The Era of Irrigated Agricultural

The growth of towns and cities across South Africa prompted changes in rural areas, as farms lost labourers to the mines and demand for food and agricultural produce increased. These shifts in the workforce necessitated the demand for food security. This resulted in the development of large irrigation schemes and storage to support the growing agricultural sector. These changes greatly increased South Africa's agricultural output as commercial farms were more efficient and had greater access to farming machinery than small farms, and saw social changes in rural areas. This increased agricultural steadily decreased the soil

³ <http://www.sahistory.org.za/archive/what-industrialisation#sthash.ic8uAUGR.dpuf>

quality. Animal husbandry also increased during this period resulting in runoff (Worden, 1994).

The irrigated agricultural era saw a dynamic shift in water policy development to support the expanding irrigated agricultural sector. The expansion in irrigated agriculture was also fundamental to the infrastructural, economic and social development of the country's water sector. This period saw a boom in infrastructure development, with little concern for social or environmental impacts and limited public participation. This infrastructure-focused planning phase reflected the dominant political and economic system at the time (Pegram et al., 2013), which has also paved way to some of the water supply issues plaguing South Africa today.

3.2.3 The Era of Water Resource Development

Agricultural, industrial and urban expansion all required more water. Given South Africa's seasonal pattern of rainfall, this meant capturing storm water run-off through enhanced storage capacity through both on-farm small dam construction and state-initiated large-dam construction. To facilitate this, a comprehensive review of existing water legislation was undertaken during 1950-52, eventually leading to the Water Act 54 of 1956, where water continued to be divided as private and public. Individuals could continue to exploit their water resources through riparian rights; the state, however, would exercise much greater control of 'normal' and 'surplus' (i.e. storm water) water in public rivers. Thus began the rapid acceleration of inter-basin transfer and large dam building-projects across South and Southern Africa (Swatuk, 2010). The number of large dams in South Africa doubled from 50 to 100 between 1920 to 1940. By 1980, this number rose to 500, levelling off at around 520 in the 1990s.

3.2.4 The Era of Effluent Treatment and Disposal

Up to the early 1950s, the focus was on sewage disposal, but with increased economic growth, the nature of pollution changed. The Water Act of 1956 was promulgated to control the industrial use of water, and the treatment and disposal of industrial effluent. The Water Amendment Act of 1984 provided for Uniform Effluent Standards, General and Special Standards, and Special Standards for Phosphate, to control pollution (DWA 2002, DWA, 2003).

3.2.5 The Era of Integration

“ Integrated Water resource Management is based on the perception of water as an integral part of the ecosystem, a natural resource and a social and economic good, whose quantity and quality determine the nature of its utilization” (UNDESA, 1992).

In 1970, the Commission of Enquiry into Water Matters noted the lack of integrated planning and the potential impacts that this would have on water resources. However, it was only

during the 1980s and onwards that South Africa started to comprehend the environmental impacts of limited regulation of agricultural and industrial development. As the industrial, agricultural and urban demands for water have increased, the natural functioning and ability of these water resources to meet these economic, social and ecological needs has decreased (World Commission on Dams, 2000). Simultaneously, many basins and aquifers in South Africa became insufficient to meet competing demands, the fitness of the water quality for use had declined and the modification of aquatic ecosystems has accelerated. As a result, during the 1970s and 1980s the water development community began to question previously held assumptions about water resources planning and management. Purely engineering solutions were no longer adequate to address the multifaceted and interconnected problems of basin management, in particular in conditions in which trade-offs between competing interests and values are required.

The Water Research Act, 1971 (Act 34 of 1971), provided for the promotion of water related research through a Water Research Commission (WRC) and a Water Research Fund. The Water Research Act is under review to improve the governance of the Water Research Commission and to align the act with all other applicable legislation. The WRC has made invaluable research contributions to the South African Water sector of a great vehicle/platform for engagement on water related issues.

In the 1990's there was a general consensus that a new and innovative approach to water resource management be undertaken. This type of thinking led to the concept of ***Integrated Water Resources Management*** (IWRM). The concepts of IWRM were captured initially in the 1992 Dublin and Agenda 21 principles. Subsequently, these concepts were cemented in the 2000 European Union Water Framework Directive (WFD) requirement for comprehensive basin management plans and the 2002 Johannesburg World Summit on Sustainable Development commitment by countries to develop IWRM plans at a national level (Pegram *et al.*, 2013). Since then, a number of countries undertook thorough reforms. China, Mexico, South Africa and Brazil were among the first countries that adapted their water law and policy to reflect the changing circumstances facing water resources management at the start of the 1990s and incorporated new basin-scale management and institutional arrangements into their legal frameworks (Pegram *et al.*, 2013). Therefore, for basins that here highly developed due to urbanisation, industrialisation or intensive irrigation, water quality planning become critical.

3.2.6 The Era of WQM Policy

The water quality management framework policy endeavoured to promote better alignment between water user requirements and associated management actions mainly by separating the management of the water resource from the management and regulation of the sources of pollution that could adversely affect the water resource (DWAF, 2003).

As the mining and industrial sectors grew, it became necessary to manage their cumulative effects on water resources. The approach changed to one that focused on the quality of the

water body that received effluent, and the requirements of all water users, referred to as the Receiving Water Quality Objectives Approach. The Department's "*Water Quality Management Policies and Strategies in the RSA*" was released in 1991. It addressed water quality management requirements at that time, within the prevailing context of evolving economic and socio-political trends. The 1991 policy also guided the evolution of the water quality management focus from primarily an effluent standard approach towards greater emphasis on the receiving water environment. The specific actions to improve water quality management as stipulated in the 1991 policy and strategy were largely fulfilled, thereby providing a foundation for further policy enhancement.

It is on this evolution that the last policy, "*National Water Quality Management Framework Policy*", was built. It also considered and aligned to, relevant legislation and policies related to water resource management. In particular, it is aligned with the National Water Act, 1998 and thus took an integrated approach to water resource management. The policy was aimed at on-going attainment of the required water quality to meet quality-of-life requirements.

The framework policy was structured in accordance with an accepted framework for the presentation of management-related information. Accordingly, it provides not only more complete operational guidance for the execution of, but also improved context and focus to, the water quality management function (DWAF, 2003).

This framework policy was to be regarded as an enabling policy and its primary aim was to direct water quality management to be people centred and also to treat water users in a consistent and equitable manner. In this regard specific changes to the existing water quality management approach were put forward. The framework policy also reflected South Africa's international obligations (as outlined in Chapter 2), national policy and legislative context, operational instruments as well as mandates and responsibilities of government departments and other stakeholders involved in the water quality management effort.

The policy also ***reiterated the upgrading of existing routine water quality management mechanisms and the applying of them in a consistent and coherent manner***. Hence, ***most of the policy is to do what is already done***, better. Moreover, the policy also ***recognised existing limitation in water quality management***, such as the shortfall in suitable human resources, and hence attempts to be realistic in that what can be aimed for and achieved in the foreseeable future (DWAF, 2003).

3.2.7 The Era of Democracy

"South Africa's water law comes out of a history of conquest and expansion. The colonial law-makers tried to use the rules of the well-watered colonising countries of Europe in the dry and variable climate of Southern Africa. They harnessed the law, and the water, in the interests of a dominant class and group which had privileged access to land and economic power." Kadar Asmal (DWAF, 2007)

In 1994, the first democratic government was sworn in and this saw a huge shift in both the political paradigm as well as the WRM paradigm. This significant change paved way for a

new South Africa, united under the rainbow nation and the opportunity to reframe policy and legislation, based upon the latest thinking and understanding of how water resources should be sustainably managed.

The Constitution of the republic of South Africa (1996) caused a paradigm shift in South African environmental policy by providing a right to “an environment that is not harmful to human health or well-being”, and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures. These measures relate to the prevention of pollution and ecological degradation, the promotion of conservation, securing ecologically sustainable development and the utilisation of natural resources while promoting justifiable economic and social development. The constitution also calls for effective, transparent, accountable and coherent government in a manner that does not encroach on the geographic, functional and institutional integrity of other spheres of government.

The National Water Policy (NWP,1997) recognised that Apartheid had left a void in management capacity in many areas across the different spheres of government. Even after 20years of democracy – there are still challenges that face the water sector.

The NWP recognised that quality can only be managed jointly with quantity; economic considerations must be weighed together with social and environmental ones; groundwater has to be managed with surface water, and international water allocations cannot be considered in isolation from the domestic context. Nor can water management easily be separated from other activities. Land use, human settlements, industrial activity and mines all impact upon (and are affected by) the water cycle and our management of it. It recommended that one restructuring priority would be to shift away from an engineering and operational focus towards more multi-disciplinary regulatory functions, which would require re-prioritisation of resources within the Department.

The development of the 1997 ‘white paper’ policy statement on the management of the national water resource, and the promulgation of the 1998 National Water Act, set a trend for the entire region in terms of policy and legal frameworks for water resources management. The 1998 Water Act required the establishment of a National Water Resources Strategy (NWRS) by the Minister of Water. At the same time, a decentralized approach to water resources management was introduced, with the Act requiring the establishment of catchment management agencies (CMAs) that have the responsibility to develop and implement a catchment management strategy (CMS) that is consistent with the framework provided by the NWRS. The South African water resources planning framework is based on the international principles of IWRM. However, the complexity of integrated planning and the capacity needed to implement the results have outstripped the ability of the country to deliver.

The need for improved groundwater management to ensure sustainable and efficient use of the resource was recognised in NWRS-1 and led to the formulation of a National Groundwater Strategy in 2002 through which strategic actions were undertaken.

Groundwater is a strategic resource in many parts of South Africa, especially in rural areas. It also plays an important role in the supply of water to small towns and villages in the drier parts of the country and an estimated 80 000 to 100 000 boreholes are being drilled annually⁴. Whilst there is considerable potential for additional development of groundwater resources to augment existing resources, the quality of water may be impacted by hydraulic fracturing, do the country's shale gas exploration. Until not, too little is known about the process to fully determine its impact on ground water surfaces.

While the first NWRS was promulgated in 2004, only two CMAs had been established by 2011. Both agencies had developed their strategies by 2012, but were awaiting final legal gazettal of these strategies by the minister. In the absence of these CMSs and in order to plan coherently for future water resources management challenges, then Department of Water Affairs had developed relatively technical water resources strategies, named internal strategic perspectives, for all river basins in South Africa. While these were compiled without stakeholder consultation or much engagement with other government departments, they represent a first attempt to bring all available information about water resources together in one document.

Whilst the first NWRS (NWRS, 2004) set out the policies, strategies, guidelines and procedures for the management of water in the country, as required by the National Water Act, 1998 (No. 36 of 1998). The updated strategy, the National Water Resource Strategy 2 (NWRS-2), released in 2013, aims to "ensure that national water resources are managed towards achieving South Africa's growth, development and socio-economic priorities in an equitable and sustainable manner over the next five to 10 years."

The strategy also responds to the priorities set by government in the National Development Plan (NDP) and National Water Act imperatives that support sustainable development. In terms of the National Water Act (Act 36 of 1998), the purpose of the National Water Resource Strategy is to:

- facilitate the proper management of the nation's water resources
- provide a framework for the protection, use, development, conservation, management and control of water resources for the country as a whole
- provide a framework within which water will be managed at regional or catchment level, in defined water management areas
- provide information about all aspects of water resource management
- identify water-related development opportunities and constraints

Under the NWRS-2 are a number of national thematic plans, including the National Climate Change Strategy for Water Resources (WCCS). The NWRS-2 has been described by the National Climate Change Response White Paper as setting out the short-term response to

⁴ <https://www.dwa.gov.za/groundwater/>

climate change, with the Water for Growth and Development Framework 2030 seen as the medium to long-term responses. It recognises that climate change will increase the pressure on already stressed water resources, further impacting on water quality, and there is thus a crucial requirement for the effective management, use, allocation and re-allocation of available water resources.

3.3 Current Day South Africa

Two decades into democracy, the euphoria of a rainbow nation and new water policies and legislation have not yet yielded the impact that the country expected, particularly on its water resources. **In light of this, the Department together with public and private sector, have a number of initiatives that, if implemented correctly, will change the face of WQM in South Africa.** This section highlights a few of the initiatives that are underway or in the process of being developed to address the challenges and will have a significant improve water quality and the way water quality is being managed and how the resources are being impacted.

3.3.1 The Fragmented Nature of WQM Policies and Strategies

Not only are some of the policies and strategies dated, but they are fragmented and thus result in a non-formalised approach to WQM. In order to improve and integrate existing water quality related policies and strategies so that they 1) address current water quality management challenges, 2) are aligned to recent executive policies and strategies and 3) meet the needs of the Department, and larger water sector; the Department (Water Resource Planning Systems) is in the process of developing a national Water Quality Management policy and accompanying Integrated water quality management Strategy.

It is intended that the WQM Policy will formalise the Department's position in respect of WQM and should include appropriate policy principles and statements. The IWQM Strategy, which will be developed through consultation with the water sector, will identify the actions that will be required to co-ordinate and improve water quality management in South Africa. It will also identify future research needs as well as the water quality procedures, guidelines and thematic strategies which will need to be updated or developed in future.

Game Changer:

- The Development of a consolidated WQM Policy and IWQMS -currently underway

3.3.2 Lack of Cooperative Governance and Alignment between Different Regulatory Mandates and Actions

Whilst there is broad alignment of policy and regulatory intent, alignment between the various legislative instruments needs to be improved. The recent suggested amendments to National Environmental Management Act (NEMA, 1998) strengthen the ability to deal with non-compliant mines and this; with the revised Environmental Impact Assessment (EIA)

Regulations strengthen the understanding of what is required in terms of EIAs. However, there remain challenges with regards to responsibilities between the DEA and DMR that are not fully clarified. Amendments to the MPRDA are in the pipeline. It was also noted the amendments to the NEMA may have some problems in terms of alignment with the National Water Act (NWA, 1998), which is also currently under review. This will require more analysis, but it does seem that these regulatory review and amendment processes are happening in isolation and are not thoroughly addressing the issues of alignment and clarifying matters related to regulatory responsibilities. Into future, we can expect continued regulatory process challenges.

Currently, the Department of Water and Sanitation (DWS) is developing a policy on mine water management, including AMD, and on long-term policy interventions by the DWS. The mine water management policy sets out the policy principles that strive to strengthen the protection of the water resources from mine water contamination for short and long term. The policy principles enshrined herein are informed by the current legislative framework on water resource management. It further proposes an integrated departmental approach to mine water management. Where legislative gap/s exist/s, this policy provides relevant and appropriate legislative remedy in order to strengthen a proactive mine water management approach. The key policy positions reflected in the draft are:

- Integrated approaches to mining closure;
- Apportionment of liabilities;
- Optimum use of appropriate /Best Available Technology;
- Classification and differentiation of mines;
- Promotion of sustainable mining development;
- Duty of care;
- Environmental Vigilance and Continuous Improvement; and
- Institutional arrangements on infrastructure management/ transfer after Mine closure.

In addition, the Department is also in the process of developing policies for hydro-fracking, sanitation, private sector investment, industrialisation, wetlands use, support for rural development and energy.

Game Changer:

- Development of the Mine-Water Policy
- Development of policies on hydro-fracking, sanitation, private sector investment, industrialisation, wetlands use, support for rural development and energy
- Amendment to NEMA
- Amendment to MPDA

3.3.3 Delay in the development of CMSs

The delay in the establishment of CMAs has consequently led to a delay in the development of catchment management strategies. These are vitally important for those catchments that

are critically endangered due to the poor water quality being experienced. The Department has recognised this crucial need and catchment specific integrated water quality management plans (IWQMP), are in the process of being developed for the following prioritised catchments:

- Olifant's River Catchment
- Crocodile West River Catchment
- Vaal River Catchment
- Orange River Catchment

Pro-active and integrated water resource planning to timeously address future water resource challenges is essential to maintaining water security. As such, the plans listed for the catchments above will address the specific water quality needs of those catchments with regards to securing water which is fit-for-use under different management and development scenarios. These plans are an essential component of a suite of other water resource management activities. The outcomes from such plans are used to inform reconciliation strategies, the resource quality objectives (RQOs), and the implementation requirements to meet these objectives. As such these plans guide future resource and source directed controls. The first of the plans should be completed by 2018 (DWS, 2015).

Game Changer:

- Development of IWQMPs for critically impacted catchments

3.3.4 Lack of formalised approach for the Witbank Coalfields

Poor mine water management practices in the Witbank Coalfields by some existing and closed mines has created immense water pollution challenges for populations that are located in close proximity to the affected water resource, particularly rural communities that do not have access to water treatment facilities. In addition, there is a high competition for access to water due to the diversity of water users in the region. These factors constrain the existing water resources, which are either not fit for use, or are not sufficient to supply the region's water demands. As the region is largely considered as water stressed, water supply and the quality of available water resources are areas of concern in the catchment.

The Mpumalanga and Highveld power stations are due to be operational for the next 30 - 40 years, and therefore presents an opportunity to ensure water quality and water resources in this region are better managed. This requires all key stakeholders in the region act collaboratively to ensure the effective management of water quality in the region.

The implementation and operation of collaborative action poses specific challenges and risks to government and mining companies, in terms of its credibility, security, quality and management of risk. Collaboration must be done within the spirit of sharing risks and benefits, through good cooperative governance, management and implementation between all partners. While various institutional models may be developed by Government or the private sector (i.e. mining companies in the catchment) to provide this function, an

autonomous statutory committee housed by a public entity may provide particular advantages in ensuring independence and stakeholder acceptability, maintaining quality and managing risk. The Strategic Water Partners Network (SWPN) has developed a business case for the establishment of a Mine Water Coordinating Body in the Witbank Coalfields to assist with the facilitation, coordination and management of mine water in the area.

Game Changer:

- Establishment of the Mine Water Coordinating Body

3.3.5 Fragmented water user licence

The responsibility for environmental protection currently lies with both the Department of Water and Sanitation and the Department of Environmental Affairs, with both the National Water Act of 1998 and the National Environmental Management Act of 1998 being used to protect resources. Thus, the NWA and the NEMA set out the parameters for regulation, including the institutional arrangements and regulatory instruments. The primary instrument to ensure that resources are taken into account as far as new projects in South Africa are concerned is the Environmental Impact Assessment (EIA) (Brownlie, Coetzee, Morris, 2013^[1]).

Although project-level EIA does contribute to some extent to providing assurance of sustainable development, there are a number of challenges: i) there is a low level of coordination and collaboration by key authorities regarding environmental management at a strategic level; ii) many projects are authorised although they do not ensure sustainable development, that is, EIA practice is largely dictated by procedural and reporting requirements in the NEMA EIA Regulations and does not really engage with key sustainability issues; iii) integrated decision-making and cooperative governance is not occurring; iv) there was discussion of moving environmental regulation from DEA to the key impacting sectors, and if this occurs there will be conflict of interest (Brownlie, Coetzee, Morris, 2013[2]). The mining sector, in particular, has been problematic.

There is a need to align the processes, for example, for requiring a mining licence, and there has been participation in the Interdepartmental Project Implementation Committee (IPIC) on integrating licencing. To ensure that the authorisation processes associated with mining are aligned, all four acts (NWA, NEMA/NEMWA and MPRDA) need to be amended and aligned.

The real opportunity exists to look at improved cooperative governance arrangements between sectors that could strengthen regulatory powers across the sectors.

^[1] <http://pmg-assets.s3-website-eu-west-1.amazonaws.com/130731ladies.pdf>

^[2] <http://pmg-assets.s3-website-eu-west-1.amazonaws.com/130731ladies.pdf>

Action:

- i) ***Sustainable development and cooperation between government departments in order to assure sustainable development needs to be given more importance;***
- ii) ***In revising the National Water Act of 1998 and National Environmental Management Act of 1998, the processes for requiring licences need to be aligned between DWS, DEA, DMR and DAFF, where necessary. (IWUL)***

Game Changer:

- Development of the Integrated Water User Licence

3.3.6 Limited financing for WQM initiatives

The budget allocation from the fiscus is a pittance in comparison to the budget that is required to fix the water quality solutions of the country. Therefore, new and innovative financing mechanisms are crucial. One such solution is the Waste Discharge Charge System (WDCS) that is being developed by the Department of Water Affairs to promote waste reduction and water conservation. It forms part of the Pricing Strategy, which is being established under the NWA. The WDCS is based on the polluter-pays principle and aims to:

- promote the sustainable development and efficient use of water resources
- promote the internalisation of environmental costs by impactors
- create financial incentives for dischargers to reduce waste and use water resources in a more optimal way.

The WDCS is premised on resource quality objectives (RQOs) as the measure of acceptable risk, and seeks to achieve RQOs at lowest total cost to the catchment. Where RQOs are exceeded or are threatened, impact on the resource is unacceptable and the WDCS may be deployed to achieve RQOs. The system will be applied at a catchment scale where the catchment is defined as those areas that have a significant impact on water quality, or are impacted by the specific water quality problem.

Table 1: Constituents for the WDCS

Variable	Description
Salinity	electrical conductivity (EC), chloride (Cl), sodium (Na) and/ or sulphate (SO ₄)
Nutrients	soluble phosphorus (PO ₄), nitrate (NO ₃) and ammonium (NH ₄)
Heavy Metals	arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), lead (Pb), nickel (Ni) and / or zinc (Zn)
Organics	chemical oxygen demand (COD)
pH	

Phase 4 of the project saw business plans being developed for implementation in three threatened catchments viz. the Upper Vaal, the Upper Olifants and Hartbeespoort Dam catchment.

Game Changer:

- Implementation of the WDCS

3.3.7 The role of green infrastructure in WQM

Wetlands have and continue to play an important role in water quality management. The proposed Strategic Integrated Project (SIP 19), aimed at improving South Africa's water resources and other environmental goods and services through the conservation, protection, restoration, rehabilitation and/or maintenance of key ecological infrastructure. This programme identifies Strategic Water Source Areas (SWSAs) as key focal areas and has phased them based on the perceived priority for improving ecological infrastructure and the rehabilitation of wetlands is one such priority (Nel *et al.*, 2013).

The Working for Wetlands programme which was established in 1995, have made headway in ensuring that the wetlands have been prioritised in South Africa. Macfarlane and Atkinson (2015) released a report prioritising catchment for wetland rehabilitation. The report also showed that whilst wetland conservation was deemed important, this priority was poorly, if at all, reflected as an action item in many planning units.

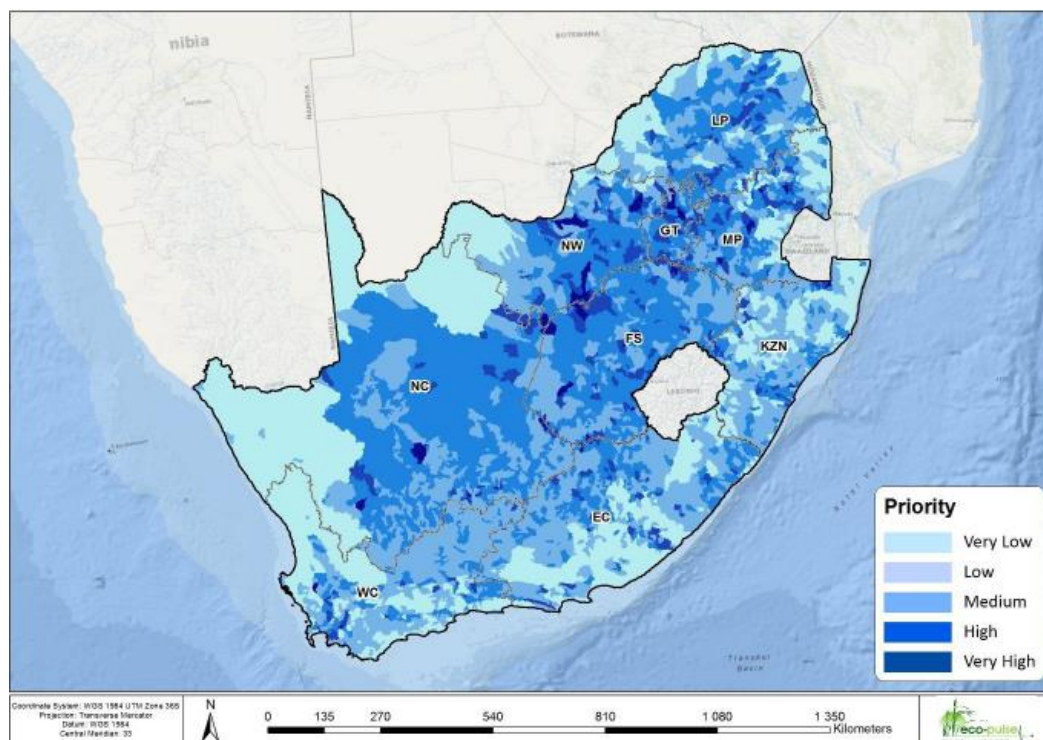


Figure 7: Map indicating the demand for water quality enhancement services provided by wetlands (Macfarlane and Atkinson, 2015)

The importance of this service is however largely dependent on water quality risks and the associated demands for this service. Indeed, the greater the extent of toxicant sources (point source and non-point source) in a wetland's catchment, the higher the likelihood that toxicants may be a problem in the river system, and the greater will be the opportunity for wetlands to trap these elements and therefore enhance water quality. As such, a measure of water quality impacts at a catchment scale provides a useful surrogate for the importance of wetlands in performing this service. The demand for this service is also dependant on user

requirements. As such, the location of planning units in relation to dams and communities that are directly reliant on water resources for water provision have also been assessed.

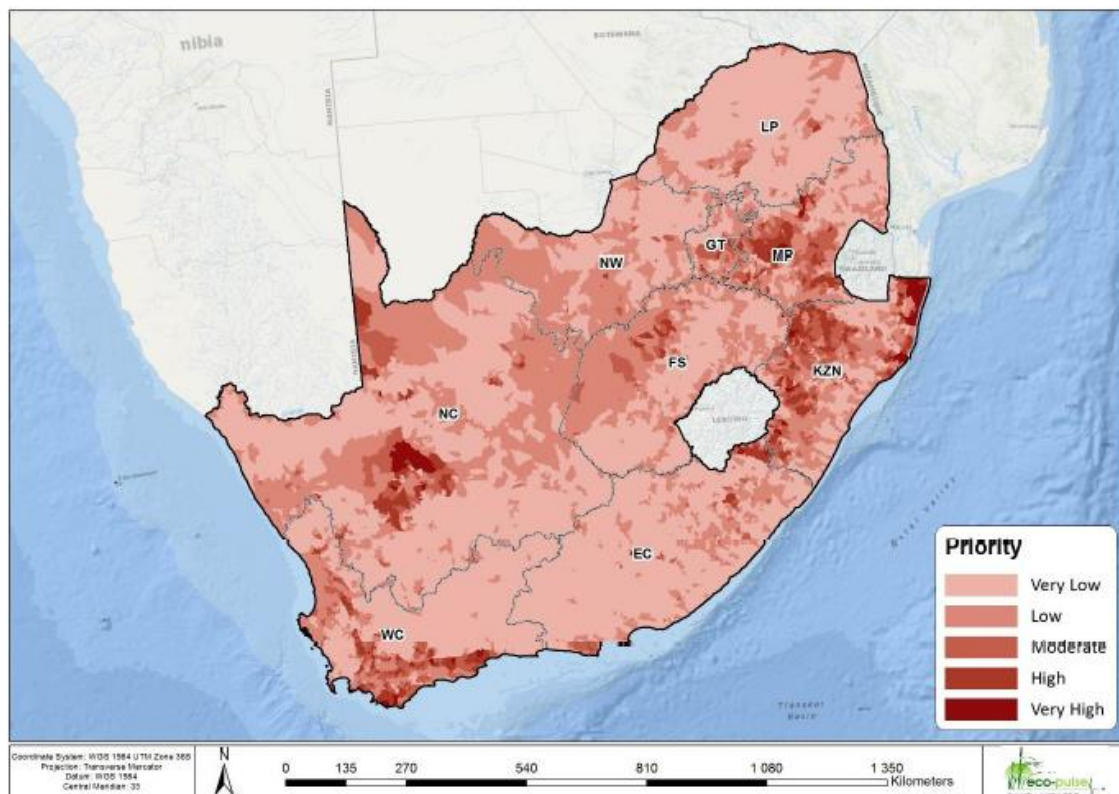


Figure 8: Map indicating the wetland rehabilitation potential of planning units

Healthy working wetlands have the ability to:

- assimilate toxins;
- act as a filtration mechanism prior to water reaching dam impoundments and areas where there is access by rural communities;
- mitigate impacts to water resources by trapping sediment, thereby reducing sediment loads and improving water quality for downstream users;
- assist with flood attenuation by wetland ecosystems; and
- provide stream flow regulation.

The Working for Wetlands programmes drives a number of conservation initiatives such as Ramsar sites, sectoral partnership, formal and informal protected areas, stewardship sites and expansion plans for protected areas.

Experience gained through implementation of the WFWetlands programme has shown that partnerships are key to the long-term success of rehabilitation activities. Where strong partnerships exist, interventions tend to be monitored and managed more effectively, securing the long-term gains brought about through rehabilitation activities (Macfarlane and Atkinson, 2015).

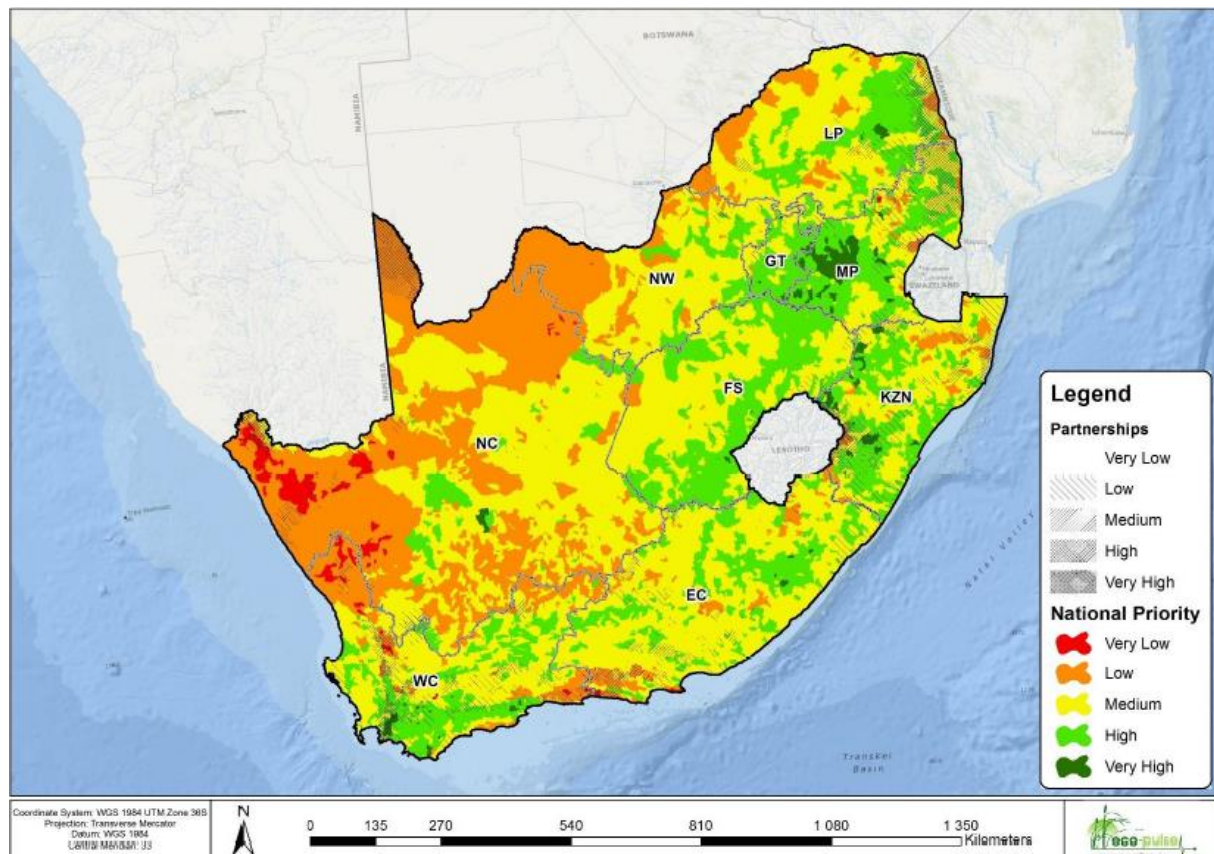


Figure 9: Map indicating results of prioritised catchments

Whilst wetlands have proven useful as a water quality management instrument, there are a number of challenges that lay ahead before they are fully utilised such as:

- local level priorities;
- inclusion in regional level initiatives; and
- resources and capacity to implement.

Game Changer:

- Stronger implementation of wetland rehabilitation initiatives

3.3.8 Inadequate coordination between different spheres of government for WQM

Currently, the way the Department is structured, water quality and WQM functions are highly fragmented. Whilst there are pros and cons to this fragmentation – unless there is a champion or home at the National level, the coordination of WQM activities will continue to be fragmented. If adequate WQM coordination takes place at the national and basin levels, it is unlikely to coordinate these efforts at the local level. The strong ties that exist within sectoral relationships, and the organizational stovepipes or silos that develop among similar agencies at different levels, will frequently overcome any attempts to work out conflicts at the local level (Pegram *et al.* 2013).

Due to the amalgamation of the WSA and the NWA, the Department is in the process of re-structuring. This provides an opportunity to align the WQM functions.

Game changer:

- Improved WQM organisational structures to improve coordination in all government spheres

3.3.9 Insufficient Monitoring and Evaluation Framework

The sustainable and equitable management of South Africa's water quality primarily relates to the assessment of the status of the country's water resources, determining objectives for their management, and devising and implementing strategies and plans of various types and at various levels to ensure that the water quality of these resources meet the requirements of water users

A report released in 2012 by Aquatic Informatics Inc. showed the global hydrological monitoring trends results show increased demand for hydrological monitoring networks to serve multiple needs (including reference for climate change and inventory for water availability) and to serve multiple purposes (including water quantity and continuous water quality monitoring).

In addition, the fourth phase of the WDCCS highlighted the need for significant upgrade of the Department's monitoring network. The most highly impacted catchments, i.e. Upper Crocodile, Upper Vaal and Upper Olifants fell short in terms of their monitoring data, which will create unnecessary loopholes for the implementation of a polluter's pay principle, when the Department does not have the evidence to attribute the pollution isn't there.

Game changer:

- Improved and increased monitoring framework for both water quality monitoring and the monitoring of WQM.

A Chronological Summation of the Evolution of WQM in South Africa
(Extract from WQM Framework Policy, 2003)

1919 to 1956

Water quality problems were experienced in South Africa during the first half of the 20th Century. This coincided with the development of towns and industries and the associated accumulation of wastes in built-up areas. Under the Public Health Act of the Union of South Africa, 1919 (Act No 36 of 1919) all sewage and sewage effluents had to be disposed of on land, by means of irrigation or through evaporation in evaporation ponds mainly due to inadequate technology or high treatment costs.

1956 to 1991

In the pre-1950 to the post-1950 era, South Africa underwent a change from an agriculturally based economy to one in which industry and mining became more dominant. The Water Act, 1956 (Act No 54 of 1956) aimed at control of the industrial use of water and the treatment and disposal of effluent. By 1956 it was becoming apparent that reconciling water supply with water demand would be increasingly difficult and that reuse of effluent would have to play a major role in the management of the country's scarce water resources. After 1956 the earlier requirement of the health authorities that prohibited the disposal of effluent to natural water courses had to fall away due to diminishing water supplies. The 1956 Act required that all effluent be returned to the water body from which the water was originally abstracted. Later amendments, notably the Water Amendment Act, 1984 (Act No 96 of 1984) broadened water quality management and the uniform effluent standards, the General and Special Standards and the Special Effluent Standards for Phosphate were developed to limit eutrophication and associated pollution.

1991 to 1998

The emphasis on the management of effluent quality did not achieve the desired results. Water quality continued to deteriorate, mainly due to other forms of water contamination, not directly covered by effluent quality control, becoming more pronounced. These primarily relate to diffuse sources of contamination and associated land use activities. This necessitated focussing on the water resource to ensure suitable water quality for beneficial water use. This resulted in the Receiving Water Quality Objectives (RWQO's) approach, complemented with a pollution prevention approach. The development of catchment management plans, although not entrenched in law, also started within this period in order to facilitate the implementation of the RWQO's approach.

1998 to present

The National Water Policy and subsequent National Water Act of 1998 entrenched the concept of catchment management and associated resource quality objectives by direct management effort. Moreover, the concept of the Reserve as part of the resource base was also established. The concept of sustainable water use as introduced by the National Water Policy and the National Water Act, 1998, not only embraces the concept of aquatic ecosystem integrity as reflected by the Reserve, but also emphasises that water use must 'benefit' human society. This is in line with the current national effort to enhance the social and economic situation of South Africa.

3.4 Considerations for an Enabling Policy Framework

The principal enhancements to the existing water quality management system relate to the following:

- Meeting the quality-of-life requirements of water users as the central focus of water quality management.
- Setting of water quality performance requirements (resource quality objectives) at local level (catchment or water management areas) will be done with due consideration of the nature of the resource and the possible developmental requirements which could depend on the resource.
- Implementation of institutional arrangements to give effect to devolution of roles and responsibilities to regional and catchment management levels
- Introduction of instruments that will encourage appropriate behaviour and provide incentives for water users to improve and optimise their water use activities
- Introduction of improved and enhanced co-operative government mechanisms to ensure that water management functions are undertaken at the appropriate level and in an effective manner.
- Improved enforcement of statutory measures and controls. In order to ensure that regulatory intervention is effective, threats to water resource quality will be categorised and action prioritised to deal with the most notable threats with the greatest effort.
- Ensuring that continuous improvement as an inherent component of water quality management. (DWAF 2003)

The success of the policy and strategy lies in its implementation through various mechanisms such as:

Table 2: Strategic mechanisms for implementation

Mechanisms for Implementation		
▪ Water quality planning	▪ Co-operative governance	▪ Organisational design
▪ Decision-making in water quality management	▪ Appropriate technology development	▪ Appropriate infrastructure development and maintenance
▪ Water use charges and related mechanisms	▪ Departmental and sector capacity enhancement	▪ Appropriate technology development
▪ Innovative financing	▪ Compulsory licensing	▪ Stakeholder Engagement
▪ Influencing land use	▪ Compliance and enforcement monitoring	▪ Appropriate research and development
▪ Alignment of policies and strategies	Conflict resolution	

4. INSIGHTS FROM INTERNATIONAL CASE STUDIES

In efforts to combat water quality and water quality management challenges, various interventions have been implemented internationally. These interventions have succeeded or failed due to each individual context. Successful interventions offer an opportunity to learn how the interventions (i.e. policies, strategies and implementation plans) were implemented and what the key factors were that contributed to the success. Unsuccessful interventions also provide an opportunity for learning, as they not only point out what the barriers to implementation were, but importantly provide guidance on what factors should be improved to enable successful water quality management (in certain contexts).

Developing countries are, traditionally, less likely to have the institutional, technical or financial capacity to undertake many water resource management activities. Several developing and developed countries, have illustrated how innovativeness can help conquer barriers. These interventions (i.e. policies, strategies and implementation plans) have been successful not only because of innovativeness, but because of the corporate governance structures that were employed in the countries. This, therefore, offers an opportunity for South Africa, and other developing countries to learn.

International best practice on WQM is often centralised around four different types of approaches:

- **Strategic and planning approaches** such as resource quality objectives and water quality strategies.
- **Regulatory approaches** such as laws and policies.
- **Contracts and agreements** that are legally binding contracts/agreements between partners.
- **Economic approaches** such as waste discharge charge systems, incentives and financing approaches (e.g. sourcing funds).

Each of the approaches listed above can be used to attain the opportunities discussed in Chapter 1. For example:

- Promoting a **green economy** by developing energy plans and development strategies that encourage renewable energy, and also economic incentives (such as subsidies) for renewable energy projects.
- **Stewardship and partnerships** that develop mechanisms for ensuring financial sustainability for WQM interventions and also develop catchment/regional water quality strategies.
- **Financial mechanisms**, through enforcing levies and/or taxes (which requires legislation) that force users to pay use and/or impacts, or implementing payment for ecosystem services (PES).
- **Restoration and rehabilitation** by providing sufficient funding to implement rehabilitation interventions, and by enforcing existing legislation.

These approaches have been successfully implemented in various countries across the globe. By reviewing these approaches, there is an opportunity for South Africa to review,

revise and refine WQM strategies to address the above-listed opportunities offered by innovative solutions. Therefore, the remainder of this chapter discusses how these approaches have been implemented to meet the WQM opportunities (as discussed in Chapter 1).

This review is conducted by the framework illustrated in the table below. The first column provides a high-level overview of the major water quality challenges and WQM challenges. For each of the challenges, at least one case study is used to illustrate how innovative solutions have been implemented to meet the opportunities. The case studies will also be evaluated against the opportunities, as well as the approach employed for WQM. Column two to five represent the WQM opportunities, while columns six to eight represents different approaches to addressing WQM.

Table 3: Framework for Best Practice Review

Water Quality Challenges	Opportunities				Approach			
	Green Economy	Stewardship (Collective Action)	Financing Mechanisms	Restoration & Rehabilitation	Strategic & Planning	Regulation	Contracts & Agreements	Economic (incl. Financial)
Eutrophication								
Municipal sewage	Rhine River				X	X (EU)	X	
Agriculture	EU Nitrates Directive: Danube-Black Sea				X	X	X	X
Acidification and Heavy Metal Contamination								
Acid mine drainage		Australia				X	X	X
Heavy metals & acidification		Canada			X	X		X
Acidic atmospheric deposits			China		X	X		X
Salinisation								
Mining & industrial activities	China				X	X		X
Agriculture (irrigation)	Indus Basin (Pakistan)				X	X	X	
Urban pollution								
Stormwater runoff		Mersey Basin, UK			X		X	X
Infrastructure & water treatment	Porto Alegre, Brazil				X	X		X
Sedimentation								
Agriculture	Agriculture Sector (Private Corporations)				X		X	X
Land management	Catchments in Western Australia				X	X	X	X
Water Quality Management Challenges								
Political Will		Ganga Basin, India			X	X	X	X
Institutional Environment		USA			X	X	X	X
Financial Sustainability		Various			X	X		X

It is important to note that this review is not a comprehensive review of water quality management approaches, but rather a review of particular cases or topics that provide insight into the changing nature of water quality problems and their management internationally. This review provides insight into how water quality and water management challenges have been addressed internationally. It does not focus on technical management

practices, but rather the enabling policy, institutional, financial and regulatory mechanisms that were/are being adopted.

4.1 Salinity in the Indus Basin, Pakistan

The Indus Basin extends over Tibet (China), India, Pakistan and Afghanistan, and covers an area of 1.12 million km². The basin is rapidly becoming a “closed” basin in which all of the available renewable resources are already allocated for use, with India (36%) and Pakistan (63%) representing almost all of the demand on the river’s water resources (SAWI, 2016).

Pakistan is the most downstream country of the basin, and the Indus River is the longest river in the country. The river is a crucial source of water for the country as surface-water resources are based on the flows of the Indus River and its tributaries (Jhelum, Chenab, Ravi, Sutlej, and Beas to the east and the Kabul River to the west) (Quereshi, 2011).



Figure 10: Location of the Indus Basin
(Source: Kalsoom, 2008)

❖ The Indus Basin Irrigation System (IBIS)

Pakistan’s agriculture sector is heavily dependent on the IBIS for its contribution to the country’s GDP (Kahlown and Azam, 2002). The Indus River basin supplies water to the largest contiguous irrigation system in the world, providing water for 90% of the food production in Pakistan, which contributes 25% of the country’s gross domestic product. The irrigation system commands a gross irrigable area of 16.85 million ha, 14 million of which are culturable command area to which water is allocated (Quereshi, 2011). In recent decades, irrigated agriculture in the Indus Basin has moved towards conjunctive use of surface and groundwater. Irrigation withdrawals in the basin account for 278 km³ or 93 per cent of total withdrawals (SAWI, 2016). The irrigation water is mainly supplied through the world’s largest canal system arranged through dams (Alam, 2000).

The concurrent use of surface water and groundwater water takes place on more than 70% of irrigated lands (Qureshi et al 2004). Intensive and continuous use of surface irrigation has altered the hydrological balance of the irrigated areas. The substantial rise in the water table has caused salinity and water logging in large areas of Sindh, Punjab, NWFP and Balochistan. The magnitude of the problem can be gauged from the fact that the area of productive land was being damaged by salinity at a rate of about 40000 hectares annually (Alam, 2000).

Inefficient irrigation is one of the root causes of salinity and waterlogging in the IBIS. Inappropriate and inefficient irrigation has raised the water table in the IBIS. Twin menace of salinity and waterlogging is reducing the productivity of agricultural lands. These two problems co-exist at most of the places (Kahlowan and Azam, 2002). Waterlogging and salinization are major impediment to the sustainability of irrigated lands and livelihoods of the farmers, especially the smallholders, in the affected areas of the Indus Basin. These problems are the result of a multitude of factors, including seepage from unlined earthen canals system, inadequate provision of surface and subsurface drainage, poor water management practices, insufficient water supplies and use of poor quality groundwater for irrigation (Quereshi et al., 2008).

Although, the country has invested heavily in surface drainage, it is ineffective due to lack of O&M (operation and maintenance) and lack of linkages of main drains with secondary and/or tertiary drains. In addition, the disposal of effluents to sea is difficult because of the distance to the sea and thus the transport of effluents is a real challenge. The shortage of canal water supplies has also forced the farmers to use groundwater of marginal to brackish quality resulting in secondary salinization (due to soluble salts) and/or sodification (due to sodium salts). Some of the small holders and resource poor farmers have lost their livelihood due to salinity and waterlogging. The good example is the areas around the Chashma-Jehlum Link canal, where excessive seepage from the link canal resulted in waterlogging to the extent that the land owners have lost their livelihood. The loss of livelihood is a major threat to the security of the country as the major issue related to Pakistan's economy is the unemployment and lack of adequate employability in the rural areas (Kahlowan and Azam, 2002).

❖ **Engineering Solutions for the Indus Basin Irrigation System**

Since the early 1960s, several efforts have been made to improve the management of salt-affected and waterlogged soils. These include lowering groundwater levels through deep tubewells, leaching of salts by excess irrigation, application of chemical amendments (e.g. gypsum, acids, organic matter), and the use of biological and physical methods (Quereshi et al., 2008).

Large-scale Salinity Control and Reclamation Projects (SCARPs) in all four provinces. The program covered 8 million ha and cost approximately US\$2 billion. Two big disposal projects were also initiated to solve the drainage disposal problems. To address the saline soil problem, some of the measures tested include leaching of salts by excess irrigation, use of

chemicals (such as gypsum and acids), and addition of organic matter and biological measures (such as salt-tolerant plants, grasses, and shrubs) (Quereshi and Sarwar, 2010).

However, in spite of huge investments, the results have in general been disappointing and the problems of waterlogging and salinity persist. Poor operation and maintenance of these systems and provision of inadequate facilities for the disposal of saline drainage effluent resulted in limited overall success (Quereshi et al., 2008). In addition, the lack of coordination among federal and provincial governments, research institutes, and national and international organizations; conventional farming and irrigation methods used by farmers; limited attention to reclamation and saline agricultural approaches; and lack of resources are some of the reasons for the low success rate (Quereshi and Sarwar, 2010).

❖ **Collaboration along the Indus Basin**

Water management challenges are compounded by the basin's transboundary nature, the uneasy relationships between its riparians and the absence of effective basin management institutions. Bilateral relations between India and Pakistan on the Indus River are regulated by the 1960 Indus Waters Treaty. The treaty established the Permanent Indus Commission (consisting of one Commissioner from each country) that meets regularly (SAWI, 2016). Under the treaty, Pakistan was allowed exclusive use of three western rivers (Indus, Jhelum, and Chenab), and India was entitled to 3 eastern rivers (Ravi, Sutlej, and Beas). This treaty also provided provision for the construction of a number of link canals, barrages, and dams on the Indus and its two tributaries (Quereshi, 2011).

Inter and intra-state competition over water resources is expected to intensify with population growth and is likely to increase tensions within and between riparian countries (SAWI, 2016). Therefore, to strengthen water resources management and coordination among riparian countries to improve water and energy security, the World Bank is taken an integral part. The South Asia Water Initiative (SAWI) is a partnership between the Word Bank and the Government of the United Kingdom, Australia and Norway. SAWI is designed to support countries improve and deepen transboundary dialog, enhance the basin and water resources knowledge base, strengthen water institutions, and support investments that lead to sustainable, fair and inclusive development. In order to achieve this, SAWI has developed an Indus Focus Area Strategy (2013-2017). The overall objective of the Indus Focus Area strategy is to strengthen water resources management and coordination among riparian countries to improve water and energy security. The two specific goals in support of this objective are: (1) Strengthen Knowledge and Capacity for long-term Basin Development and Investment Planning; and (2) Support Investments and Capacity Building for Improved Water and Energy Security in the Basin. Additional activity areas may include issues that may promise early wins for collaboration such as management of water quality, floods, groundwater and water use efficiency (SAWI, 2016).

❖ Collaborative Funding for the Indus Basin Irrigation System (IBIS)

As part of the Indus Waters Treaty, financial agreements were reached. This included a schedule for India to provide its fixed financial contribution of \$62 million, in ten annual instalments during the transition period (i.e. April 1, 1960 to March 31, 1970). In addition, the World Bank organised a consortium of donors to support development in the Indus basin, which raised close to \$900 million (Wolf, 2008). These efforts were mainly focused on infrastructure projects such as dams and canals. The involvement of the World Bank was mainly been due to conflict between India and Pakistan. Although the initial conflicts have been resolved, the World Bank continues to be involved in the Basin. Recent efforts have included building water efficiency and minimising impacts by the agriculture sector, as well as building capacity of the water sector (as shown in the boxes below).

Sindh is one of the primary beneficiaries of Indus Basin Irrigation System with three major barrages that divert some 48 million acre feet of water annually to the 14 main canal commands in the province. Sindh is one of the poorest regions of the country, and 56 percent of household income in Sindh comes from agriculture, directly or indirectly. The project covers over 1.8 million ha of irrigated land, benefiting over 600,000 farm-households or over 3.6 million people.

In 2014, the World Bank approved US\$138 million loan to the Sindh Water Sector Improvement Project to further improve the efficiency and effectiveness of the irrigation water distribution system of three Area Water Boards (Ghotki, Nara and Left Bank) in the Sindh province.

The additional financing will help increase agricultural productivity, employment and incomes in more than 30 percent of the irrigated area in the province.

The additional financing will further support the Sindh Irrigation and Drainage Authority in improving the irrigation service delivery to about 600,000 farm households, with special focus on reliability, equity, and user satisfaction. The project promotes equitable distribution of irrigation water and boosts shared prosperity by increasing farmers' income and reducing their vulnerability to future droughts.

Source: World Bank, 2014.

<http://www.worldbank.org/en/news/press-release/2014/12/16/improving-irrigation-system-sindh>

Initiated in 2015, the objective of the Additional Financing for the Water Sector Capacity Building and Advisory Services Project (WCAP) for Pakistan is to strengthening institutional capacity for improved development and management of the Indus Basin Irrigation System (IBIS) in the context of economic, social, and environmental change. The Ministry of Water and Power is implementing the project with financial assistance from the World Bank (WB).

In the context of sustainability of water resources of Indus Basin, it was considered important to strengthen the capacity of the provincial irrigation research laboratories through imparting training to their staff, upgrading their existing facilities and providing modern equipment in the laboratories, as their research results provide input to federal policy and planning for development and management of water, power and agriculture sectors.

Source: World Bank, 2015.

<http://documents.worldbank.org/curated/en/2015/10/25156876/pakistan-water-sector-capacity-building-advisory-services-projectwcap-additional-financing-environmental-assessment-environmental-social-management-plan>

❖ **Reforming Water Charging in Sindh, Pakistan**

Water charging issues in Sindh are comparable to water charging issues in other mega canal systems in India and Pakistan: low water rates, problematic recovery and chronic under funding. One distinct feature of the irrigation administration in Sindh was the limited number of professional staff. In spite of the technical issues (waterlogging, multi-functionality of the irrigation and drainage system) there is no coordination between irrigation, drainage, storm water removal and groundwater management. However, a number of steps have been taken to reform the irrigation system with implications for the water charging system. Reforms were initiated, but only took shape from 1999/2000 onwards (van Steenberg, n.d.).

The reform process in Sindh was defined in the SIDA Act that was passed in 1997. It has two faces; first is the transition of the Irrigation and Power Department into a financially autonomous Sindh Irrigation and Drainage Authority (SIDA) and the formation of ultimately self-financing Area Water Boards (AWB) on the canal commands. To reach this stage of self-financing a period of ten years was earmarked for the new institutions. The second part is the transfer of responsibilities at distributary and minor level to Farmer Organisations FO's). These Farmer Organisations are supposed to typically serve areas of 3,000 hectares. This makes them stand out from the watercourse-based Water Users Associations that were formed earlier under the On Farm Water Management Program. These earlier Water Users Association played a short-lived role in the lining of water courses, but disappeared into informal arrangements or nothingness soon after. In addition, the pricing strategy and strategy for collecting water charges was also changed. The reforms in Sindh initially had challenges, such as the inability to subsidize irrigation and drainage operations with public resources, the difficulty to maintain performance standards and the increased unwillingness of water users to contribute in cash or in kind (van Steenberg, n.d.). However, the restructuring of the entire system has resulted in improvements to the system, such as increase in cost recovery. Reforms to the sector continue in efforts to meet the cost of treating water polluted water.

What can South Africa learn from this case study?

Although the Indus Basin Irrigation System (IBIS) is faced with many challenges, there several lessons that can be learned from it. These include:

- The basin explored various technical solutions to minimise the impacts of the agriculture sector on water resources. It is essential to promote the use of water and energy efficient technologies with minimal natural and social impacts.
- The study illustrates that although technical interventions and financial sustainability are important, these are not enough. It is essential to build institutional capacity to ensure long-term sustainability of interventions.
- Collaborating with all required stakeholders is, however, not at the level that it should be. This influences the decision-making process within the system, as stakeholders such as basin management entities, for example, need to have a say. It is important to reach binding agreements with stakeholders that promote sharing risks and benefits, including between water managers and irrigation associations.

- As the quality of water of poor, the provinces of Sindh initiated various reforms to improve the water sector. These are intended to improve the collection of water use charges. Meeting the cost of treating and providing water is essential to ensuring long-term sustainability infrastructure (through O&M) and institutions (through sufficient capacity and resources). Although further reforms are still required, improvements in the system are evident.

Water quality challenge: *Salinisation (Agriculture - irrigation)*

Opportunities met: *Green Economy, Stewardship, Financing Mechanisms, Restoration and Rehabilitation*

Approach employed: *Regulation, Contracts and Agreements, Planning and Strategic*

4.2 Land Management and River Restoration in Australia

The nature of its economy and size and density of its population has meant that Australia's rivers have been spared much of the industrial and urban pollution that has beset rivers in Europe, the United States, and more recently, much of Asia. Rather, in most instances freshwater degradation has been linked to agriculture, as a result of both abstraction of water for irrigated agriculture and the clearing of vegetation and associated catchment degradation (GIWP, 2015). A number of measures have been implemented to address these issues. Australia also has considerable history in traditional riparian and catchment restoration projects in small and medium sized catchments. Such projects have primarily been led by local government, catchment management authorities, or community groups and have involved activities such as planting of riparian restoration, re-establishing instream habitat, and removal of invasive species, particularly invasive fish (GIWP, 2015). The box below illustrates such efforts, and an additional two projects are described below.

A massive investment was implemented to improve river flows in the Murray-Darling basin. This has involved the federal government committing A\$12.9 billion over ten years in water buybacks, infrastructure to improve water use efficiency and policy reforms. This includes A\$3.1 billion to purchase water entitlements in the basin to be returned to the river for environmental purposes (DEWHA, 2008).

❖ River Restoration in Healthy Country project, South-East Queensland

The restoration project was funded by the Queensland Government (\$8 million over 4 years) and the project partners included the SEQ Healthy Waterways Partnership (SEQ HWP), SEQ Catchments, Dept of Environment and Resource Management (DERM), Dept of Employment and Economic Development (DEEDI), and the SEQ Traditional Owners Alliance (SEQTOA) (Mooney et al., 2008).

As part of the project, a regional committee was formed to coordinate project management, restoration plan development, budget confirmation, implementation of management actions, communication and resolution of issues during the life of the project. This committee worked in conjunction with local committees that were formed from community members from each focal area along with industry representatives and local council officers. The committee

members developed an agreed set of objectives for the project and were instrumental in championing this work at differing levels of government, through public awareness outlets and in their local areas (Saxton et al., 2013).

The main goal of the Healthy Country Program was to validate and refine the “proof of concept” for the catchment/community approach to waterways and landscape restoration and sustainable land-use. The objectives of the project were: (1) Develop rehabilitation methods to decrease sediment loads from targeted catchments by 50%; and (2) Improve the health of the waterways (Saxton et al., 2013).

A total of about \$3.1 million was invested into 83 on-ground projects across the three focal areas for waterway restoration (Crimp, 2012), as well as an additional \$170,000 that was invested in a component of the project to implement sustainable land management practices for the farming community (Saxton et al., 2013).

The Healthy Country project was the first proof of concept initiative to be undertaken in the region that addressed river restoration on a sub-catchment scale. The lessons learnt from the project were relevant for prioritisation of investment at this scale and engagement of a community more so than individual landholders (Crimp, 2012).



Figure 11: Location of Healthy Country Project, South-East Queensland

❖ **Healthy waterways project in the Yule Brook**

Yule Brook is a natural watercourse at its headwaters, which turns into a network of deeply incised drains in its lower reaches that combine to form the Yule Brook Main Drain. The drain discharges into the Canning River at the project site, running past Yule Brook Homestead. The project site includes the Brook, Canning River, melaleuca thickets and connected swampy areas. The understory is weed infested and water quality data indicates that phosphorus levels are a concern (Landcare, n.d).

The project is run by the South East Regional Centre for Urban Landcare (SERCUL), which was formed in 2003 as an independent Natural Resource Management body in Perth. It brings together the community, business and government to develop and implement projects that improve the health of waterways and other ecosystems in southern Metropolitan Perth (Landcare, n.d).



Figure 12: Project activities on drains that discharge into the Yule Brook (Source: Landcare, n.d.)

The healthy waterways project was a multi-pronged approach to rehabilitate Yule Brook including community planting days & community education activities to improve water quality. Project activities assisted with improving water quality in the Swan and Canning River systems by planting local native seedlings along and adjacent to the banks of the Yule Brook which has helped to reduce nutrients, prevent erosion of the banks, reduce sedimentation and provide habitat for native fauna. The

education component raised awareness and stewardship of the participants in the importance of Yule Brook and how to effectively look after the area. Local residents, landcare volunteers and school students participated in a range of activities to improve the health of the catchments including revegetation, river restoration, water quality monitoring, fauna surveying and community environmental education and information sessions (Landcare, n.d).

In 2010 to 2011, one of the key achievements of the project included rehabilitation work over 4.3 ha which included weed control of arum lilies, sagittaria, blackberry and paspalum and revegetation along the lower reaches of the Yule Brook Drain. The long-term outcomes of weed control and revegetation will result in reduced nutrients in Yule Brook. Yule Brook is a natural watercourse that turns into a network of deeply incised drains in its lower reaches, which combine to form the Yule Brook Main Drain, flushing the contents of the drain into the Yule Brook and Canning River (Landcare, n.d).

What can South Africa learn from this case study?

South Africa therefore has an opportunity to lead the pack, by not only restoring and rehabilitating degraded natural systems, but by also using interventions to promote other sustainable development goals. The several factors that can be taken away from this study are outlined below:

- Water quality initiatives and water quality management is part of the broader catchment management initiative, supported by regulatory and financial mechanisms.
- Innovative financial mechanisms that protect or rehabilitate natural infrastructure are explored. These include funds from regulating authorities, catchment green funds/bonds or payment of ecosystem services (PES).
- Exploring stewardship and partnerships is key to exploring catchment-based activities. This includes regulating and basin management entities, for rehabilitation and WQM interventions.
- Promoting a green economy and sustainable development interventions should be explored, such as biogas projects, agriculture projects for rural communities or treating contaminated water.

Water quality challenge: Sedimentation (land management)

Opportunities met: Green Economy, Stewardship, Financing Mechanisms, Restoration and Rehabilitation

Approach employed: Regulation, Planning and Strategic, Contracts and Agreements, Economic Approaches

4.3 Managing the Mining Industry in China

❖ Ecological Restoration of Mines in China

The land impacts of coal production and use are regulated primarily under the various Acts and Laws. The laws also cover the land impacts of transportation, transmission and waste disposal (Kholhe and Khot, 2015). Mine related impacts, however, still occur, with some being ruined beyond any use. The destruction to land is most direct and obvious for surface mining. In addition to the land damaged directly by mining, the destruction of soil erosion and regional ecological environment caused by mining goes beyond the boundaries of the mine areas (Zhenqi et al., 2012).



Figure 13: Ecological restoration in China. Top two: Ecological restoration effect of the waste dump of Pingshuo surface coal mine in Shanxi Province. Bottom two: Ecological restoration effect of the waste dump of Pingshuo surface coal mine in Shanxi Province (Source: Zhenqi et al., 2012)

As surface coal mines can be divided into several parts, such as the stope, waste dump, tailing pond and industrial site, its land degradation includes excavation, occupation and pollution, of which excavation and occupation are most direct (Hu 1995). China has implemented various methods for restoring land that has been used for coal mining. Two of these approaches are illustrated in Figure 13 below. These methods have been implemented

in many countries, including South Africa and Australia. Developing countries, however, usually fall short in enforcing rehabilitation of closed mines.

❖ Emissions causing Acidification of Water Resources in Southern China

In China, emission from human activities (such as industrial activities and the burning of fossil fuels) or natural causes (such as volcanic eruptions) result in acid rain. Acid rain refers to any precipitation that is more acidic than usual, and is caused by emissions of sulphur dioxide and nitrogen oxide, which react with the water molecules in the atmosphere to produce acids.

One of the major causes of acid rain is the increasing consumption of cheap, abundant coal, as the country struggles to cope with energy shortages and meet power demand. China is the world's largest source of soot and sulphur dioxide (SO₂) emissions from coal, which fires three-quarters of the country's power plants. The growth of nitrates, due to a swift rise of coal consumption is also playing an increasing role in the country's acid-rain pollution (Geocases, undated).

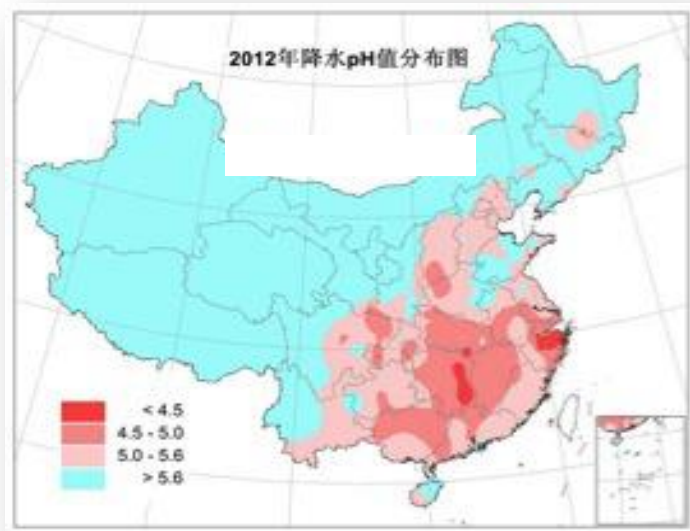


Figure 14: pH distribution in China, 2012 (Tang and Wu, 2012)

The distribution of acid rain is primarily confined to the southern regions of China (Figure 14). The areas prone to the most acidic rainwater are the Chongqing, Sichuan and Guizhou provinces. These areas and the majority of acid rain areas exist south of the Yangtze River (Tang and Wu, 2012). Aquatic ecosystems are vulnerable to acid rain, as leaching from acid rain creates polluted water, which in turn hinders aquatic flora and fauna in lakes and rivers (Bhargava and Bhargava, 2013).

In an effort to decrease the cause of acid rain, which is mainly coal related emissions, the Chinese government has made significant efforts and progress in energy saving and consumption reduction. In industry, the government has taken measures such as the introduction of levying charges for pollution emissions, and issuing licences for discharging air pollutants. It has also promoted the adoption of clean coal, energy conservation and desulphurisation technologies to help with the prevention of acid rain (Geocases, n.d.).

In addition, implementation of pollution levies and prosecution of cases related to non-compliance has improved, with approximately 350 cases involving 282 million yuan (\$44.27 million) in fines for violations of environmental laws during the first seven months of 2015, including 43 million yuan in Hebei province, which surrounds the capital Beijing (Rose, 2015).

According to China's Ministry of Environmental Protection, the emitted levels of sulphur dioxide and nitrogen oxide, both associated with acid rain, were down 4.6 percent and 8.8

percent, respectively, over the same period last year. This is mainly due to the ministry stepping up punitive measures to combat environmental degradation (Rose, 2015).

This was accomplished by updating the Environmental Protection Law (EPL), which came into law on the 1st of January 2015. The updated EPL includes various additions and revisions, the most significant of which include (1) heightened consequences for violating China's environmental laws, (2) expanding the scope of projects subjected to environmental impact assessment requirements, and (3) allowing nongovernmental organizations to take legal action against polluters on behalf of the public interest. The updated EPL imposes significantly greater controls and responsibilities on corporations and local government bodies, while also giving China's environmental regulators and enforcers more "teeth" to incentivize and demand compliance. The five most significant developments included in the new EPL in relation to businesses are (1) increased accountability of polluters; (2) increased accountability of government bodies/officials; (3) increased public disclosure; (4) public interest lawsuits; and (5) protection for whistle-blowers (Falk and Wee, 2014).

Although there are some gaps in the governance structures in China, such as the fragmented and overlapping structure of environmental governance, the Government of China is making strides to ensure the effective implementation and enforcement of its Laws and policies. For example, in 2014, the Central Committee of the Communist Party of China decided to establish a recording, communication and accountability system. The system is intended to limit judicial intervention by government officials, and to integrate promoting the rule of law into the remit of officials at all levels. The system could restrain officials from advising judges on how to decide on court cases, including those pertaining to the EPL (Zhang and Cao, 2015).

The intent of the Government of China to address its challenges in the natural resources governance landscape illustrates a shift from an industry-centralised economy, to an economy that promotes inclusive and sustainable development.

❖ **Moving Towards Cleaner Coal**

Instead of treating the pollution from the coal industry, China has shifted its focus to minimising the pollution. The decline of China's coal consumption and its crackdown on pollution suggests a pivot to clean and green technology. Numbers show that China is on the cusp of a "great reversal" with three separate agencies - the China National Coal Association, the China Electricity Council and the National Energy Administration - reporting a decline in coal use during the first half of 2015. These are not declines in the rate of growth but absolute declines in the amount of coal consumed in power generation as well as energy-intensive industries like steel and cement production (Mathews, 2015).

The decline suggests that the tightened regulation of coal consumption under China's Environmental Protection Law is having an impact. New provisions to the law brought into effect this year include more effective mechanisms to protect the environment and harsher penalties for polluting enterprises. These penalties resulted in the suspension of operations

for 15,000 enterprises in the first half of 2015 and the actual shut down of more than 9,000. While the new law is not without its flaws, it is indicative of the pronounced green direction also espoused in China's 13th five-year plan, which was adopted in draft form in Beijing in October 2015 (Mathews, 2015).

China is not only focusing its efforts on coal consumers, but is also improving efficiency by coal producers. For example, several small mines and inefficient power plants have been closed. According to the IEA, no other country has been able to implement such a wide-scale role-out and restructuring the industry in such a short time-scale. Although several challenges are experienced due to institutional capacity, China has shown the willingness to ensure the long-term successful implementation of this intervention.

In order to meet its development objectives, China is moving is moving towards cleaner coal. In recent years, different Chinese government department have proposed various policies to promote the sound and sustainable development of the coal industry. These policies, laws and regulations encourage the development of high-specification power generation technologies with large capacities, high efficiency, low water usage and effective environmental controls. Successive Five-Year Plans and recent energy and environmental policies provide a framework for sustainable development. In June 2007, China unveiled its National Action Plan for Climate Change, which includes goals to develop clean coal technologies, form more efficient coal mining equipment, to CO₂ capture and storage (CCS) (IEA, 2009).

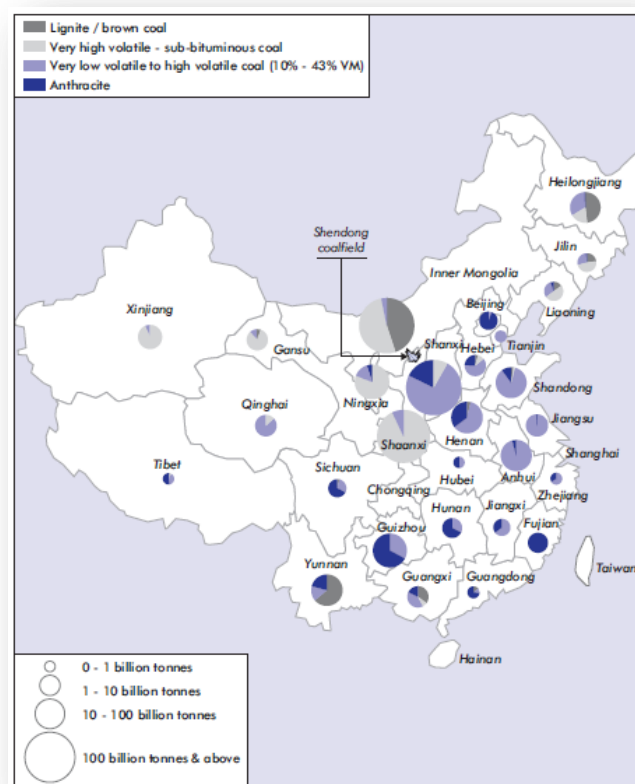


Figure 15: Location of major coal resources in China (IEA, 2009 Adapted from Beijing HL Consulting, 2006)

Experience worldwide shows that deployment of clean coal technologies must encompass the entire coal supply chain, and that parallel progress is needed in technical and non-technical areas for coal to remain an acceptable component in a country's energy mix. China already hosts facilities that feature some of the largest-scale and most-advanced equipment in the world. This success of this is due to China's long recognised need to establish an effective research and development (R&D) platform through the high-level coordination of activities by government, enterprises and research institutes. Government and industry-supported R&D organisations, some with significant budgets, have emerged and evolved (IEA, 2009).

According to Bloomberg New Energy Finance, China's ability to scale-up manufacturing could help bring down prices for renewable energy technologies everywhere. China is already making an impact in terms of investing in non-thermal sources, experimenting with an "everything but the kitchen sink" approach at national, provincial, and local levels. China has also made efforts to reduce thermal generation and stimulate development of photovoltaics. In the short-term, China's clean energy incentives are making significant differences, such as the adoption of a feed-in tariff for solar photovoltaics in 2013 (China Environment Forum, 2014).

What can South Africa learn from this case study?

China's challenges with acid rain were mainly due to the country's dependence on coal as an energy source, an industrial economy, and most importantly a regulatory environment that does not ensure monitoring and compliance of emissions. The combination of regulatory control, political will and implementation flexibility has allowed the government and miners to address the problem in innovative ways. There are several factors that have contributed to the success of the Chinese Government. These include:

- Increasing strategic intent and promoting an enabling institutional environment required to enforce compliance. When compliance and enforcement are key focus areas for governing institutions, regulation becomes possible.
- By changing its regulatory environment, China was able to reduce emissions from pollutants responsible for acid rain. Aligning legislation and being more stringent on the mining and industrial sector requires political will, as well as the institutional capacity to enforce compliance and holding the mining sector accountable (regardless of its contribution to the economy).
- Enforcing the rehabilitation of closed mines, which not only focuses on innovative solutions, but also tried and tested methods (particularly when cost is an issue). This requires the political will to hold the mining sector accountable as well as the institutional capacity to enforce compliance.
- The knowledge that non-compliance with environmental laws exposes companies to legal consequences works as a strategy to force the sector to transition to cleaner coal technologies. Improving monitoring and evaluation of emissions, as well as enforce reporting by industrial companies. Monitoring and evaluation enables enforcement and compliance.
- By creating an enabling environment for the private sector to explore greener options, China has made it easier for the coal industry to explore green technology. It is essential to create an enabling environment for collaboration in the efforts of promoting research and development, and the exploration of green technologies. In addition, the market should enable the growth of the green economy.

According to the study conducted by Josipovic et al. (2011), acidic atmospheric pollution deposition will continue to be a challenge, particularly in the Highveld. Therefore, as in the China context, it is imperative that South Africa continues to reduce emissions by not only increasing the roles and responsibilities of the regulating institutions (including with water managers), but also improving the environment in which those institutions operate. If required, restructuring of roles and responsibilities to enable consistency and alignment between various laws and policies, as well as the mandates of implementing agencies. Institutional strength, coupled with clear roles and responsibilities enables ownership.

Water quality challenge addressed: *Salinisation (Mining and industrial activities) and Acidic atmospheric deposits*

Opportunities met: *Green Economy, Stewardship, Financing Mechanisms, Restoration and Rehabilitation*

Approach employed: *Regulation, Planning and Strategic, Economic Approaches*

4.4 Rehabilitating Abandoned Mines

❖ Strategic Approach in Canada

The United Nations Environment Programme (“UNEP”) has described abandoned mine sites as one of the major outstanding international environmental problems related to mining (Castrilli, 2007). In Canada, the legacy of abandoned mines remains a complex for governments, the mining industry and communities (Canada, 2002). Canada defines orphaned or abandoned mine sites as closed mines whose ownership has reverted to the Crown, either because the owner has retired from business or, as is the case with some historic properties, because no owner can be found. They are also described as mine sites where the owner has ceased or indefinitely suspended advanced exploration, mining, or mine production without rehabilitating the site (MAC, 2001). In order to address the challenge of abandoned mines, the Government of Canada is exploring four types of collaborations, which are focused on funding the cost of rehabilitation. These are outlined below:

First, there are **federal-provincial collaborations**.

Under the Canada-Ontario agreement respecting abandoned uranium mine and mill tailings, each government agrees to cover 50% of perpetual care costs where a producer or owner is unable to pay for clean-up due to bankruptcy, insolvency, or emergency circumstances (Castrilli, 2007).

Second, there are **federal-territorial collaborations**.

Under the Canada-Yukon DTA, Canada is responsible for the remediation of environmental impacts associated with activities that occurred on an abandoned mine site prior to 1 April 2003. In turn, the Yukon is responsible for the remediation of impacts associated with permits or authorizations issued by that government to mining operations after this date (Castrilli, 2007).

The first two types of collaborations noted above (federal-provincial, federal-territorial) are arrangements wherein the totality of environmental clean-up costs mines is paid from public funds. Their advantage is making available a broader base of public funding for clean-up actions. Their disadvantage is that, with only public funds available, the clean-up process may still be very lengthy due to a variety of factors arising from the lack of a permanent dedicated funding source (as opposed to simply monies from consolidated revenue) as well as the overall magnitude of the orphaned/abandoned mine problem (Castrilli, 2007). This recognition stems from the pragmatic perspective that it is in the public interest and that the state benefited from the revenue (taxes) and growth generated from the mining.

Thirdly, there are **federal-industry collaborations**.

Under the 2002 federal mine site reclamation policy for the Northwest Territories, if a mine operator is insolvent and a receiver, interim receiver, or trustee-in-bankruptcy abandons a mine because the unsecured environmental liabilities exceed the economic value of the mine, the federal government will enter into transactions with a purchaser of such an abandoned mine under certain conditions (Castrilli, 2007). These conditions include the following: the purchaser would have limited liability for the existing environmental condition of the property; a portion of the economic value of the production from the mine would be attributed to a fund for the remediation of the existing liabilities at the site; and the purchaser would remain fully liable for the remediation costs of any environmental impact resulting from its own operations at the site (Castrilli, 2007).

Pursuant to this policy, the federal government entered into a variation of this arrangement with respect to the Giant Mine. While the federal environment commissioner commented adversely upon the particulars of this arrangement, in part because it may have departed from some of the conditions set out in the policy, the federal government has defended the arrangement given the circumstances (Castrilli, 2007).

Fourth, there are **provincial-industry collaborations**.

Ontario and Falconbridge entered into an arrangement with respect to the abandoned Kam Kotia mine that granted the company exclusive exploratory rights for five years in exchange for environmental funding of \$50,000 per year toward site clean-up. Ontario also exempted Falconbridge from full clean-up costs respecting existing hazards, unless the company significantly worsened the situation (Castrilli, 2007).

The third and fourth types of collaboration noted above (federal-industry, provincial-industry) have the potential to alleviate some of the government's financial burden, while imposing acceptable liability on the industry. The public purse will fund only part of the clean-up costs and the availability of a broader base of funds can accelerate the response to the problem. One potential disadvantage of these types of collaboration is that they do not tackle systematically the overall orphaned/abandoned mine problem: the sites that may be on Crown land or attract industry interest may not be those most in need of environmental attention. Further, the proportion of public to private funds may (likely will) vary considerably from site to site, as will the terms and conditions of the arrangement, depending on the best "deal" that can be negotiated in the circumstances (Castrilli, 2007).

Canada's provinces have primary jurisdiction over mining because it is about natural resource extraction. The federal government has legislation that covers key aspects of the sector (Canada, 2015). In 2012, significant legislative changes were made, including introducing a new Canadian Environmental Assessment Act, changes to the Fisheries Act and Navigable Waters Protection Act, and an announcement of a review of the Metal Mining Effluent Regulations (MMER) (The Mining Association of Canada, 2016).

While regulating mining activity is primarily the responsibility of the provinces, there are many aspects that require approval from several federal government departments (The Mining

Association of Canada, 2016). The Minister of the Environment is responsible for the Environmental Assessment Act, and administering the MMER under the Fisheries Act. Mining operations which are not captured under the MMER, such as coal mines, diamond mines, quarries, and other non-metallic mineral mining facilities, are subject to the requirements of the Fisheries Act (Canada, 2015).

A robust and efficient federal regulatory system is integral to the success of the industry and Canada's ability to attract mining investment. However, as previously stated, regulating mining activity is primarily the responsibility of the provinces. Therefore, to ensure a smooth and efficient regulatory environment between the provincial and federal government, the Mining Association of Canada is currently promoting the mining industry's needs at the federal level for a reasonable, timely and efficient environmental assessment and permitting process, as well as federal-provincial coordination and a smooth implementation of the above-mentioned legislative changes (The Mining Association of Canada, 2016).

❖ Strategic Approach in Australia

In January 2011, the Ministerial Council on Mineral and Petroleum Resources (MCMPR) and the Minerals Council of Australia (MCA) released their 'Strategic Framework for Managing Abandoned Mines in the Minerals Industry' (Unger, 2011). The framework aims to "promote a strategic approach to managing abandoned mines so that risks are minimised, sites are managed efficiently and sustainably, and the values associated with these sites are recognised". Previously, each state and territory has developed its own approach to managing abandoned mine sites.

Funding the Savage River Rehabilitation Project, Tasmania

This project concerned the rehabilitation activities related to the Savage River Mine, which originally operated as an open cut magnetite mine from 1966 until 1996, resulting in sizeable AMD impacts. Before the mine was re-opened in November 1997, the Tasmanian Government developed and implemented an agreement with the new owners.

Funds for the remediation were provided by both the purchase money and the closure funds left by the original owners. Because these funds were significantly less than what was required to remediate, the Tasmanian Government and the new owners initiated and implemented a cooperative management and remediation regime that allowed for mutual benefit (MCMPR, 2010). The agreement permitted the mine owners to undertake remediation contracts for the Crown to "work off" the purchase price. The statute which was enacted by the government to allow for the remediation provided the mine owners with indemnity against pollution caused by previous operations both existing and that which may occur in the future. (Where pollution is caused or might be caused by previous operations and this may be impacting on Grange's operations or discharges, Grange is indemnified against that emission and the state cannot set emission limits. Grange is however required to operate to best practice environmental management.)

The partnership is producing long-term dividends and aquatic life has improved significantly. This agreement and several others of its kind have proven to be successful in cases where mining takes place on previously mined areas with existing pollution.

The framework promotes convergence of these approaches across jurisdictions, to address issues such as: (1) site inventories and site data management; (2) improved understanding

of liability and risk relating to abandoned mines; (3) improved performance reporting; (4) the standardisation of processes and methodologies; and (4) knowledge and skill sharing across jurisdictions (MCMPR, 2010).

This framework highlights the need for partnerships in the management of abandoned mines, as they enhance the “value for money” on such projects. The proposed funding mechanism for such remedial activities is suggested to be through direct government funding, offset arrangements and partnerships. The MCMPR/MCA emphasises the benefits of partnership, which in the Australian context have proven to be successful in improving the quality of rehabilitation projects, whilst allowing interested stakeholders to be directly involved in the rehabilitation.

What can South Africa learn from this case study?

Canada and Australia had major challenges with the rehabilitation of abandoned mines. By developing financing mechanisms as well as an enabling institutional environment, the two countries were able to rehabilitate mines and therefore minimise the impacts associated with AMD and other mine related impacts in the public interest. These experiences highlight a number of lessons:

- Government playing a crucial role in leading the development and implementation of interventions related to financial mechanisms as well as the actual rehabilitation efforts.
- Developing innovative ways to ensure joint action and access funding in order to implement rehabilitation.
- Developing financial mechanisms that are adaptable, or developing numerous mechanisms for different situations (such as the Canada case). Each mechanism should be applicable to the individual case, as this will increase the possibility of success.
- Promoting alignment of approaches employed in different jurisdictions (such as the Australia case). This enables consistency and assurance of quality of the implementation process.

South Africa is currently ahead of the global practice in terms of initiatives that explore partnerships to strategically address these impacts (e.g. such as in the West Rand and Olifants). However, when it comes to political will and financial backing by the government, South Africa is lagging behind.

Water quality challenge: Acidification and Heavy Metal Contamination (Heavy metals and acidification)

Opportunities met: Stewardship, Financing Mechanisms, Restoration and Rehabilitation

Approach employed: Regulation, Planning and Strategic, Contracts and agreements, Economic Approaches

4.5 Cleaning up the Ganga

The Ganges, also Ganga, is a trans-boundary river of Asia, which flows through the nations of India and Bangladesh. It is the third largest river by discharge (Bluebird Marine Systems, n.d.). The Ganga is India's most important and iconic river. It flows down from the high Himalayas before draining into the Bay of Bengal through the Sunderbans delta, the largest mangrove system in the world. Along its 2,500 km journey, the river enriches huge swathes of agricultural land and sustains a long procession of towns and cities (World Bank, 2015). The Ganga is also the most sacred river to Hindus. It is also a lifeline to millions of Indians who live along its course and depend on it for their daily needs. It is worshipped as the goddess Ganga in Hinduism (Bluebird Marine Systems, n.d.).



Figure 16: A Holy Man prays in the Ganges River (Source: <https://shipbright.wordpress.com/2010/02/08/holy-water-holy-river-the-ganges-the-goddess-of-purity-is-not-well-tibetan-plateau-series-4/>)

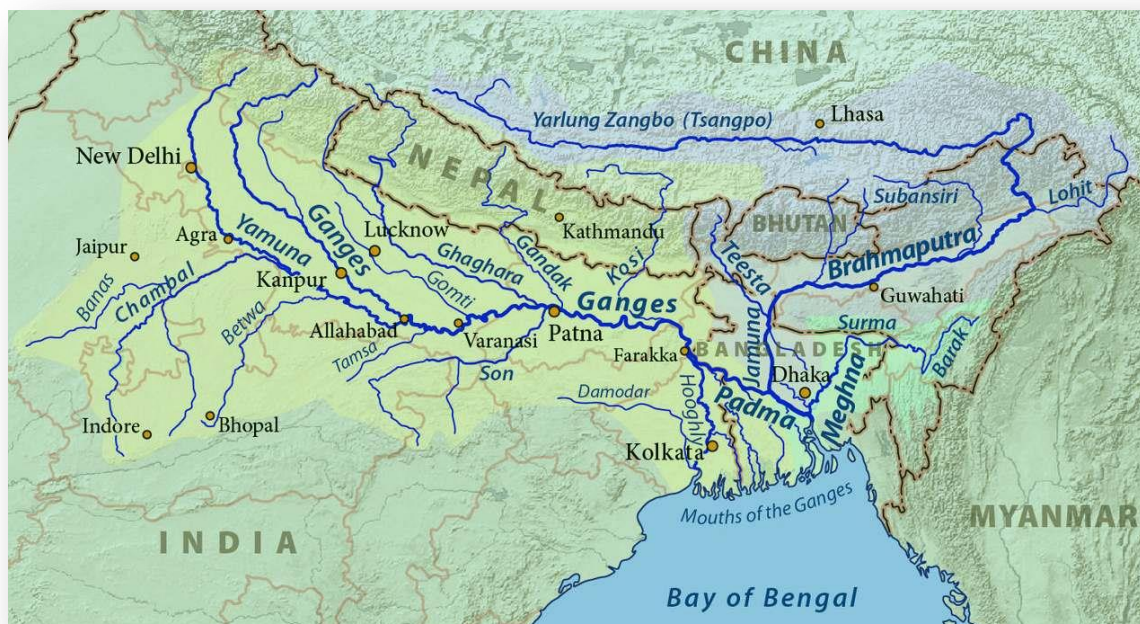


Figure 17: Map of the Ganges/Brahmaputra basin (Source: http://www.bluebird-electric.net/oceanography/Rivers/The_River_Ganges.htm)

Despite this iconic status and religious heritage, the Ganga today is facing formidable pollution pressures, along with the attendant threats to its biodiversity and environmental sustainability. An ever-growing population, together with inadequately planned urbanization and industrialization, has affected the quality of the river's waters. Today, the Ganga's waters are sullied by the incessant outpouring of sewage, as well as by the large volumes of solid and industrial waste that are churned out by human and economic activity along the river's banks.

The Ganges was ranked as the fifth most polluted river of the world in 2007. Pollution threatens not only humans, but also more than 140 fish species, 90 amphibian species and the endangered Ganges river dolphin (Bluebird Marine Systems, n.d.). The absence of adequate infrastructure, along with weak environmental governance and little technical expertise to manage these extreme pollution pressures, has resulted in the rapid deterioration of the water's quality in recent decades (World Bank, 2015).

One of Prime Minister Narendra Modi's election vows was to clean up the river, which sports contaminants from industrial waste to dead bodies. On May 13, 2015, the Modi government announced a Special Ganga Protection Law which will make polluting the Ganga an illegal act, National Mission to Clean Ganga (NMCG). The cabinet has approved "Namami Ganga", or in the name of Ganga, a comprehensive program to clean the river with unprecedented levels of funding (Rs. 20,000 Crores or \$3 Billion) (Sharma, 2015).

PM Modi's government have initiated a new plan that is stricter on polluters and relies on community participation (Sharma, 2015). Many textile operations have been closed due to non-compliance with newly established pollution controls. For example, the area of Tirupur in Tamil Nadu is a textile belt that has suffered from India's crackdown on industrial water pollution. The textile industry is a heavy contributor to the crisis, due to factories discharging coloured effluent from their bleaching and dyeing units. More than 600 dyeing units remained closed for almost two years until a reliable solution was implemented (Bluebird Marine Systems, n.d.).

Yet, many challenges remain on how to reform the religious and industrial polluters, who may not want to adopt new technologies to clean the river. In addition, other challenges include land owners who do not want to give up land to build Sewage Treatment Plants along the river, the defenders of faith who see rising threats to traditional Hindu practices, and ironically from environmentalists who fear that by diverting the water flow the ecology of the river basin is being disturbed (Sharma, 2015). A similar initiative, the Ganga Action Plan, an environmental initiative to clean up the river, has been a major failure thus far, due to corruption, lack of technical expertise, poor environmental planning, and lack of support from religious authorities (Bluebird Marine Systems, n.d.).

The National Ganga River Basin Authority, set up to clean the river will ensure no sewage or industrial effluents are released into the Ganges by 2020, the government has said. The river authority will fund pollution abatement projects on 70/30 cost-sharing basis between central and state governments. This includes a World Bank-assisted National Ganga River Basin

project worth \$1.1bn (£740m, INR 70bn) and a Japan International Cooperation Agency-assisted project at Varanasi. In addition, Germany is also keen on investing in water waste and sewage treatment as well as renewable power sectors, apart from education and healthcare (Bluebird Marine Systems, n.d.).

Although the government of India is showing initiative in cleaning the Ganga, a lot more needs to be done. As a developing country, the economic development agenda also need to promote sustainable development. For example, while on the one hand the Modi government is calling for rejuvenating and cleaning the Ganges, it is simultaneously talking about developing this river in ways that could undermine the rejuvenation efforts. On the table are plans to build 16 new dams across a 1,600-km long stretch of the Ganges between Varanasi and Hooghly. There are also plans to develop the Ganges as a waterway for commercial activities (Ramachandran, 2014).

There misalignment of government priorities, as well as the reliance on the private sector for the country's economic growth, may also create reluctance on clamping down on polluters. In addition, institutional capacity and will is required to implement the political agenda. And lastly, and most importantly, buy-in from the private sector and the communities is required to minimise the amount of pollution in the river. This requires, either the will do to so (by changing behaviour or implementing incentives), or being forced to do so (through compliance and enforcement).

What can South Africa learn from this case study?

Exposed to challenges with the industrial sector, the Government of India is driving the efforts to clean the Ganga Basin. The intent shown by the public sector to clean the basin has also attracted international buy-in, with several other countries and institutions willing to come on board to assist in cleaning the basin. Although significant amounts of money have been, and will be, invested into the initiative, institutional challenges and buy-in from the people of the basin (especially the industrial sector) are a challenge. In addition, the clashing of government agendas is an issue that needs to be addressed (particularly as a developing country that requires the GDP created by the industrial sector). These experiences highlight a number of lessons:

- Political will is required to implement large-scale intervention focused on rehabilitation of degraded water resources.
- Exploring innovative financial mechanisms in order to obtain sustainable finances to rehabilitate the basin is possible, although it requires building the required capacity to source funding and implement rehabilitation and to implement mechanisms that prevent further contamination of the basin.
- It is essential to obtain buy-in from polluters to minimise pollution. This requires being more stringent on the public and settlements, municipalities and the industrial sector, and also enforcing existing legislation. This requires political will, as well as the institutional capacity to enforce compliance.
- It is essential to have development agendas that are aligned and help bring the same overall sustainable development goals. For example, building more dams and/or barrages might not help achieve goals of restoring rivers to the natural habitat.

- It is essential to find innovative solutions to rehabilitate the basin. This could include bringing on board communities (who require employment) to clean up the basin and to monitor contamination and pollution (e.g. physio-chemical properties). In addition, technical solutions such as increasing the flow to 'flush out the basin' could also be viable (as long as the pollution is not merely flushed out to sea).
- Importantly, it is important to build the political will required to hold the mining and industrial sector accountable (regardless of its contribution to the economy) as well as the institutional capacity to enforce compliance.

Water quality challenge: *Salinisation (Industrial Activities)*

Opportunities met: *Green Economy, Stewardship, Financing Mechanisms, Restoration and Rehabilitation*

Approach employed: *Planning and Strategic, Contracts and Agreements, Economic Approaches*

4.6 Land-use, Drainage and Stormwater Management in Urban Environments

❖ Stormwater Management in the Mersey Basin, UK

In the 19th Century, the north-west of England became one of the world's first industrialised regions. The rapid industrial growth brought about the rapid expansion of urban areas. Domestic sewerage systems were based on untreated disposal directly into rivers and sea. Manufacturing industry became established along the region's rivers and new canal system, which served as the major conduits for removing and transporting industrial waste. By the second half of that century the Mersey, and its major tributary (the Irwell), which in 1721 had supported fish as a commercial industry, had become so grossly polluted that a royal commission was appointed to study and report on the problem. However, little priority was attached to addressing these issues by the municipal authorities and, as late as the 1980s, the Mersey was the most polluted estuary and river system in the UK (Jones, 2000).

Throughout the 20th century progressive changes to legislation and institutions, including the formation of ten Regional Water Authorities across the UK in 1974 (including the North West Water Authority which served the Mersey Basin), brought about improvements. Even so, towards the end of the century the region's waterways remained among the most polluted in the world, and industrial decline was manifested in dereliction, poor housing and growing social problems (GIWP, 2015).

This resulted in riots, which caused government policy to begin focusing on the problems of inner cities, and of post-industrial dereliction. A number of targeted regeneration programmes and projects followed, including the Mersey Basin Campaign. The Campaign was established in 1985, with government backing and a 25-year initial life span. Its role was to address the problems of water quality and associated landward dereliction of the River Mersey and its tributaries. (It has since expanded to include the River Ribble in Lancashire) (Mersey Basin Campaign, n.d.).

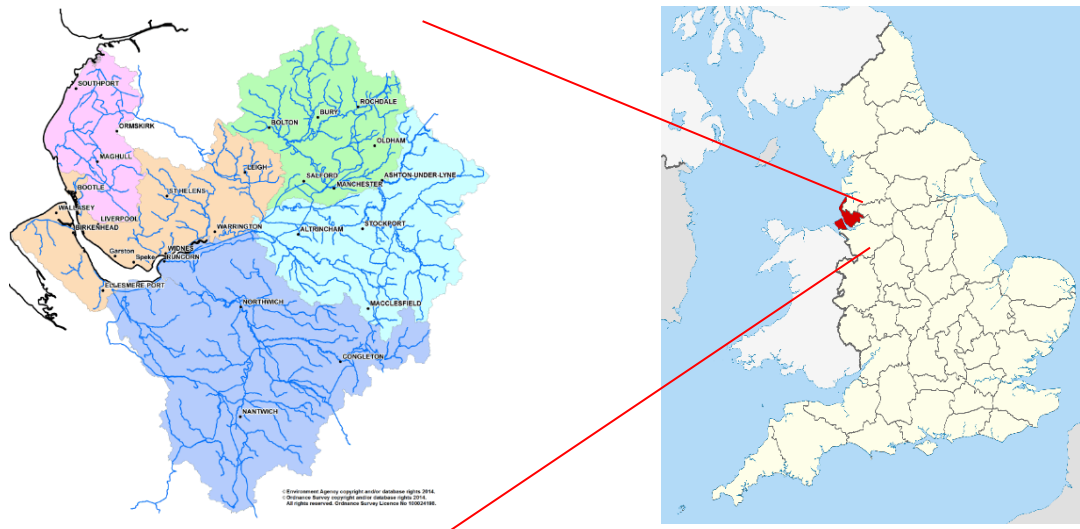


Figure 18: Location of the Mersey Basin (Sources: Healthy Waterways Trust and Ordnance Survey, 2010)

The Campaign would work to improve water quality in the Mersey Basin, thereby stimulating the regeneration of derelict land beside the river and its tributaries (Mersey Basin Campaign, 2016). At the time, there was no national environmental programme for water quality improvements. The Campaign was conceived as a ‘sustainable development’ approach to water quality management and river restoration. This translated into three key aims for the Campaign, identified at the start of the initiative: (1) to improve river quality across the Mersey Basin to at least a ‘fair’ standard by 2010 so that all rivers and streams are clean enough to support fish; (2) to stimulate attractive waterside developments for business, recreation, housing, tourism and heritage; and (3) to encourage people living and working in the Mersey Basin to value and cherish their watercourses and waterfront environments. These three simple, but clear, aims have remained the same throughout the life of the Campaign (Mersey Basin Campaign, n.d.).

The Mersey Basin Campaign broke new ground in British administrative practice with its uniquely collaborative programme. To take action on local stretches of river, the Mersey Basin Campaign set up a network of over 20 Action Partnerships, working closely with volunteers, schools, businesses, local authorities, regulators and politicians on a wide range of improvement projects (Mersey Basin Campaign, 2016).

The scale and complexity of the clean-up programme required in order to deal effectively with the gross water pollution and waterside dereliction was too great for any one authority or agency (Mersey Basin Campaign, n.d.). The management of the operation alone require the establishment of an independent entity. Thus, the Mersey Basin Business Foundation (MBBF), which is a non-profit making limited company with directors from the different partners, carries out the task of overall operational management for the Campaign. The MBBF was the recipient of the central government grant to the Campaign, which amounted

to £0.5m, as well as in-kind contributions from a range of sources (with a financial value of £3.2m in 2004-05).

The successes of the campaign include:

- The return of ecosystems to the river (i.e. porpoise, dolphins and seals in the estuary, and salmon in the river's headwaters)
- The Mersey Waterfront Regional Park regeneration programme that extended round 135km of estuary and coastline within the Liverpool City Region.
- The Speke and Garston Coastal Reserve partnership, which was responsible for the transformation of this derelict land into a safe and flourishing riverside coastal reserve with unique access to the river Mersey.

❖ **Floods Management in Porto Alegre, Brazil**

Porto Alegre is the capital of the State of Rio Grande do Sul, Brazil. The metropolitan area has some 3 million inhabitants and the city county has about 2 million inhabitants (Tucci, n.d.). Over recent decades, Brazilian cities went through accelerated and chaotic urbanization. This process produced major changes in the urban environment, especially significant impacts on water resources (Forgiarini, 2008).

In the event of flooding, Porto Alegre is protected by a system of dykes, storm water and pumping stations designed and constructed before 1970. However, the actual capacity of the drainage is not enough to discharge the upstream increase of flood peak and volume in some parts of the city (Tucci, n.d.). Therefore, greater and more frequent floods and contamination of surface and groundwater sources are major causes for deterioration of the inhabitants' well-being Forgiarini, 2008).



Figure 19: Location of the Porto Alegre (Source: <http://www.lahistoriaconmapas.com/atlas/brazil-map/porto-alegre-brazil-map.htm>)

Flooding in Porto Alegre during October 2015

Approximately 1,500 people were left homeless after a storm brought torrential rain and floods to the city of Porto Alegre in Rio Grande do Sul, Brazil. The storm struck Porto Alegre on Wednesday 14 October 2015 after around 32 mm of rain fell in a 24-hour period. (The area had already see a period of heavy rainfall over the previous days, where over 100 mm of rain fell between 08 and 10 October.) The Guaíba River and Guaíba Lake overflowed, causing flooding in the city.



Image of flooded areas in Porto Alegre (Photo by Daniela Barcellos/ Palácio Piratini)

The dense population (located in informal settlements) is often affected during flood events. Due to illegal connections of sewage into drainage, and large amounts of sediments, litter and debris that aren't managed properly, flood events result in the water contamination. Similarly to most cities in Brazil, flood events result in water-borne illnesses and contaminated drinking water.

Source: <http://floodlist.com/america/brazil-floods-1500-displaced-in-porto-alegre-rio-grande-do-sul>; <http://www.green-lotus.org/wp-content/uploads/2014/07/Water-Management-Yangon-GGP3.pdf> and <http://episcopaldigitalnetwork.com/ens/2015/11/16/brazilian-church-responds-to-floods-notes-climate-change-impact/>

To contribute to improve the socio-economic conditions of Porto Alegre's population and the recovery of the urban environmental conditions of the city through the construction of sanitation and drainage systems. In order to reach these objectives three components will be developed whose specific purposes are: (i) to improve the water quality of the Guaíba lake and Cavalhada River, through the construction of intercepting networks and residual water treatment plant of; (ii) to reduce the risk of floods caused throughout several of the streams that cross the city and nonprotected areas of the Guaíba Lake margins, by means of construction of docks and channels of drainage, and measures of protection against swellings; and (iii) to improve the quality of the environmental management in the Municipality, by means of the implantation of mechanisms of planning, participation, education and control.

Inter-American Development Bank (IDB) approved US\$83.2 million to support the Integrated Socio-environmental Program of Porto Alegre. The program was carried out by the Municipal Department of Management and Strategic Support. This program improved the quality of life of the population of Porto Alegre by restoring water quality along the west side of Lake Guaíba and directly benefitting more than 700,000 residents through expanded public sanitation services and urban environmental improvement.

Source: <http://www.iadb.org/mobile/projects/project.cfm?id=BR-L1081&lang=en>

In Porto Alegre, the Urban Drainage Master Plan serves as a planning mechanism to integrate the development of stormwater infrastructure in harmony with the occupation of the urban areas. The planning aims to prevent economic losses and to improve the environmental hygienic conditions in the city, within the boundaries defined by the Urban Master Plan (Gersonius et al., 2008). The Urban Drainage Master Plan was formulated in phases. The first phase was the proposal for non-structural measures. The non-structural measures consisted of (a) new legislation on source control for developments which has been implemented since March 2000; (b) capacity building in the form of urban drainage education at engineer level; and (c) preparation of a design manual. The second part consisted of a review of the design capacity of the storm water drainage of the basin, which is pumped out from inside the dyke system, and the Plan of six important sub-basins of the city (Tucci, n.d.).

Accordingly urban drainage management has broadened from the originally technical, sectoral discipline (Gersonius et al., 2008). As demand for land in cities is high, it is not possible to assign land purely for flood management purposes – it therefore needs to have an alternative use to ensure that informal settlements do not appear. In Porto Alegre, areas designated for flood control are also used as football pitches to discourage further illegal invasions and squatter settlements (Tucci, 2002). This is crucial for Brazil as urbanisation of cities has been marked by the removal of native vegetation, piping and occupation of lowland and riparian areas, which, in general, tends to aggravate natural floods (Forgiarini, 2008).

However, the adoption of a sustainable approach for the urban stormwater management faces many difficulties, mainly due to data deficiency, uncontrolled urban expansion, lack of legal instruments, lack of knowledge and technical information on infiltration and storage devices, and water quality problems (Gersonius et al., 2008). Therefore, in order to implement the plan successfully, interventions to build institutional capacity were initiated. Through the Brazilian National Program in Flood Management, a technical manual and documents to support urban water plans and related actions was developed. And, most importantly, capacity building interventions and governing institutions was developed. This was a basin on the country's focus on building a sound institutional framework to deal with the Basin Water Management which usually are based on national and State govern management and the Integrated Urban Management which is a municipality management.

Porto Alegre's Resilience Strategy (released January 2016)

Porto Alegre is one of the first cities in the world – and the first in the Global South – to release a Resilience Strategy, a process that is undertaken by all 100RC cities. Over the course of its development, the Resilience Strategy process has enabled Porto Alegre to identify, reorient, and leverage a variety of existing and new projects and initiatives that will make the city more resilient to the social, economic, and physical challenges of the 21st century.

Mayor Fortunati also signed the 10% Resilience Pledge, which commits 10% of the city's budget to defined resilience initiatives and projects, including those included in the strategy. The city is the 23rd to make this commitment, bringing the total amount pledged to approximately \$5.5 billion. Through Porto Alegre's Resilience Strategy, the city is embracing some of its most pressing challenges head-on: flooding, economic diversity, violence, land tenure, urban and rural planning, and a healthy and engaged citizenry.

The Porto Alegre Resilience Office, with strong support from Mayor Fortunati, and the offices of Innovation (INOVAPOA) and Civil Defense, has teamed up with NGO and private sector stakeholders to identify and investigate the root causes and effects of some of the city's most pressing shocks and stresses.

Porto Alegre's Resilience Strategy lays out six strategic objectives, to address a series of interconnected challenges in the city:

Strategic Objective #1: A Porto Alegre with a dynamic and innovative ecosystem. *A diversified economy that fosters creative economies, collaborative and new technologies, develops degraded areas of the city, explores the agricultural productive potential of rural areas, and stimulates the production of organic and family farming.*

Strategic Objective #2: A Porto Alegre with a Culture of Peace. *Access to quality education, preventive health and public safety, focusing on the integration of concepts, practices, and systems, along with the expansion and qualification of preventive, restorative, and collaborative action.*

Strategic Objective #3: A Porto Alegre that responds effectively to risks. *A risk prevention system that is organized and capable of responding to risks, especially the risks of flooding and landslides, to protect families from losing their belongings and avoid displacement – while preventing the occupation of areas susceptible to risk and avoiding environmental accidents.*

Strategic Objective #4: A Porto Alegre that responds to quality mobility. *The public has a system that meets the needs of Porto Alegre with alternative modes, relieved traffic, punctual public transportation, universal accessibility, and sidewalks without damage or irregularities.*

Strategic Objective #5: Porto Alegre that has reformed land regulations. *A process of land regularization able to transition informal settlements, providing basic water, electricity, sanitation and transportation to all. This goal is reached through a dialogue based on trust and collaboration and transparency.*

Strategic Objective #6: Porto Alegre Participatory Budgeting and Resilient Management. *Local governance that promotes a culture of resilience in all city actions and a qualified participatory budget that contributes to the increased resilience of the city.*

Source: <http://www.100resilientcities.org/blog/entry/porto-alegre-releases-latin-americas-first-resilience-strategy-signs-10-res#/-/>

What can South Africa learn from this case study?

There are several factors that have contributed to the success of the catchment-based Mersey Basin Campaign and Porto Alegre strategic land-use planning approach. These include:

- A clear and consistent vision and objective over 25 years (for the based Mersey Basin Campaign). This enables stakeholders to build the required financial and institutional capacity required to implement the interventions. In addition, the basin recognised that basin clean-up efforts are processes that take place over an extended period of time.
- The collaboration with key stakeholders, which are impacted by the poor quality, are responsible for pollution, or are decision-makers. The collaboration was also not only at a strategic level, but also at the implementation level (through the establishment of a separate entity that was accountable to the Campaign's governing body).

- Government buy-in and support was a critical factor to the success of the partnership, particularly by taking a leading role in the governance structure of the collaboration. The support was not only on a collaborative governance level, but also by providing a sustainable funding source.
- Ensuring sustainable sources of finance over 25 years was vital to ensuring the sustainability of the Mersey Basin Campaign. The fiscal funding was supplemented by external funds and in-kind contributions from partners; this enabled successful implementation of campaign.
- Porto Alegre promoted an urban planning landscape that is not focused on infrastructure. This requires moving away from engineering solutions, and focusing research and development efforts in non-structural and integrated/holistic interventions that also aim for sustainable development. These interventions are not only less expensive than infrastructure, but they are easily adaptable to changing environments.
- Evaluating the success or failures of newly implemented strategies in Porto Alegre enabled the role players to adapt their strategies, and to implement measures that ensure the successful implementation of strategies.
- A lack of institutional capacity caused the institutions to be ineffective on implementing the new approach in Porto Alegre. By initially changing the focus from implementing the plan, to building the required capacity to implement the plan, Porto Alegre was eventually able to successfully promote innovative solutions to flood management. In addition, the intervention of the national environment in the capacity building efforts, credibility and quality were ensured. Collaborating with different government institutions when inadequacies are evident (e.g. funds, skills) was crucial for the success of the planning landscape, which ultimately resulted in the development of a resilience strategy with financial backing by the municipality.

Water quality challenge: Urban pollution

Opportunities met: Stewardship, Financing Mechanisms, Restoration and Rehabilitation

Approach employed: Regulation, Planning and Strategic, Economic Approaches

4.7 Evolution of Water Quality Management in the USA

❖ Centralised Water Governance: The Environmental Protection Agency

The U.S. Environmental Protection Agency, formed in December 1970, is a hybrid of various multifarious and frequently conflicting patterns. The Agency was saddled with a difficult regulatory mission: How should ecological goals be balanced with those related to public health and the common law rights of the individual? How should the atmosphere of public and media hysteria be dispelled? How should scientific findings be interpreted and correlated - and their gradations of uncertainty communicated to lawmakers, reporters, and citizens (EPA. 2015).

Laws written by Congress provide the authority for EPA to write regulations, which explain the technical, operational, and legal details necessary to implement laws. Therefore, when Congress writes an environmental law, the EPA implements it by writing regulations. Often, EPA sets national standards that states and tribes enforce through their own regulations. If they fail to meet the national standards, the EPA can help them. The EPA also enforces its own regulations, and helps companies understand the requirements. In addition, the EPA issues policy and guidance documents to assist the public and regulated entities (EPA. 2015).

EPA's purpose is to ensure that:

- *all Americans are protected from significant risks to human health and the environment where they live, learn and work;*
- *national efforts to reduce environmental risk are based on the best available scientific information;*
- *federal laws protecting human health and the environment are enforced fairly and effectively;*
- *environmental protection is an integral consideration in U.S. policies concerning natural resources, human health, economic growth, energy, transportation, agriculture, industry, and international trade, and these factors are similarly considered in establishing environmental policy;*
- *all parts of society -- communities, individuals, businesses, and state, local and tribal governments -- have access to accurate information sufficient to effectively participate in managing human health and environmental risks;*
- *environmental protection contributes to making our communities and ecosystems diverse, sustainable and economically productive; and*
- *the US plays a leadership role in working with other nations to protect the global environment.*

Nearly half of the EPA budget goes into grants to state environmental programs, non-profits, educational institutions, and others. They use the money for a wide variety of projects, from scientific studies that help us make decisions to community clean-ups. Overall, grants help the EPA achieve the overall mission: protect human health and the environment. The EPA also collaborates with businesses, non-profit organizations, and state and local governments through dozens of partnerships. A few examples include conserving water and energy, minimizing greenhouse gases, re-using solid waste, and getting a handle on pesticide risks. In return, the EPA shares information and publicly recognizes the partners (EPA. 2015).

The Office of Inspector General is an independent office within EPA that performs audits, evaluations, and investigations of the Agency and its contractors, to promote economy and efficiency, as well as prevent and detect fraud, waste, and abuse.

The EPA quickly became and today remains involved in many of the most controversial issues in the federal government. Yet the Agency has made important progress over the past 17 years: great strides have been made in cleaning up America's air and water. Especially the highly visible forms of desecration that fueled the crisis mentality of the 1960s. The persistent, organochlorine pesticides of two decades ago, such as DDT, have been largely eliminated, and good progress is being made in dealing with abandoned hazardous waste sites (EPA. 2015).

❖ Water Quality Management

Interest in protecting U.S. waters through legislation started at the beginning of the 20th century with the Rivers and Harbors Act (RHA) of 1899. The RHA included a provision (known as the Refuse Act) that addressed the dumping of refuse into waterways (Downing et al. 2003). Although the RHA with the Refuse Act included many environmental policies, few were actively enforced (Migliaccio et al., 2007).

The next significant water-related legislation was the 1948 Federal Water Pollution Control Act. This act placed responsibility for controlling water pollution on the states and primarily focused on the treatment of sewage wastes (Deason et al. 2001).

In the US, very little attention was paid to water quality until Ohio's Cuyahoga River catching on fire in 1969. On June 22, the Cuyahoga River burst into flames in Cleveland when sparks from a passing train set fire to oil-soaked debris floating on the water's surface. The 1969 fire was not the first time an industrial river in the United States had caught on fire (including a previous fire in the Cuyahoga in 1952), but the last. The flaming Cuyahoga became a figurehead for America's mounting environmental issues and sparked wide-ranging reforms, including the passage of the Clean Water Act and the creation of federal and state environmental protection agencies (Latson, 2015).

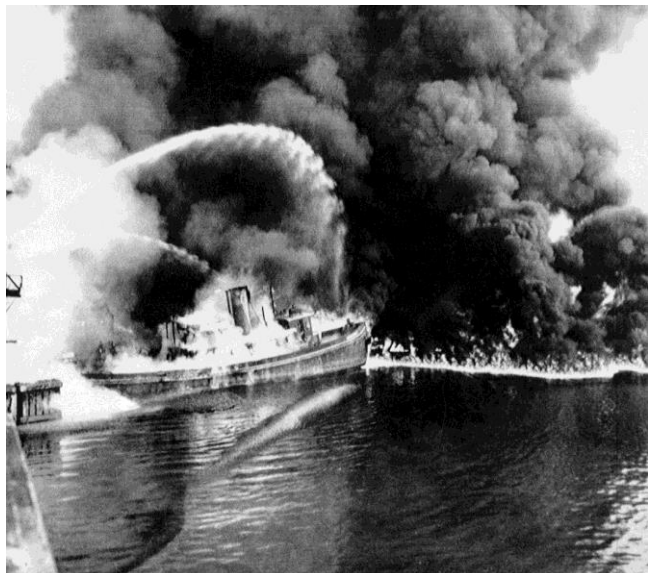


Figure 20: A fire tug fights flames on the Cuyahoga River in Cleveland in 1952 (Source: Latson, 2015)

Amendments to the Water Pollution Control Act were passed in the 1970s to improve the protection of water resources. This was referred to as the 1972 Clean Water Act (CWA). The

CWA identified the goal of restoring waters considering their chemical, physical, and biological integrity. The CWA also set federal requirements for identifying polluted or impaired water bodies and for developing estimated loads of a particular pollutant that could be received by each water body and still meet water quality standards. This concept is often referred to as the Total Maximum Daily Load (TMDL). Additionally, the CWA gave authority to the U.S. Environmental Protection Agency (EPA) to issue permits to major pollutant dischargers and to establish national discharge limitations (Migliaccio et al., 2007).

Thus, early water protection efforts focused on "point sources" of pollution, which refers to pollution from a stationary location or fixed facility, such as a pipe, ditch, ship, or factory smokestack (Migliaccio et al., 2007). When the Clean Water Act was voted into law in 1972, approximately 85 percent of water quality impairments were from "point sources" of pollution, including wastewater and industrial effluent, with only 15 percent composed of runoff from city streets, suburban lawns, and farm fields. More than 40 years later (and after massive investments in structural and highly engineered pipes, pumps and treatment facilities), the pollution distribution today is exactly the opposite, with 85 percent of current water impairments associated with non-point source urban stormwater and agricultural runoff (Scarlet, 2016).

Much U.S. water management infrastructure was built even before the Clean Water Act, and, as communities all across the United States are learning, these pipes, pumps and treatment facilities are inadequate to handle current stormwater pollution, manage floods, and sustain water supplies. Aging infrastructure, inadequate maintenance budgets and a significant and growing funding gap to address infrastructure needs today and into the future are leading issues in the water sector. The waterways and coastal areas are increasingly under threat from worsening pollution caused by stormwater runoff and failing infrastructure. Urban stormwater runoff is recognized as the only major growing source of water pollution in many parts of the United States (Scarlet, 2016).

To protect human health and aquatic life, states, territories and authorized tribes establish water quality standards. Water quality standards are provisions that describe the desired condition of a waterbody or the level of protection or mandate how the desired condition will be expressed or established for such waters in the future. Each state, territory and authorized tribe has its own legal and administrative procedures for adopting water quality standards. In general, standards are developed using a work group process or informal public meetings and are eventually proposed for public comment (EPA, 2016).

To ensure consistency and to maintain credibility, EPA must review and approve or disapprove each submission from a state, territorial, or authorized tribe. Proposed water quality standards must be approved by EPA before they can be used as the basis for actions under the Clean Water Act, such as establishing water quality-based effluent limitations or total maximum daily loads (TMDLs). In certain situations, EPA also consults with tribal governments as well as other federal agencies under the Endangered Species Act (EPA, 2016).

❖ Water Quality Monitoring

The 1972 Act shifted the focus of water quality management, for a time, from control of in-stream water quality conditions to control of discharges to streams via the newly created discharge permit system. In-stream monitoring did not disappear, but questions about its role in management began to surface. Due to reporting requirements, in-stream monitoring was still being conducted, although not as much as before. Hence, during the mid-seventies, the quality of waters began to deteriorate, resulting in new laws being updated. The Council of Environmental Quality (1980) call for more coordination in water quality monitoring (Ward et al., 2003).

The US EPA (1987) published a framework for change in surface water monitoring. The purpose of the report was to initiate an assessment of surface water monitoring with the goal of improving the design of such systems and, ultimately, of improving the information generated for water quality management decision making (Ward et al., 2003). With larger volumes of data to manage than ever before, today's water resource professionals are concerned with ensuring data quality and interoperability. Hence, water managers are implementing clearly documented Quality Management Systems and adopting internationally accepted standard operating procedures (Aquatic Informatics, 2012).

The U.S. Geological Survey (USGS), under the Department of the Interior, provides a centralised service for water quality monitoring, by assessing the quality, quantity, and use of U.S. water resources (USGS, 2016). The USGS provides information on issues such as the suitability of water for public supply and irrigation, aquatic ecosystem health, effects of agriculture and urbanization on water resources, acid rain, and disposal of radioactive waste. Through the integration of its six major water-quality programs (which are independently managed and funded), the USGS organizes and integrates the different activities over time to capitalize upon existing resources. The USGS continues its mission to provide timely and relevant water-resources data and information that is freely available to all levels of government, non-governmental organizations, industry, academia, and the general public (Mallard and Hamilton, 2002).

The USGS works with many other Federal agencies and the private sector to accomplish its science mission through formal memorandums of understanding and memorandums of agreement. Every day 10,000 scientists, technicians, and support staff of the USGS are working in more than 400 locations throughout the United States (USGS, 2016).

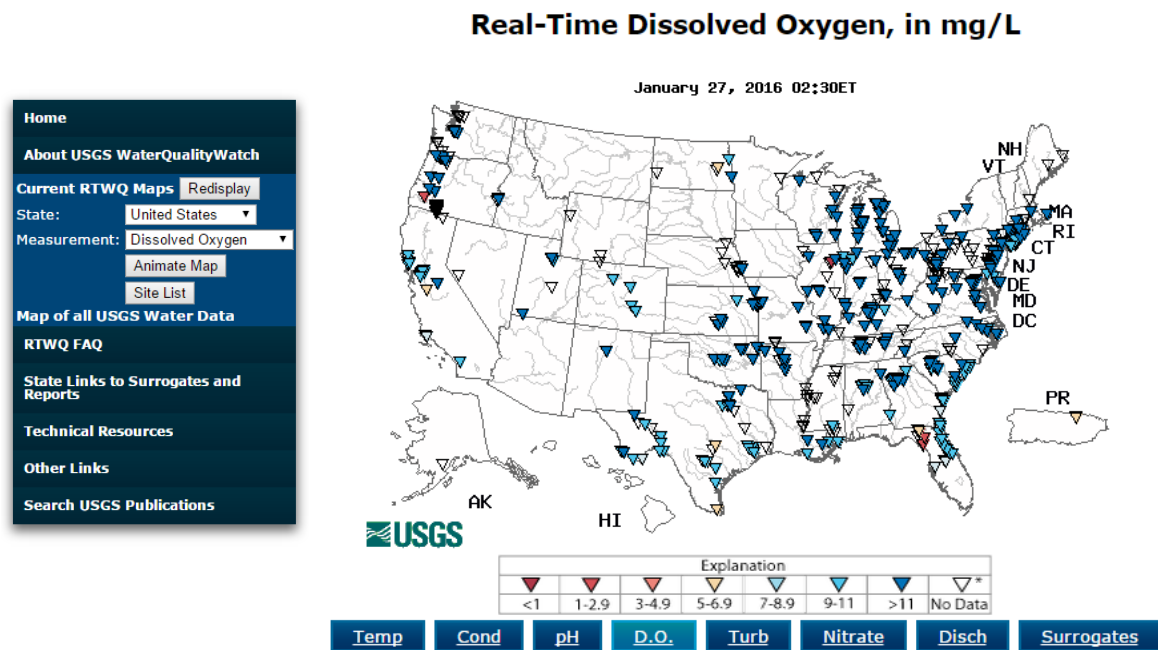


Figure 21: Screenshot of Water Quality Data of the USGS Website (Source: USGS, 2016)

Several other online monitoring portals for national water quality data exist, such as:

- The Water Quality Portal (WQP) is a cooperative service sponsored by USGS, U.S. Environmental Protection Agency (EPA), and National Water Quality Monitoring Council that integrates publicly available water-quality data from the USGS National Water Information System (NWIS) database and the EPA STorage and RETrieval (STORET) data warehouse.
- NWIS-Web is the general online interface to the USGS National Water Information System (NWIS) database. Discrete water-sample and time-series data from 1.5 million sites in all 50 States. Results from 5 million water samples with 90 million water-quality results are available from a wide variety of retrieval methods including standard and customized map interfaces.

Much can be learned about fundamental principles of science and applications of science and technology by looking at global perspectives. In fact, the strategic science themes of USGS are inherently global in nature and need international collaboration in order to make scientific progress (USGS, 2016). Cooperation with various entities to enable monitoring of water quality is also practiced by the industrial sector globally (as shown in the text box below). This is particularly important since there is increased demand for hydrological monitoring networks to serve multiple needs (including reference for climate change and inventory for water availability) and to serve multiple purposes (including water quantity and continuous water quality monitoring) (Aquatic Informatics, 2012).

Insights from the Global Industrial Sector: Water Quality Monitoring

According to a survey conducted by Aquatic Informatics, for the “Global Hydrological Monitoring Industry Survey” in September and October of 2012, with over 100 global participants, meeting the growing information needs of stakeholders is being addressed by the industry through the mass adoption of real-time monitoring and communications technologies. Digital multichannel data loggers and solid state electronic sensors are currently used by 71% and 67% of respondents, respectively. By 2022, automated sample collection and multi-parameter water quality sensors are expected to be used by 43% and 66% of respondents, respectively. With more continuous data being collected, water resource managers are turning to real-time communications technologies for data transmission. Results show that by 2022, the most popular data publishing methods are forecasted to be Web 2.0 (e.g. dynamic content), Web services (e.g. SOAP, REST, WaterML, XML), and mobile device dissemination (e.g. iPhone)(Aquatic Informatics, 2012).

Industry is implementing clearly documented Quality Management Systems and adopting internationally accepted standards. More specifically, 62% of question respondents have adopted “clearly communicated objective(s) for data quality.” 66% of respondents use, or plan to start using, the U.S. Geological Survey (USGS) accepted standard operating procedure reference documents. Water professionals are also turning to the World Meteorological Organization (WMO) and International Standards Organization (ISO), selected by 43% and 39% of participants, respectively. This is good news for the industry – water professionals are working towards a better future with greater data quality, consistency, and interoperability (Aquatic Informatics, 2012).

The majority of organizations represented in the survey co-operate or co-manage at least a component of their monitoring network with other agencies, perhaps as a cost saving measure and to increase the volume of data they need to meet their program goals. Co-operating organizations specified, in order of popularity, included the USGS, state/provincial governments, Water Survey Canada, the US Bureau of Reclamation, and many others (Aquatic Informatics, 2012).

The USGS Water Resources Assessment Team has made strides to equip and train a core group of Afghan engineers and technicians. Activities included compiling existing hydrologic and geologic maps and data and developing ground water monitoring plans for water level and water quality, and surface water monitoring focusing on the **Kabul and Helmand Basins in Afghanistan**. The initial approach consisted of water level and water-quality monitoring, monitoring of rivers and reservoirs, assisting in the installation of a meteorological gaging network, assessing water-resources availability, assessing water management practices, developing a national water resources database, and helping in the initiation of a water quality laboratory at the Afghan Geological Survey in collaboration with Afghan colleagues. The USGS efforts also emphasized on-hands capacity building of colleagues at the Afghan Geological Survey. Some training, equipment, and supplies were provided, institutions were strengthened to the extent possible within the timeframe of the project, development of a water-quality laboratory led by an NGO was overseen, and a national water-resources database was initiated. Training colleagues of the Hydrogeology Group at the Afghan Geological Survey as well as colleagues from other Ministries is proposed to continue and additional capacity building for the Ministry of Water and Energy and Agriculture also is proposed. Finally, a national water resources database will be completed for use by several Afghan Ministries (USGS, 2014). Since 2004 the U.S. Geological Survey has collaborated with the U.S. Department of State's Iraq Transition Assistance Office (ITAO) and the Italian Ministry of Environment and Territory (IMET) in support of the **Iraq Ministry of Water Resources (MoWR)** and their goal of renovating the Iraq National Hydrologic Monitoring Network. An extensive network previously operated by the MoWR had fallen into disrepair after 30 years of neglect, wars, and embargoes. In 2005 and 2006 personnel from USGS Water Science Centers and the Army Corps of Engineers traveled to northern Iraq to establish automated stream gaging stations on the Tigris and Dokan Rivers and to provide training for MoWR engineers on modern stream gaging techniques. In 2007 additional training for MoWR personnel was conducted in Italy that focused on the establishment of a satellite ground station needed for real-time data acquisition. In the fall of 2007 20 engineers and scientists from the MoWR traveled to the USGS Idaho Water Science Center in Boise for 9 weeks of intensive training on a variety of topics related to the establishment and maintenance of a modern hydrologic monitoring network. The USGS continues its involvement with the MoWR by providing technical assistance and training in support of the establishment of 105 new stream gages, 25 water-quality monitoring stations, and 10 snow monitoring stations. The objective of this work is to enable the Iraqis to better manage their valuable water resources which in turn will result in an improved quality of life. A hydrologic assessment project also is being implemented (USGS, 2014).

As one of the world's premier science agencies, the USGS has long recognized the mutual benefits resulting from interaction with scientific partners abroad and extending research and investigations to other countries (USGS, 2016). Efforts have included providing training and building institutional capacity, building hydrological networks, as well as providing equipment and supplies (as shown in the text boxes above).

What can South Africa learn from this case study?

The several factors that can be taken away from this study are outlined below:

- The EPA is critical to aligning to successful water management in the US, as it ensures that new laws are applied correctly, it ensures alignment of regulation and the enforcement of laws, policies and frameworks. It has a simple mission (to protect human health and the environment), and provides the 'centralised' regulatory mechanisms to achieve this. This approach, which obtains financial support, ensures that legislations is implemented by water users.
- Under the Clean Water Act, all States are required to develop water quality standards which enable the implementation of the Act. The EPA is tasked with approving all water quality standards, to ensure that objectives of the CWA are achieved and that the principles for 'good' water quality management are maintained throughout the country.
- The changing nature of the US landscape meant the pollution sources changed from point source pollution to non-point source pollution. The lack of infrastructure maintenance and improvement has become a 'new' challenge, which required a change in the institutional approach. An adaptive institutional environment enable constant progress in water quality management through constant innovation (which is legislated by the local/regional water quality standards).
- The online water quality monitoring approach is based not only building the capacity internally, but also incorporating other monitoring systems that are already functioning. This enables the major focus of the monitoring efforts to not only be on building networks, but also on expanding the currently existing monitoring network.
- Through collaboration, the US is able to lean on the expertise provided by the private sector. This enables the expansion of the water quality monitoring network, and through the USGS, sharing of water related information. The existence of a well-functioning institutional environment that enforces compliance means that the industrial sector is 'forced' to monitor the water resources that the impact on.
- The US is also sharing expertise with other countries, particularly developing countries. This enables knowledge sharing, and thus building the required capacity to monitor water resources properly.

4.8 Funding the Cost of Water Treatment

Even through "all-encompassing policy frameworks for financing can hardly be found" (Mattheiss, Strosser and Rodriguez, 2010), there are various instruments and mechanisms in place that help collating financial resources finances that are employed by the water sector in different countries (ACTeon's. 2010). For example, several countries take the vulnerability of the recipient water body into account (Mexico). In some cases, the use of technologies to treat water can lead to rebates for water users (Czech Republic). On the other side of the

coin, non-compliance fees have to be paid for discharges in several countries if the pollution concentration exceeds permitted levels (China, Colombia, Czech Republic). The number of measured pollutants varies from country to country, but often complex systems of pollution charges are used (Mexico, which found it was necessary to simplify the system). Whereas some schemes cover only direct discharges, others include indirect discharges. In most cases fees/charges are collected at the local level (Australia, China), others at river basin level (Brazil, Colombia) and in some instances nationally (Czech Republic, Mexico, Australia) (DWA, 2012). Several of these approaches are reviewed in the remainder of this chapter. (The box below provides a brief summary of the types of approaches that employed.)

There are different approaches countries for financing IWRM. These include:

- *Financial compensation for environmental services in France; displaying a modern economic approach to water management where water users are requested to contribute financially to the support by dams to ecological river flow in the Loire river basin;*
- *The pesticide tax in Denmark, stressing a relatively successful example of eco-taxation applied to the agriculture sector.*
- *Economic mechanisms for storm water management, a water management issue that receives increasing attention from government and local authorities including in the context of climate change. The paper provides a short review of European experiences with regard to storm water management and flood control.*
- *Water abstraction charge in the Baltic countries, illustrating a rather common instrument that is applied following key principles such as the polluter-pays-principle, the adaptation to the vulnerability of water resources (tax levels being differentiated by sources of water), and the search for increasing water efficiency.*
- *Water abstraction charge in the Baltic countries, illustrating a rather common instrument that is applied following key principles such as the polluter-pays-principle, the adaptation to the vulnerability of water resources (tax levels being differentiated by sources of water), and the search for increasing water efficiency.*
- *Pollution charges for direct discharge of wastewater in Germany, an additional example of the enactment of the polluter-pays-principle on pollution from urban areas.*
- *Working for Water: payment for watershed enhancement in South Africa, the instrument linking poverty alleviation with watershed enhancement that is partially financed through high-water-use-tariffs.*
- *Abstraction charges in the Seine-Normandie River Basin (France); are combined with higher consumption charges (i.e. diversified revenue calculation).*

Source: ACTeon's, 2010

The German scheme, introduced in 1976, is based on pollution units and closely coupled with obedience of emission standards. The Wastewater Charges Act has been enacted in 1976. It has provided a basis for the first eco-tax which is levied at Federal level as a steering instrument. It applies the polluter-pays principle as direct dischargers (municipalities, industry) have to bear at least some of the environmental costs related to their use of water (indirect dischargers are affected by the tax via the ordinary waste water user fee). Exemptions from the charge are e.g. given for wastewater from watercrafts, discharge in underground layers which are naturally not suitable for drinking water supply and other special cases (ACTeon's. 2010).

The pollution charge was established in order to regulate the direct discharge of wastewater into a waterbody (from point sources). It is targeted to provide incentives for reducing the amount and the noxiousness of wastewater (ACTeon's. 2010). Although the level of charges

was too low to achieve the desired water quality objectives through incentive effects alone, even these low charges were shown to have noticeable incentive effects when private abatement costs were lower than the effluent charge (Lovei, 1995).

In some cases, the use of “state of the art” technologies can lead to rebates as, for example, in Germany. The rate is reduced of 75% if certain minimum requirements according to the best available technology are met. Furthermore, certain types of investment designed to improve wastewater treatment may be offset against the charge (ACTeon’s. 2010). Brown and Johnson (1984) demonstrated, for example, that BASF (a large chemical firm) achieved low unit abatement costs by a large-scale integrated treatment process that treated not only the company's own waste water, but the waste of neighboring municipalities as well. Individual branches were subject to implicit effluent charges based on an accounting price per unit of effluent for the branch. The internal charge system resulted in a substantial voluntary decrease in discharge through process change, recycling, and other management responses (Lovei, 1995).

The Länder authorities are responsible to decree implementation laws which set certain details. The funds are collected by the Länder who can also mandate the Kreise (districts) to execute the law (e.g. Bavaria, Brandenburg). The revenue raised by the tax is spent by the Länder authorities on municipal sewage treatment, water quality programmes and on administration (Ecotec 2001).

❖ **Discharge Fee System in Colombia**

Colombia’s first comprehensive environmental law, namely Law 2811 of 1974, establishes the legal foundation for discharge fees. This law contains provisions that allow regulatory authorities to charge fees to for-profit operations to cover the cost of mitigating any damages they inflicted on natural resources. The second environmental law, Law 99 of 1993, also includes provisions for discharge fees. Article 42 mandates that Corporaciones Autónomas Regionales (CARs) and Autoridades Ambientales Urbanas (AAUs) charge “retributive charges” for water effluents. The fees differ from those contained in previous regulations in that they are to be charged to both for-profit and non-profit facilities. In addition, in determining the level of the fees, regulatory authorities are supposed to take into account a broad range of factors, not just administrative costs (DWA, 2012).

Colombia’s discharge fee system follows a simple strategy: in the absence of facility-level information on the marginal costs of pollution abatement and environmental damages, the authorities first set pollution reduction goals in each watershed and then use trial and error to adjust fees until the goals are met. Pollution charges start low and increase every 6 months until they exceed the cost of “cleaner” technologies. The aim is to create incentive-based regulations to give businesses new flexibility in meeting water-pollution standards. This design draws heavily on environmental economics literature on how regulatory authorities should set fees when they lack the facility-level information on the marginal costs of pollution abatement and environmental damages (DWA, 2012).

Colombia's discharge fee program has, however, been beset by a number of serious problems including slow or limited overall implementation in some CARs and AAUs. Additional challenges include significant differences in pollution reduction goals across regional environmental authorities, incomplete coverage of point sources, low fee collection rates in some CARs and AAUs, widespread noncompliance by municipal sewage authorities, and a confused relationship between discharge fees and discharge standards. Despite these challenges, the weight of available evidence suggests that in a significant number of regional jurisdictions, BOD and TSS discharges dropped significantly following the implementation of the system in 1997. This was mainly attributed to significant improvements in permitting, monitoring, and enforcement of both discharge fees and emissions standards (DWA, 2012).

❖ Nile Basin Trust Fund

The Nile Basin Initiative is supported by contributions from the NBI countries themselves and through support from several multilateral and bilateral donors. The financial mechanisms in support of the NBI were designed with several objectives in mind: to maximize riparian ownership and control of the process; to meet donor requirements for fiduciary accountability; and to provide timely and efficient administration of funds. Given the nascent nature of the cooperative Nile institutions, the magnitude of financial resources involved, the imperative for early implementation of projects, a multi-donor trust fund was proposed by the Nile Council of Ministers as the preferred initial funding mechanism (requested in March 2001 and launched in January 2003). This was to allow funds to be transferred according to established disbursement and procurement procedures. The objective is the eventual transfer of the trust fund to a Nile Basin institution as program implementation progresses and a permanent institutional framework established (Pegasys, 2009).

The Nile Basin Initiative

River basin management in the Nile Basin presents challenges that are national, regional and trans-boundary. Throughout the region, forests, woodlands and wetlands are continuously lost as the population seeks out new areas for grazing, farming or burning charcoal from trees. Joint action generates 'public goods' and reduces costs of extreme water events associated with climate variability and change such as flood and drought. Joint river basin management enhances watershed management and conservation of the ecosystems, thereby enhancing integrated water resources management and ensuring sustainable development. The agriculture sector (the broader production sector that includes animal husbandry and fisheries) is of great importance to all Nile Basin countries as it is a major contributor to GDP, employment and food security. Agriculture is also the single largest water consuming sector in the Nile Basin. A regional approach to agriculture development and trade offers the best means of raising income, ensuring adequate food security and accumulating the assets necessary to survive shocks such as droughts and floods. Such an approach also offers a platform for designing interventions geared towards improved water storage and gains in water productivity.

Source: <http://www.nilebasin.org/index.php/nbi-core-functions/water-resource-development>

The NBTF is a funding mechanism that helps administer and harmonize donor partner support pledged to the Nile Basin Initiative (NBI). (The contributors to the NBTF are Canada (CIDA), Denmark (DANIDA), European Commission (EC), Finland, France, Netherlands,

Norway, Sweden (SIDA), United Kingdom (DFID), and the World Bank.) The NBTF has an institutional purpose (as defined above) and specifically supports the preparation and implementation of NBI programs. The majority of funds supporting NBI programs and projects are administered through the NBTF, and it has proven to be a very effective mechanism for harmonizing donor support to the NBI and ensuring a unified and coherent approach to managing funds (Pegasys, 2009).

At the basin-wide level, the NBTF supports strategy, stakeholder engagement through the process of NBI dialogue and engagement; and institutional capacity through strengthen the NBI institutions. At the sub-basin level, the NBTF supports the development of investment programmes (ENSAP and NELSAP); and the preparation and implementation of joint investment projects (Pegasys, 2009).

What can South Africa learn from this case study?

The cost of WQM management is a major challenge in South Africa, and in most countries around the world. In South Africa, various measures have been explored to meet the cost of managing and treating water quality. These have however not been properly implemented. The two case studies explored above illustrate that in addition to implementing measures to obtain costs for treating water from the users, it is often also essential to implement additional measure to ensure success. For example:

- The implementation of incentive for good water management practices entices users to implement measures to reduce their water pollution (such as in Germany). This is particularly useful for the industrial sector, which in the South African context, is responsible for a large portion of the water pollution challenges in the country.
- Government systems and institutions are required to have an enabling environment to successfully implement interventions (as in Colombia). If required, efforts should also be placed on improvement institutional capacity and efficiencies such as permitting, monitoring, enforcement, as well as information sharing.
- Funding obtained from collaborative action – private and stated funding mechanisms:
- Reducing the scale of interventions, as well as the cost of water treatment, increases the likelihood of success. As in Colombia, in each town, a useful strategy was to start with low charges and to increase the charges by trial and error in order to achieve the standards. This however requires institutional capacity and political will, as well as good communication with users.

In addition, as stated in DWS (2015), there is a range of alternative and innovative financing mechanisms available that provide opportunities to support improved WQM. Finances and funds from such sources as the International Climate Fund, the Green Fund, the financial provisions made by the mining industry, pollution charges, WRM charges and DEA's financial provisions (released Nov 2015 which needs to be considered in licensing applications for unconventional gas and is already considered in the water use license procedure), can all contribute. Consideration of these funding alternatives and the management possibilities that they can support will be a key dimension of policy, strategy and implementation planning (DWS, 2015).

4.9 Federal Collaboration in the Rhine River

From its source in Switzerland and Italy, the Rhine flows through France, Germany and the Netherlands into the North Sea. The Rhine is 1 320 km long and has a catchment area of 200.000 km² (Schulte-Wülwer-Leidig, n.d.). The basin is one of the most industrialized and densely populated areas of the world, with approximately 50 million inhabitants (Open University, 2012). Rhine water is used for industrial and agricultural purposes, for energy production, for the disposal of municipal wastewater and for the production of drinking water for more than 30 million people. Furthermore, the Rhine is the natural habitat for a great variety of plants and many birds, fish and other species (Schulte-Wülwer-Leidig, n.d.).

Until recently, countries tended to dump waste into the River Rhine and then leave it to be dealt with by the next country downstream. Parts of the Rhine basin are intensively farmed, and fertilizers and agricultural chemicals also add to pollution in the river. These uses are often at odds with each other; for example, the Netherlands needs Rhine water for irrigation, but the high salinity of the Rhine, which can reach 600 mg l⁻¹ at the Germany–Netherlands border, and comes mainly from French potash mines, can make the water unsuitable for the agricultural sector (Open University, 2012).



Figure 22: The Rhine River (Source: <http://www.rollintl.com/roll/rhine.htm>)

The Rhine River was a free flowing system until 100 years ago when the mainstream was altered into the most important shipping canal in Europe for the transportation of goods. Regulation measures on the mainstream and its tributaries include channelling of the mainstream, construction of dams, weirs, sluices, dikes, and closure of the estuarine river

mouths, which increase water stagnation. The combined effect of human activity, pollution, and river alterations caused a drastic decline in aquatic species.

Although water quality problems in the Rhine were already recognised in the 15th century, the deteriorating quality of the river was not really apparent before the end of the 1960s. By that time, the pollution of the Rhine with organic substances had led to acute oxygen problems in the river and almost all aquatic life had disappeared. Other threats to the river ecosystem were the wastewater discharges of industries, agriculture, traffic and households. Large amounts of heavy metals, pesticides, hydrocarbons and organic chlorine compounds were discharged into the Rhine, causing further ecological problems: disappearance of indigenous species, deterioration of the water quality and sediment pollution. More and more efforts were needed to produce good quality drinking water, and by the end of the sixties the Rhine had the distressing reputation of being the sewer of Europe (Schulte-Wülwer-Leidig, n.d.).

❖ **The Convention of the International Commission for the Protection of the Rhine**

At the insistence of the Netherlands, which was concerned about increased salinity, France, Germany, Luxembourg, the Netherlands, and Switzerland began discussing arrangements for reducing pollution in the 1950s, and formed the International Commission for the Protection of the Rhine against Pollution (ICSR) in 1953 (Open University, 2012).

Within the ICPR, Switzerland, France, Germany, Luxembourg and the Netherlands closely co-operate, while the European Economic Community co-operates in matters pertaining to water. The ICPR was established as the first intergovernmental body for the management of transboundary waters. Although the ICPR originated as a joint monitoring strategy in the 1950s and 1960s, it has become a comprehensive integrated management strategy of the Rhine, comprising aspects of water quality, emission reduction, ecological restoration and flood prevention (Schulte-Wülwer-Leidig, n.d.). This was a technical commission, charged with monitoring pollutants (Open University, 2012).

Progress following the creation of the ICPR remained slow for the next decade due to conflicts between the Dutch, who bore most of the cost of pollution, and France and Germany, where most of the polluting industries were located. To stem increasing pollution from industrial and municipal sources, in 1976 a series of deals were reached resulting in the Convention on the Protection of the Rhine against Pollution by Chlorides (Chlorides Convention) and the Convention for the Protection of the Rhine against Chemical Pollution (Chemical Convention) (Villamayor-Tomas et al., 2014).

The first two decades of co-operation within the ICPR were dedicated to getting a common understanding of the Rhine problems and to creating a legal and institutional basis for cooperation. This first period of cooperation, just after World War II, was essential to create confidence, trust and understanding between the member states. Joint monitoring programmes were developed, but the first joint measures to protect the river against the effects of organic pollution were only taken after 1970. Between 1970 and 1985, successful

programmes were developed to reduce inputs of polluted municipal and industrial wastewater. Oxygen levels steadily rose. Some improvements could be observed in the situation with regard to pollutants. In this period, the main efforts focused on "end-of-pipe" techniques, i.e. wastewater treatment, rather than on preventive measures (Schulte-Wülwer-Leidig, n.d.).

This situation lasted until 1986, and, as often is the case in environmental decision-making, a serious disaster was needed to enable another step forward (Schulte-Wülwer-Leidig, n.d.). On 1st November 1986, another heavy pollution wave, now called the Sandoz Accident occurred in the course of putting out a warehouse (containing 30,000kg of toxic chemicals) fire in Basle, Switzerland. The disastrous chemical spill at Sandoz, Basel was widely considered a turning point in attempts to clean up the Rhine. In response to the Sandoz accident, the ICPR developed the Rhine Action Program (RAP) in 1986 (GIWP, 2015).

RAP sought to produce drinkable water from the Rhine, reduce sediment pollution, and restore the Rhine environment so that aquatic life returns (Open University, 2012). RAP has clearly defined goals to be reached by the year 2000:

- to improve the ecosystem of the Rhine to such an extent that higher species, such as salmon and sea trout, again become indigenous.
- to guarantee the production of drinking water from the Rhine for the future.
- to reduce the pollution of river sediments to such an extent that sludge may at any time be used for land filling or be dumped at sea
- to improve the ecological state of the North Sea (Schulte-Wülwer-Leidig, n.d.).

The first edition of the RAP (1987–2000) was relatively successful. A crucial aspect of that success was continuing threats from the Dutch government and private parties to claim compensation for damages from upstream polluters, as well as Dutch flexibility to adopt innovative measures to clean up or facilitate the discharge of pollutants, and to give financial aid to upstream polluters for their mitigation activities. Subsequent agreements have built on the successes of the RAP, including additions to the Chlorides Convention, new goals for salmon restoration, further agreements between downstream and upstream users, and the renegotiation of the Berne treaty and the RAP (Villamayor-Tomas et al., 2014).

The ICSR parties agreed to a 50% reduction (from 1985 levels) in the discharge of 30 priority pollutants into the river by 1995, and this was achieved. France, Germany, the Netherlands and Switzerland agreed to share costs of \$136 million. In the summer of 1991, the German chemical industry federation agreed to reduce the discharge of toxic chemicals into the Rhine. These international efforts, combined with domestic pollution controls, particularly sewage treatment, have produced measurable benefits: since the early 1970s, concentrations of heavy metals have fallen and biological treatment of organic waste has reduced oxygen depletion and fish deaths (Open University, 2012).

❖ Compliance and Monitoring by the ICPR

The ability of the ICPR to affect pollution patterns depended to a great extent on its ability to link environmental information to polluter behaviour. This observation is associated with two variables, namely the existence of strong environmental monitoring systems and the clarity of the underlying biophysical boundaries of the system. This is mainly due to the fact that information fosters transparency and thus cooperation among users. Also, environmental monitoring permits the assessment and adjustment of management measures to changing local conditions. In the case of the Rhine, environmental monitoring allowed for the emergence of a close-knit scientific community and an advanced understanding of the dynamics and potential solutions to the pollution problem, which was fundamental to assign pollution abatement responsibilities among (Villamayor-Tomas et al., 2014).

The environmental monitoring network in the Rhine is strong in large part because it has a long history and is based on diverse institutions. One of the main accomplishments of the Berne Convention was gathering and publishing information about concentrations of pollutants in the watershed. In the 1970s, the International Commission for the Hydrology of the Rhine Basin (CHR) was created to strengthen data exchange and standardize measuring methods. The Chlorides and Chemicals conventions signed in the mid-70s led to the consolidation of a network of measuring stations that enabled an assessment of the influence of upstream polluters within the Rhine and its main tributaries on pollution concentrations. The increased availability of information and its centralization in the ICPR facilitated the watchdog role played by downstream interest groups and nations and an increasing public awareness of pollution activities by the chemical industry (Villamayor-Tomas et al., 2014).

With the RAP, monitoring efforts expanded from the assessment of ambient concentrations to the supervision of emissions by industrial firms. Over the years, the monitoring program increased the frequency of sampling, the number of parameters measured, as well as the speed of diagnosis and information diffusion in case of major spills or other disasters. This emphasized the need to improve the governance of non-point source pollutants like nitrogen, which currently constitutes one of the main concerns of the ICPR (Villamayor-Tomas et al., 2014).

The development of the monitoring network was facilitated by the relatively clear boundaries of the Rhine's hydrological system and its fit with the boundaries of the governance system. The Rhine's governance system emerged and has evolved as a multi-level enterprise of self-organized actor groups like the riparian nations and the industrial polluters. In pollution cases, clear social boundaries and small group size can facilitate the assignment of pollution abatement responsibilities across different actor groups as well as the emergence and development of cooperation among agents within each group. This seems to have been the case of the group of riparian nations and the industry in the Rhine (Villamayor-Tomas et al., 2014).

❖ **Regulating the ICPR**

The Dutch government played a leadership role at different points in time with mixed results (Verweij 1999; Dieperink 2000). The Dutch government was one of the first governments to create regulations to control pollution at the national level as well as to raise the issue of water quality in the Rhine at the international level. The first steps towards the creation of the ICPR were the result of lobbying by the Dutch national and local governments, and Dutch waterworks associations (Bernauer and Moser 1996; Dieperink 2000; Disco 2007). However, the Dutch lacked authority to enforce agreements on other countries and their credibility was undermined by an adversarial approach to dealing with upstream polluters (Villamayor-Tomas et al., 2014).

The Chemicals Convention did not include any sanctioning mechanism at the international level (Nollkaemper 1996). However, regulations at the national level did and this was effectively used several times by interest groups to force upstream firms to comply with emission limits and/or to compensate downstream users for pollution externalities (Nollkaemper 1990). Additionally, the extensive political and legal activity by national governments within the ICPR in the 1970s was seen by the industrial firms as the prelude to stricter regulations in the Rhine. The interest in anticipating such regulations also motivated firms to reduce emissions (Bernauer and Moser 1996). Later on, the RAP did not add any sanctioning provisions to the governance system; however, it further strengthened monitoring by integrating the industrial sector within the environmental information systems (Villamayor-Tomas et al., 2014).

❖ **Success of the ICPR**

All along the river, measures have been taken to prevent pollution and as early as 1994 the ICPR could report that most of the reduction targets had been reached. In the field of industrial sources, the 50% target had been almost completely met. In particular, the discharges of noxious substances by municipalities and industry fell distinctly. Inputs of most priority substances were reduced by 70 -100% or were no longer detectable. In the year 2000, at the end of the implementation process, almost all reduction targets had been achieved (Schulte-Wülwer-Leidig, n.d.).

More recently, the ICPR and other stakeholders in the basin have successfully implemented urban wastewater management strategies and dramatically improved the water quality of the Rhine. Additionally, in the past 15 years, the adoption of new, integrated policies has resulted in the restoration of a substantial area of floodplains in the densely populated Rhine delta. (This big achievement resulted in the River Rhine receiving the first IRF European *Riverprize* in September 2013 for remarkable achievements in integrated river basin management following a 50-year legacy of river degradation, and subsequently the International *RiverPrize* in 2014) (GIWP, 2015). From being the sewer of Europe in 1970, the Rhine River has developed into one of the cleanest international rivers in Europe (Schulte-Wülwer-Leidig, n.d.).

In a joint initiative, a number of Dutch conservation organisations and the state forest board are proposing the development of multi-functional natural climate buffers, which should increase the amount of space available in this densely populated country to deal with more water while at the same time providing opportunities for recreation and innovations in housing such as floating houses. Part of this initiative is a set of projects that will restore the connections between the Netherlands' largest forest complex, the 100,000 hectares Veluwe. The other ecological 'hubs and important nature areas for the Netherlands are in the neighbouring countries of Germany and Belgium (Hontelez, 2008).

One such project is at the southern edge of Veluwe forest, near the village Renkum, where a corridor reconnects the forest by way of the vale of a small creek, the 'Renkumse Beek', to the floodplains of the Rhine River. The establishment of this corridor required the removal of a small industrial site of 12 hectares but a relocation agreement with the users of the industrial site was achieved. The project required a number of adjustments to the roads and railway tracks that prevented wildlife such as red deer and wild boars from reaching the floodplains. Apart from serving as a corridor for wildlife, the restored meadows will also serve as a reservoir to store water when peak floods are coming down the Rhine River (Hontelez, 2008).

There is a move, over the last few years, to return the river back to its natural state. This is focused largely on the adoption of green infrastructure. For example, over the last 20 years eight green bridges have been constructed in the Netherlands, including the longest green bridge in the world (800 meters), with another 26 planned to be built by 2018. This has significantly increased the living space for wildlife such as red deer, wild boar, badgers, foxes and semi-wild cattle, thereby also increasing the attractiveness of the region for tourism (Hontelez, 2008).

The negative and positive lessons learnt from co-operation in the ICPR may serve as an example for other (international) water management authorities all over the world (Schulte-Wülwer-Leidig, n.d.). Even though international agreements and cooperation have been necessary to reduce pollution of the river, cleaning up polluted rivers or lakes is more complicated when they pass through more than one country. For example, the River Rhine has parts of its catchment in eight countries, and an almost total lack of pollution control has resulted in the Rhine being probably the most polluted large river in the world (Open University, 2012).

The achievements of the Rhine Commission have also triggered and guided further development at EU level, such as the Water Framework Directive of December 2000 and the Directive on the assessment and management of floods (2007). These directives do not only legally underpin the implementation of measures by EU Member States; they have also strengthened the importance of river basin commissions in Europe, as they oblige Member States to coordinate measures at the international river basin level (Schulte-Wülwer-Leidig, n.d.).

What can South Africa learn from this case study?

There are several factors that have contributed to the success of the International Commission for the Protection of the Rhine (ICPR). These include:

- The building of political will from each of the individual countries. Although resulting from a disaster, the combined efforts to share the risks and opportunities by working together resulted in the formation of the partnership. This was mainly due to the sharing of the risks brought about by poor water quality in the basin. Political will enables countries to mobilise the required resources to manage water quality.
- Collaboration and sharing risks between the countries. This includes sharing the costs of remediation, where the financial contribution of each country depends on the country's contribution to the problem. Added to these, each country was tasked with minimising its impact on the Rhine.
- Strong state institutions, with the ability to enforce change (in a collaborative manner) were integral to the success of the collaboration.
- The objectives of the collaboration were straight forward and clear, but were not prescriptive. This enabled countries to innovate and implement a solution that was most applicable for them. Through the course of the collaboration, strategies have included updating water quality regulation to improving wastewater treatment plants. This is particularly important in transboundary countries where national objectives, resources, and institutional capacities are different.
- The national regulations (of each country) were more stringent than the requirements of the ICPR. This meant that enforcing the regulations in each country would enable the collaboration to meet its objectives.
- Established in 1953, the collaboration had a clear and consistent vision and objective. This enables stakeholders and regulating authorities to establish the required regulatory, financial and institutional mechanisms required to successfully meet the objectives of the collaboration. Basin (and water quality) restoration is a long-term issue, therefore political will is required throughout the entire process.
- As the cause of poor water quality was point source pollution, it was essential that the objectives of the collaboration be focused on managing the pollution, instead of getting distracted by numerous pollution challenged.
- Enforcing national regulations meant that each country had to monitor water quality in the tributaries. For effective compliance and monitoring, the monitoring network was expanded, and the sources of pollution identified. This enabled water quality management strategies to be implemented. In addition, as the cause of poor water quality was point source pollution, it was essential that the objectives of the collaboration be focused on managing the pollution, instead of getting distracted by numerous pollution challenged.

Water quality challenge: *Eutrophication (municipal sewage)*

Opportunities met: *Green Economy, Stewardship, Financing Mechanisms, Restoration and Rehabilitation*

Approach employed: *Regulation, Planning and Strategic, Economic Approaches*

4.10 European Union Nitrates Directive: Danube-Black Sea

❖ The EU Nitrates Directive

The Nitrates Directive (1991) aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. The Nitrates Directive forms part of a comprehensive framework of EU legislation to protect the environment. The Nitrates Directive has close links with other EU policies concerning water, air, climate change and agriculture (European Union, 2010).

The Nitrates Directive requires EU member states is to set up “action programmes” for reducing the pollution of their water bodies. In this respect, the Nitrates Directive essentially differs from the EU Water Framework Directive (WFD), the latter requiring that a “good status” of all water bodies be achieved by 2015. The Nitrates Directive requires that surface water and groundwater be monitored to identify which water bodies are polluted by fertilisers. Moreover, it requires the designation of “nitrate vulnerable zones”. For such zones, action programmes with a view to accomplishing the goals of the directive need to be developed (Aqua Press International, n.d.).

Action Programs

Action programmes have to include a set of measures laid down in the Directive, relating to, for example, periods when fertilisation is prohibited, minimum storage capacity for livestock manure, and rules to control the spread of nutrients near water or on slopes, to reduce the risk of contamination. All 27 Member States have drawn up action programmes to cut nitrate pollution, and their quality is improving. Farmers are becoming increasingly positive about environmental protection, exploring new techniques such as manure processing (European Union, 2010).

Most action programmes cover all the vital measures, and all of them include the limit of 170kg nitrogen per hectare per year from livestock manure that is set out in the Directive. But some programmes need to set tougher rules on storage provisions, balanced fertilisation and periods when fertilisers are banned.

- *Storage capacity has increased since the last reporting period, but is still a frequent problem. It has to cater for the periods when applying manure is banned, or impossible due to weather conditions. The main obstacle for farmers is the lack of financial resources, so some extra investment may be needed.*
- *Most farmers comply readily with the rules. Where problems exist, they centre on inaccurate record-keeping and lack of knowledge, especially among smallholders. However, several countries report growing support for environmental protection among farmers.*
- *Cyprus, Hungary and Spain couple fertiliser application rules with regulation of irrigation systems. For example, 85-90% of Cypriot farmers apply advanced irrigation techniques adapted to actual crop needs.*

An expanding monitoring network is demonstrating a trend towards steady or falling nitrate concentrations Under the Nitrates Directive. All Member States have to analyse their waters’ nitrate concentration levels and trophic state. Good monitoring is crucial, and means setting up high-quality monitoring networks for ground, surface and marine waters. There are currently 31 000 groundwater sampling sites in the EU, and 27 000 surface water stations. Belgium, Malta and Denmark have the densest monitoring networks. Every four years, the

European Commission compiles a report on implementation of the Nitrates Directive, based on information from national authorities. In 2008-2009, for the first time, all 27 Member States made formal submissions (European Union, 2010).

Implementation of the Nitrates Directive

The Commission's report for the period 2004-2007 reveals that 15% of groundwater monitoring stations in the EU-27 found nitrate levels above the limit of 50mg of nitrates per litre. On the other hand, 66% reported levels below 25 mg/l. As most of the EU-12 reported for the first time, trends in concentrations were only assessed for the EU-15, where two-thirds of monitoring stations reported steady or falling levels of nitrates, and for Bulgaria, Cyprus, Estonia and Hungary, where 91% of monitoring sites found steady or decreasing levels.

According to data on fresh surface water, 21% of monitoring stations in the EU-27 found nitrate concentrations below 2 mg/l, and only 3% reported more than 50 mg/l. At EU-15 level, 70% of sites reported stable or falling levels of nitrates compared to the period 2000-2003. Austria, Germany, Greece, Finland, Ireland, Luxembourg, Portugal and Sweden detected no surface waters with nitrate levels above 50mg/l.

❖ **Case Study: GEF Strategic Partnership for Nutrient Reduction in the Danube/Black Sea Basin**

Historical attempts at restoration of the Danube River began in the 1940s with the designation of nature reserves. Since that time, restoration has been undertaken across much of the 2800km length of the Danube and its tributaries. However, until relatively recent agreements, including the 1994 Convention for the Protection of the Danube River and the WFD, there had been little coordination of activities at a basin level. Restoration has been a combination of large scale, strategic, multi-project, cross-border restoration projects such as the Lower Danube Green Corridor and the Danube-Mura-Drava UNESCO Biosphere Reserve; and smaller, localised projects such as those in the Isar and Wien rivers (tributaries of the Danube flowing through, respectively, Munich and Vienna). Restoration has been instigated in response to a variety of issues including legislation and international conventions, concerns about urban amenity, biodiversity restoration and community lobbying (GIWP, 2015.).



Figure 23 The Danube River (Source: <http://teacherpages.hallco.org/webpages/tpoole/class.cfm?subpage=947073>)

Agriculture, however, is another major source of water-related problems, such as nutrient pollution, in the basin. Farmers continue to adopt more sustainable practices. Huge efforts

are still needed in order to restore water to optimal quality across the EU (European Union, 2010).

Nutrient pollution is a serious problem throughout the Danube River Basin and can put countries along the basin at risk of not meeting the objectives of the Nitrates Directive. For example, the Black Sea's coastal waters, into which the Danube River flows, 'at risk' from nutrient pollution and 'possibly at risk' from hazardous substances. With over half of the Sea's waters originating from the Danube, the Danube's waters are bound to have considerable impact (ICPDR, 2007).

In the 1970s and 1980s, excessive nutrient pollution led to a severe ecological imbalance in, and the large-scale eutrophication of tens of thousands of square kilometres of, waters in the western Black Sea, as the depletion of oxygen decreased biodiversity and worsened water quality. In 1992, the Danube Basin was site of the first 'international waters regional programme' ever funded by the GEF. By 2001, GEF activities had evolved to become the **Danube Regional Project (DRP)**. The DRP is part of the larger USD 95 million '**GEF Strategic Partnership for Nutrient Reduction in the Danube/Black Sea Basin**' approved in 2001. Additional components of the project include the '**Black Sea Ecosystem Recovery Regional Project**' (which is focused on rehabilitating the six countries along the Black Sea), and the '**Investment Fund for Nutrient Reduction**' (which is implemented by the World Bank and is geared to supporting single-country investment projects for nutrient reduction as well as wetland and floodplain restoration). The partnership aimed to assist countries along the Danube and Black Sea in to address transboundary concerns from nutrient pollution. One of the key achievements of the DRP was to strengthen cooperation between Danube and Black Sea decision-makers (ICPDR, 2007).

One of GEF's largest and perhaps most ambitious water-related projects in the world, its long-term objective is for countries to take measures to reduce nutrient pollution and hazardous substances to levels necessary to permit Black Sea ecosystems to recover to 1960s conditions.

The Carl Bro Project

Funded by the DRP, the Carl Bro project begun in 2001 until June 2007, managed by the UNDP and funded by the Washington D.C.-based Global Environmental Facility (GEF).

Managed from the Danube city of Vienna, the DRP's main goal was to reduce nutrient and toxic pollution to Danube Basin waters. Its main beneficiaries were the 13 Danubian countries that signed the Danube River Protection Convention and are cooperating under the ICPDR. The Dzenopoljac's farm was one of eight that Carl Bro eventually worked with in the area. And building the manure storage was one of 15 'best agricultural practices' (BAPs) that Carl Bro trained the farmers in using. Others included the preparation of fertiliser plans and spreading manure fertiliser on fields between 15 October and 1 March. Some of the BAPs also reduce toxic pollution. In the end, the project found that implementation of the 15 BAPs by the eight farms could annually save the environment from about 14,000 kg of nitrogen, 2000 kg of phosphorus and 250 kg of pesticides.

To avoid a new increase of nutrient loads into the Black Sea, it is essential to adopt best-practice methods to get both point source as well as non-point source emissions in the entire Danube catchment area under control (Aqua Press International, n.d.). New technologies such as manure processing are growing in popularity and offer new ways to deal with

pollution. The reports reveal a growing interest in manure processing initiatives. In livestock intensive areas with high nutrient surpluses, farmers are processing their slurry for easier transport and management. Techniques range from simple separation into solids and liquid, to drying, composting or incineration of solid fractions, and membrane filtration or biological treatment to allow the cleaned liquid fraction to go back into water systems. This is often combined with digestion processes in biogas installations for energy production. Groups of farmers have invested in cooperative installations, notably in Belgium, the Netherlands and Spain. Livestock farmers are also experimenting with new feeding techniques such as low N diets and advanced feeding management, which improve feed conversion efficiency and reduce nutrient excretion (European Union, 2010).

The Danube is also exposed to another source of nutrient pollution, namely ineffective wastewater treatment. This is particularly the case along the downstream portion of the basin, which is composed of the former eastern block countries. The cost of treating polluted water is a major obstacle for countries along the basin. Various innovative solutions have been implemented by both the developed and developing countries in the basin (as discussed in the boxes below).

Wastewater Treatment in Croatia

In Karlovac, Croatia, 60,000 residents were unhappy with the untreated wastewater entering the local Mrežnica and Kupa rivers. Residents never liked how it affected the city's drinking water or local swimming, fishing and boating. With Croatia in the process of joining the EU, the city was going to be declared a 'vulnerable area' under the Nitrates Directive.

Therefore, the Karlovac's water supply and wastewater treatment utility decided to build a new wastewater treatment plant with tertiary treatment – the first time in this country. The sewer network would also be extended to more households.

To pay for the investments, the utility received a total of EUR 36 million in grants and loans from the EC, EBRD and Government of Croatia. The next step was to determine how to best spend the money, how to cover its own operating costs and what price to charge customers. Not long ago, those decisions were made by the state, but has since become the responsibility of engineers who had never received finance training.

"The first step is for utility managers to take an honest look at their true current costs and where they might be losing money now," says András Kis, a Budapestbased consultant working on the DRP sub-project. "Reforms such as reducing leakage from old pipes free up money for new investments."

Seeing that people like Kresimir and his colleagues lacked the necessary financial tools to assess these complex considerations, Karlovac was selected as a demonstration site for the DRP project. Pitesti in Romania was another. "Once Karlovac selects its reforms, then these can be fed into our new decision-making tool called ASTEC," says Kis. "This will then give a range of various prices they can charge consumers for future services." ASTEC tests the impacts of a range of simultaneous considerations on pricing. "With ASTEC, we discovered that many customers weren't paying their bills including 20% of the utility's own employees – a problem we fixed in one week," says Veble.

Household Treatment in Slovakia

Near the Hnilec River, 75 km outside Kosice, Slovakia, residents found it hard to get external funding to clean their wastewater. A project managed by NGO Creative was developed to fill the gap.

A DRP-supported treatment system sends household sewage through pipes funded by the local municipality to improved settling tanks and a newly constructed reedbed that removes nutrients – without using electricity. The system is inexpensive, environmentally friendly and low maintenance, so it's helpful for distant communities in Slovakia and throughout the Danube Basin. The quality of output water released to the creek is double the national standards and helps maintain the quality of the nearby protected EU Natura 2000 meadow lands.

Financing the Cost of Water: Developed vs Underdeveloped Countries along the Danube

Polluted wastewater discharged by Vienna to the Danube is minimal. That's generally the case in the Upper Danube countries of Germany and Austria, in part because they were able to pay for the high costs of advanced wastewater treatment. By doing so, they also met the EU Urban Wastewater Treatment Directive (UWWT), designed to protect the environment from the adverse effects of wastewater from cities and the agro-food industry.

In the countries downstream, however, wastewater treatment was often neglected during communism. As a result, the messy municipal brews of residential and industrial waste are another major source of Danube nutrient pollution. "The UWWT is expected to be the most expensive EU water quality requirement to implement for the new Member States," says ICPDR Technical Expert Mihaela Popovici. "In Romania, it could account for over 45% of the total costs for complying with EU environmental regulations." One UWWT requirement is that wastewater treatment should be 'more stringent' in 'sensitive areas' where water bodies are eutrophic. That could mean introducing 'tertiary treatment' to remove nutrients. And loans and grants to improve treatment are available through the EU and international financing institutions such as the World Bank and EBRD.

As a result of the dense population, the land is intensively used and fragmented, impacting the water resources and ecosystems in the Danube. This is a concern as the Danube serves as an important migration corridor for fish, fowl and other fauna, including the massive Beluga sturgeon, which spends most of its 100-year lifespan in the Black Sea but makes regular trips up the Danube to spawn. The Lower Danube and Danube Delta are especially important as breeding and resting places for some 331 species of birds, including the rare Dalmatian pelican, the White-tailed eagle, as well as 90% of the world's population of Red-breasted geese (WWF, 2015).

The EU and member states have recognized Green Infrastructure as an important tool for conserving biodiversity as well as for regional development, water management and adapting to climate change. In contrast to most "grey" infrastructure such as motorways, bridges, water and sewage treatment plants, "green" infrastructure provides multiple benefits: wetland areas for example help mediate floods and droughts, purify water, provide vital nurseries for fish and habitats for other animals, but also are areas for rest and recreation. Wetlands are important not only for nature but also for humans, providing a host of different services. The wide array of benefits they provide include flood and drought management through holding and slowly releasing water, water purification through filtration, production of natural resources (e.g. fish and reeds), recreation and many others. The value of various benefits from Danube floodplains has been estimated to be at least €500 per hectare per year (WWF, 2015).

In 2000, the governments of Bulgaria, Moldova, Romania, and Ukraine pledged to work together to establish a green corridor on the river's final 1,000 km. Recognizing benefits not only for nature, but also for flood management and water purification, the four governments committed themselves to preserve a total of 935,000 ha and to restore 224,000 ha of former wetland areas. The agreement represents a significant investment and commitment to secure and restore a vital element of Europe's Green Infrastructure (WWF, 2015).

What can South Africa learn from this case study?

There are several factors that have contributed to the success of improving nutrients along the Danube. These include:

- The Nitrates Directive set objectives for monitoring and reporting nitrates pollution that were not very prescriptive. With only a target, countries had the ability to innovate and implement solutions that was most applicable for them. This is particularly important in transboundary countries where national objectives, resources, and institutional capacities are different.
- Countries along the Danube have different economic profiles. This means that each country has different financial resources available to them. While the countries upstream had the ability to implement financing mechanisms where the users pay for services/pollution, the less developed countries had to develop more innovative financial mechanisms. These have included sourcing money from external funding sources, funding from the national fiscus, as well as collaborative efforts and subsidies.
- Implementing basin clean-up efforts is costly, and innovative approaches have the potential to minimise the costs of rehabilitation. The adoption of natural infrastructure to assist in assimilation provides long-term benefits for the basin. Traditional funding sources are financial mechanisms that were explored in the EU, and also provide opportunities for other countries.
- Projects implemented had multiple objectives. This means that projects were not only focused on minimising pollution, but also on promoting development objectives like water access and electricity, as well as natural resource objects like rehabilitation. Financing the treatment of waste water is a development imperative as it promotes sustainable development. Therefore, innovative measures to source water treatment should be a key focus.
- Collaboration between various communities, government agencies and the private sector enabled the sharing of risks (e.g. dirty water for domestic use or not meeting the EU objectives) and the sharing of benefits (e.g. rehabilitation of ecosystems or clean water).

Water quality challenge: *Eutrophication (agriculture)*

Opportunities met: *Green Economy, Stewardship, Financing Mechanisms, Restoration and Rehabilitation*

Approach employed: *Regulation, Planning and Strategic, Economic Approaches*

4.11 Corporate Stewardship

This section provides a brief overview of stewardship efforts that have been initiated by various private companies worldwide, often in partnership with government or nongovernmental organisations.

❖ Basin Stewardship by WWF

Leveraging the extensive local networks, WWF is developing strategies to facilitate collective action and engage communities, businesses and government to improve water management in these basins. The focus on collective action is essential to highlight the shared dependence on and responsibility for this vital resource. As WWF understands water-related risk, and brings stakeholders together to develop solutions, solutions are locally relevant, and allow best practices to flow from basin to basin, continent to continent (WWF, 2015).

The Buyuk Menderes Basin, in Turkey, is faced by pollution and water scarcity, which is caused by and also impacts the textiles, leather, cotton producers sectors. The textile industry is located upstream of the cotton growers (who are therefore impacted by water from the textiles). However the cotton growers also supply products to the textiles industry. This therefore creates a vehicle for engagement (WWF, 2015).

WWF has been working in the basin on wetland habitat protection and wise use of water resources in agriculture. The current water stewardship programme is built on and complement this work. WWF is engaging textiles and leather producers as well as cotton growers on best practice and will leverage this work to develop a collective action platform in the basin. This work also aims to integrate the private sector into the development of the River Basin Management Plan being developed for the Buyuk Menderes basin (WWF, 2015).

The Ganges Basin, or Ganga Basin, in India, is faced by pollution and unsustainable water use challenges caused by the metalware and leather industries. In the basin, WWF is working on improving water management practices of leather SMEs in the city of Kanpur and of metalware SMEs in Moradabad. The research on technical and financial feasibility of various clean technology options for SMEs in these regions will be used to support their adoption by SMEs to reduce pollution and improve water use efficiency. In both cities, WWF plans to develop collective action platforms and potentially a clean-tech funding mechanism with industry, the city administration and in other key stakeholders (WWF, 2015). *(Interestingly, the Government of India is simultaneously involved in efforts to clean up the basin. This is discussed in Section 4.5)*

WWF is currently involved in protective **the Taihu Basin**. In the past 10 years, tremendous amount of resources have been invested by all levels of governments and relevant stakeholders for reducing pollution emissions, improving water quality, maintaining ecosystem health and ensuring safety of drinking water, which resulted in substantial improvements. However, there are still enormous challenges in all aspects of water resource management in Taihu Basin. Therefore, current collaborative efforts (from late 2015) are taking a more holistic approach, which ensures efficiency and effectiveness at all levels, and fully engages the government, enterprises, civil societies and the public. Efforts in the basin are currently focused on government investment, engineering projects, and pollution source control (WWF and Jiangsu Engineering Consulting Center, 2015).

❖ **Collective Action for Groundwater Sustainability: SABMiller in Lima, Peru**

Around 80% of Lima's water supply comes from the Rimac basin, where a growing number of businesses are operating and where SABMiller's subsidiary, Backus, has its main brewery. The growth in demand for water in the Rimac basin is unsustainable, depleting aquifers and effecting water quality. The rapid melting of the Andean glaciers, which are the source of the Rimac, means that the situation is expected to get much worse. This has generated water risks not only for businesses, but also for communities living in the watershed. Acknowledging the situation, Backus, WWF and GIZ entered into a partnership in late 2010, with a view to assess and address the shared water risks to the basin. This is part of the global Water Futures Partnership, which supports on-the-ground partnerships in a growing number of countries, focused on addressing shared water risks through public-private-civil society collective action. The objective of the Peru partnership is to contribute to the improvement and sustainability of groundwater use in Lima, in order to meet the human and industrial demand in the lower watershed (CEO Water Mandate, 2013).

The partnership has followed a focused process involving several phases. The first phase consisted of a preliminary assessment of the water situation, stakeholders, and risks. In a second phase, and in close dialogue with the local municipalities, public-private investment projects have been identified that have high potential to address the identified risks. From these projects, an Aquifer Sustainability Programme has been developed with three overarching themes: improving natural and artificial groundwater recharge, reducing the demand for groundwater, and developing an aquifer monitoring and evaluation body (CEO Water Mandate, 2013).

One of the driving philosophies behind the partnership has been that, although Backus is a significant company, the partners need to generate the collective investment and advocacy among multiple businesses to stand a chance of reducing risk. One of the initial goals of the partnership has been to establish a group of private-sector actors willing to invest in improving the water resource situation. Interest in this initiative has grown rapidly outside the circle of the founding members of the partnership. Therefore, this case study illustrates the importance of attentiveness to the structural and management aspects of effective collective action (CEO Water Mandate, 2013).

❖ **Collaborating for Erosion Management in Honduras**

The Mesoamerican reef contains more than 65 species of coral and is rich in biodiversity, being home to a number of endangered species including sea turtles, the West Indian manatee and various types of crocodile. This unique environment is under severe natural and human-induced threat, which jeopardises the species present and the food security and livelihoods of the inhabitants who rely on these ecosystems. However, due to agricultural activities, the residues of chemicals used to grow crops, together with sediment and soil eroded during cultivation, drain through rivers and streams that comprise the watersheds of the region and find their way to the coral reefs (SABMiller, 2011).

In 2009, Cervecería Hondureña, a SABMiller's Honduran subsidiary, entered into a 5-year partnership with WWF Honduras, with the aim of addressing this problem. Since then, a series of projects have been undertaken, including those working with local farmers who supply sugar cane that is used in our Coca-Cola plant to help them develop more cost effective and sustainable farming practices. By encouraging better water use, and fertiliser and pesticide application, the farmers have been able to increase their efficiency and the productivity of their land, whilst at the same time making their agricultural practices more environmentally sustainable (SABMiller, 2011).

The concept of partnership extends further than just working with farmers: for example, after the installation of an effluent treatment plant in 2010, Cervecería Hondureña found that though the water they were discharging complied with national regulations, the river itself was polluted, as water discharged from the surrounding residential areas was contaminated. Therefore, the treated water from the effluent plant brought no benefit to the surrounding communities. In response to this, Cervecería Hondureña worked with the local government to remove sewage water from the creek and send it to a treatment plant (SABMiller, 2011).

❖ **Coca-Cola involvement in the Latin American Water Funds Partnership**

As water is central to the Coca-Cola Company's business, managing water supplies and stress is a vital commercial consideration. Therefore, beyond the plant level, Coca-Cola has acknowledged that there is a need to participate more holistically in preserving and improving water resources in the regions where they operate and to help conserve the ecosystem services that are critical for the sustainability of the business, including water quality. Where water is stressed, in the markets that they operate, Coca-Cola is at the table and seeks to be a part of the solution (Koch, 2015).

In Latin America, the commitment to the Latin American Water Funds Partnership emerged from this growing understanding that there is a need to invest directly in water resources and ecosystem services. The Coca-Cola Company Latin Center (the Coca-Cola business unit covering countries in Central America and Northern South America) and its local bottling partners, Arca Continental, BEPENZA, and Coca-Cola FEMSA, invested \$7.4 million to replenish 6.9 million cubic metres of watersheds in seven Latin American countries. The funds, which are managed through a partnership between The Nature Conservancy, Fundación FEMSA, the Inter-American Development Bank and FMAM, back a range of conservation projects, from reforestation through to community and farmer education initiatives (Koch, 2015).

❖ **Horticulture in Lake Naivasha, Kenya**

Lake Naivasha is the center of the horticulture industry in Kenya, which is the largest contributor of foreign exchange to the country. The lake is the second largest in Kenya and has traditionally been a valuable resource for irrigation, fishing, farming, livestock grazing, and geothermal energy. However, as a result of over-abstraction, pollution and declining

biodiversity, the water catchment area has come under significant stress jeopardizing industry and livelihoods there. There are large irrigators who conduct commercial horticulture, pastoralists who live a nomadic existence in the region, a vibrant tourism industry, water service providers who supply potable water to local residents, and commercial users, such as the state utility KENGEN, who use water for geothermal electricity. Given these different players with differing interests, only a collective approach can be taken to begin to address the water stress in the region (WWF-UK, 2010).

Industries around Lake Naivasha have taken the initiative to address water use and environmental management by helping to implement Kenya's national water policy, which promotes decentralised governance by user groups. The Lake Naivasha Growers' Group (LNGG), which includes companies such as Homegrown, funded a Water Allocation Plan to guide the establishment of multiple local Water Resource Users' Associations (WRUAs). The LNGG has supported the WRUAs in the area, particularly those in the upper catchment, who significantly impact water availability and quality, in adopting water conservation measures and environmentally friendly livelihood strategies. LANAWRUA, the WRUA responsible for Lake Naivasha and the immediate area around its perimeter, is currently seeking funding with the assistance of the government, CARE International and WWF, to broaden its activities and undertake components of its own Sub-Catchment Management Plan to improve positive water management in the region. This case illustrates the benefits of a group of companies getting together to help implement what is a good national water policy on paper, to help reduce shared risk around the lake (WWF-UK, 2010).

Increasing demands for extraction and increasing likelihood of dry and hot periods under climate change mean that Naivasha faces a severe and immediate water management challenge. Ultimately, a failure to address this challenge threatens hydrological and ecological crisis, and social and economic impacts that will be felt nationally. The risks are shared by government, communities, business and environmental concerns and therefore present a shared opportunity for collaborative action. In a recent assessment by local stakeholders supported by WWF, those opportunities were defined as improving institutions, innovative partnerships and the development of a stewardship standard to guide, incentivise and differentiate responsible water use in the basin. Thus the Alliance for Water Stewardship (AWS) effort responds to local demand in Kenya as well as the international demands of sensitised consumers and retailers (Hepworth et al., 2011.)

The AWS brings together a growing number of organisations into a united, coherent effort to develop an International Water Stewardship Standard (IWSS). The Lake Naivasha case study identifies the importance of collective action and improved performance of statutory water management systems and begins to clarify what responsible suppliers can do to drive better water management both within, and critically, beyond their fence line. According to the AWS, the Kenya case study validates the business case for AWS water stewardship standard. The standard is a valuable tool and will add value to the ongoing process of raising awareness and competence in water management at the sub-catchment level initiated by the Lake Naivasha Grower's Group (LNGG) and now forming the backbone for the implementation of the recently launched Imarisha Naivasha Project (AWS, 2011).

What can South Africa learn from this case study?

Increasingly, the private sector is being recognised as a key actor in supporting the efforts of water resource management and improving access to water resources. This is particularly important as partnerships allow the attainment of objectives through efforts that could not be easily achieved by the private or public sector independently. Partnerships with the private sector thus have the potential to achieve highly ambitious sustainable development goals, especially adequate access to good quality water resources which is a basic human right (DWS, 2015).

The success of these partnerships does however hinge on the functioning of the governance and management aspects of the partnership and individual institutions themselves. In addition, appropriate funding and investment decisions supported by functioning institutional arrangements will enable the success of these solutions (DWS, 2015).

There are a few of these types of partnerships that exist in South Africa. This includes the National Business and Biodiversity Network or NBBN (a partnership between businesses and the DEA) and the Strategic Water Partners Network (SWPN). Through the initiative of the SWPN, there is now for example, an opportunity to solve the water quality challenge in the Olifants Catchment through the establishment of a Mine Water Coordinating Body. Joint action by all relevant role-players will allow for an optimal solution, as well as coherent and integrated catchment-wide water resource management (DWS, 2015).

5. INSIGHTS AND RECOMMENDATIONS FOR SOUTH AFRICA

A key outcome of this review is insight into the changing nature of water quality problems and their management both locally and internationally. These insights can be described as:

- WQ challenges have shifted from predominantly point source to nonpoint sources. This is a consequence of inadequate land-use planning and development and operation and maintenance of waste infrastructure (predominantly urban challenge). Traditional WQ challenges however, still exist, such as traditional agricultural nonpoint sources. As seen in the USA and the Mersey Basin (UK), the changing development landscape presents changes to the WQ challenge, thus requiring adaptive WQM.
- WQM challenges are inherently institutional, financial, economic and social/behavioural, rather than technical. Technical solutions are constantly improving, and therefore require the enabling environment and political will to implement sustainably. As illustrated in the Indus Basin, technical solutions that are financially sustainable require institutions and enabling environments in order to be implemented sustainably. The Ganga Basin study also illustrates that buy-in from all stakeholders is key for effective and sustainable WQM.
- Good WQ monitoring enables enforcement and compliance. Added to this, the timely sharing of data and information allows the development of relevant and applicable WQM interventions, which have a high likelihood to succeed. As illustrated in China, the USA, and in the EU, updating of the monitoring network and monitoring services (such as online monitoring) enables effective enforcement and compliance of laws and regulation.
- Clean tech supported by green economy initiatives and financing mechanisms provides targeted ways of reducing pollution at source. The private sector has a crucial role to play in minimising its impacts on water resources. Collaborative efforts by the private sector and international funding organisations (such as the World Bank) and/or NGOs (such as WWF) illustrate that by sharing water risks, benefits can also be shared. There is therefore a recognition that business risk associated with physical, reputational and/or regulatory impacts has contributed to collective action initiatives associated with new emerging partnerships. This, however, requires an enabling environment for R&D and the promotion on the clean tech industry.
- WQM increasingly requires catchment rehabilitation through a range of rural and urban measures, implying an integrated approach that requires cooperation with other sector regulators. Political will and basin institutions that are leading rehabilitation efforts have been illustrated as key to successful rehabilitation of catchments in Western Australia and the Mersey Basin.
- In the presence of a strong institutional and regulatory landscape, alignment and consistency is an emerging challenge that requires cooperative governance and regulatory/strategic approaches that aim for alignment. As in the USA, a centralised

unit that aligns legislation and fosters the sharing of knowledge, data and WQM skills is essential for sustainable basin management.

- Regulatory and strategic approaches are increasingly focusing on minimising pollution by being stringent on polluting sectors. As illustrated by China, shifting the regulatory approaches to improving monitoring and compliance, and also enforcing the 'polluter pays' principle, forces polluters to minimise pollution and also provides finances to the regulating entity (through taxes or fines). India is also showing intent on implementing this strategy, although institutional challenges are delaying implementation. Innovative land-use planning approaches in Porto Alegre illustrate that all sectors have a role to play in minimising pollution.
- Coherent regulatory regimes and strategic institutional approaches are being supported by appropriate financial mechanisms and cooperative actions within these catchments. Improvement in the Environmental Protection Law (EPL) in China enabled the effective implementation of monitoring and compliance, and therefore emission levies. In Porto Alegre, for example, the recently released Resilience Strategy promotes building resilience by collaboration, participatory budgeting and aligning the strategic intent of the various departments.
- Natural (green) infrastructure is recognised as critical aspect of integrated management of water quality in urban and rural settings. The Danube and Rhine Rivers have shifted basin management efforts (including WQM and flood management) to green approaches that meet water management objectives while also preserving ecosystems.
- Addressing WQ problems requires political will at all levels, because sustained financing and attention is required over a long period of time, and can have short term economic impacts (that are balanced by long-term economic benefits). This has two components. Firstly, basin management is long-term process that requires political will to build the required institutional capacity and financial sustainability. Secondly, there are various economic (and financial) approaches that can be implemented to fund the cost of water management, and the selection of the approach should be depend on the individual context. This can range from pollution charges for direct discharge of wastewater in Germany, or financial compensation for environmental services in France
- Government needs to play a lead role in driving, coordinating and often financing the remediation of critical water quality problems in the public interest, possibly leveraging innovative sources of finance. The Ganga Basin initiative in India illustrates that government needs to drive efforts to remediate water resources, and also source funding. As in India, political will has increased the willingness of international funding entities to be involved in funding the initiatives, and to also build the required institutional and regulatory mechanisms required to rehabilitate the basin.

- Clean tech supported by green economy initiatives and financing mechanisms provides targeted ways of reducing pollution at source. The private sector has a crucial role to play in minimising its impacts on water resources. Collaborative efforts by the private sector and international funding organisations (such as the World Bank) and/or NGOs (such as WWF) illustrate that by sharing water risks, benefits can also be shared. There is therefore a recognition that business risk associated with physical, reputational and/or regulatory impacts has contributed to collective action initiatives associated with new emerging partnerships.
- The SDG implementation provides a valuable opportunity to tackle WQ problems in a coherent manner. A key success of the EU Nitrates Directive is that the interventions implemented by countries (in order to meet the EU objectives) have multiple benefits, such as improving WQ monitoring, providing electricity through biogas, and improving agricultural efficiency.

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APPENDIX A: SUMMARY OF SA POLICY AND LEGISLATURE

Constitution of the Republic of South Africa, 1996

The Constitution caused a paradigm shift in South African environmental policy by providing a right to “an environment that is not harmful to human health or well-being”, and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures. These measures relate to the prevention of pollution and ecological degradation, the promotion of conservation, securing ecologically sustainable development and the utilisation of natural resources while promoting justifiable economic and social development. The constitution also calls for effective, transparent, accountable and coherent government in a manner that does not encroach on the geographic, functional and institutional integrity of other spheres of government.

National Environmental Management Act, 1998

The National Environmental Management Act, 1998, gives legal effect to the internationally agreed principle of sustainable development. This aspect must be taken into consideration in all decisions that may affect the environment. In addition, the Act also provides for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote environmental governance and procedures for co-ordinating environmental management functions.

The Act also stipulates a number of principles providing the framework for environmental management. The principles of specific relevance to this framework policy can be summarised as follows:

- Environmental management must place people and their needs at the forefront of its concern
- Development must be socially, environmentally and economically sustainable
- Access to environmental resources, benefits and services to meet basic human needs and to ensure human well-being must be pursued
- Community well-being and empowerment must be promoted through environmental education and awareness
- Beneficial use of environmental resources must serve the public interest and the environment must be protected as the people’s common heritage.

National Water Act, 1998

The National Water Act, 1998, is the primary statute, providing the legal basis for realising South Africa’s water quality management policy.

The Act stipulates that the water resource of the country is a national asset for which the National Government must act as public trustee. The water resource must be managed to

achieve sustainable water use for the benefit of all users. The use of the water resource in a manner that meets basic human needs and provides for ecologically sustainable development, is enshrined in the Reserve, which enjoys priority by right.

The Act also requires protection of the quality of the water resource (by establishing resource quality objectives) as well as integrated management of all aspects of the water resource. Participation of everyone in the management of the water resource must be promoted by the delegation of management functions to regional and catchment levels. In the management of the water resource, cognisance must be taken of international requirements.

The Act also states specific considerations with the issue of licences. These include the need to redress the results of past racial and gender discrimination, efficient and beneficial use of water in the public interest as well as the socio-economic impact of water use.

Water Services Act, 1997

The Water Services Act, 1997 was promulgated to provide the legislative framework for the effective provision of water services, including for basic human needs. The Act is infused with the spirit of co-operative governance with the emphasis on building capacity at all levels of government. The Act places the responsibility on the different local authorities for service provision. The local authorities may make use of water services providers to ensure that the responsibility is fulfilled. The Act also regulates the use of water for industrial use in that water for industrial use may only be obtained from a source or the distribution system of a water services provider approved by the relevant local authority. The effluent produced by industrial use must also be disposed of as approved by the local authority.

If a local authority exercises any of the powers conferred on it in such a manner that it could result in the quality of the water in the water resources not being maintained fit for use, then the Constitution, National Water Act, 1998 and the Water Services Act, 1997 allow the Minister of the Department of Water Affairs and Forestry to intervene by prescribing measures to be taken by the local authorities or water services providers or by taking measures themselves to ensure that the services are provided in such a way that the quality of the water remains fit for use. The intervention is not related to measures on the water service provision, but to ensure that the quality of the water stays fit for use.

National Water Policy (1997)

The National Water Policy for South Africa was based on 28 fundamental principles. These principles have a bearing on water quality management policy as related to sustainable water use for social and economic benefit; maintenance of the ecological functions of the water resource on which humans depend; equitable access of all user sectors of water to desired quality; and integrated management of water quality and quantity in a manner consistent with broader environmental management approaches. The principles also require the delegation

of water resource management to catchment level for greater participation in the management of the water resource.

The policy also states that the most important objective of water resource management is to promote the well-being of all South Africans, present and future. The policy also alludes to the concepts of “beneficial water use in the public interest” and “optimum” water use.

South African Government Framework

Government is constituted as national, provincial and local spheres of government. According to the Constitution, these spheres are distinctive, interdependent and interrelated. Each sphere contains different organs of state necessary for government to fulfil its obligations. Organisations exercising public powers or performing public functions in terms of legislation are also organs of state, although they do not form part of any sphere of the government. Examples of these are the Catchment Management Agencies and the Water Tribunal. Water User Associations could also be represented on these structures.

The different spheres of government and the organs of state within each sphere may only exercise powers and perform functions conferred upon them. As the policies and activities of one sphere of government or organ may impact on the responsibilities and functioning of another, they are required to follow the principles of co-operative governance and intergovernmental relations as set out in the Constitution. Executive authority is bestowed on each of the three spheres of government. The executive authority constitutes the authority to implement laws and to exercise the powers conferred by those laws.

Intervention in the executive powers of the provincial and local spheres of government may take place in terms of the Constitution. Executive power of intervention is stipulated in terms of specific laws.

National Water Resource Strategies

The National Water Resources Strategy (2004) sets out the policies, strategies, guidelines and procedures for the management of water in the country, as required by the National Water Act, 1998 (No. 36 of 1998). The updated strategy, the National Water Resource Strategy 2 (NWRS-2), released in 2013, aims to “ensure that national water resources are managed towards achieving South Africa’s growth, development and socio-economic priorities in an equitable and sustainable manner over the next five to 10 years.”

The strategy also responds to the priorities set by government in the National Development Plan (NDP) and National Water Act imperatives that support sustainable development. In terms of the National Water Act (Act 36 of 1998), the purpose of the National Water Resource Strategy is to:

- facilitate the proper management of the nation’s water resources

- provide a framework for the protection, use, development, conservation, management and control of water resources for the country as a whole
- provide a framework within which water will be managed at regional or catchment level, in defined water management areas
- provide information about all aspects of water resource management
- identify water-related development opportunities and constraints

Under the NWRS-2 are a number of national thematic plans, including the National Climate Change Strategy for Water Resources (WCCS). The NWRS-2 has been described by the National Climate Change Response White Paper as setting out the short-term response to climate change, with the Water for Growth and Development Framework 2030 seen as the medium to long-term responses. It recognises that climate change will increase the pressure on already stressed water resources, and there is thus a crucial requirement for the effective management, use, allocation and re-allocation of available water resources.

National Water Bill (1998)

Sustainability and equity are identified as central guiding principles in the protection, use, development, conservation, management and control of water resources. These guiding principles recognise the basic human needs of present and future generations, the need to protect water resources, the need to share some water resources with other countries, and the need to promote social and economic development through the use of water.

The department has embarked on a process of introducing major changes to the current policies which process will be used to inform the development of a revised National Water Bill. There are currently four policy documents that underpin the legislations administered by the Minister, which are: White Paper on Water Supply and Sanitation (1994), White Paper on a National Water Policy for South Africa (1997), White Paper on Basic Household Sanitation (2001) and the Strategic Framework for Water Services (2003). (Sanitation provision is governed by the Strategic Framework on Water Services (2003) and the Water Services Act of 1997.)

White Paper in a National Water Policy for South Africa (1997)

The primary objective of the White Paper is to outline guidelines for the management of water, the drafting of effective legislation, and the creation of programmes of action. It aims to promote equity in access to and benefit from the nation's water supply. The White Paper states that it will 'actively promote the values enshrined in the Bill of Rights.' It identifies the right to equality as fundamental to the development of a new water policy. This right requires equitable access by all South Africans to, and benefits from the nation's water resources. It also demands an end to discrimination on the basis of race, class or gender.

The overall management of water resources is based on the principles enshrined in the 'Fundamental Principles and Objectives for a New Water Law for South Africa.' The White Paper identifies the following core objectives:

- The principle of equity is central to the water law reform process. It pays special attention to addressing the needs of those who were historically denied access to water. The White paper seeks to identify the policies, institutions and practices that will support the principle of equity and equitable access.
- To achieve optimum, long-term, environmentally sustainable social and economic benefit for society, National Government must ensure that the country's limited water resources are used to improve the quality of life for all South Africans.

Water for Growth and Development Framework

The WfGD Framework points to the relationship between the availability of water and the many forms of economic activity that depend on the available supply of water of specific levels of quality. The department's position is that the country's economic growth target cannot be achieved at the expense of the ecological sustainability of water resources or meeting people's needs. It wishes to respond to the needs of the different economic sectors and this is best achieved when water supply and the impact of use are factored in during planning. Rather than being an add-on or afterthought, the department's position is that the need for water has to be mainstreamed and placed at the nucleus of all planning decisions in the public and private sector. For water to support economic growth without compromising primary needs or ecological sustainability requires adequate integrated strategic planning. Although the WfGD framework was approved by Cabinet, it was never gazetted. The revised NWRS-2, however, has incorporated aspects of the WfGD that pertain to water resource management as key core strategies.

Water Research Act, 1971

The Water Research Act, 1971 (Act 34 of 1971), provides for the promotion of water related research through a Water Research Commission (WRC) and a Water Research Fund. The Water Research Act is under review to improve the governance of the Water Research Commission and to align the act with all other applicable legislation.

Water Pricing Strategy (2016)

The Water Pricing Strategy sets out the government's approach to pricing raw water. It provides, in principle, for full cost pricing for non-agriculture water users, including depreciation and a return on assets (ROA). In practice, annual price increases have been capped and hence prices are below full cost for most agricultural water schemes and some schemes dedicated to industrial and domestic supply.

The strategy is currently under review (as of January 2016). The review of this strategy seeks to improve the financial viability of government's bulk raw water business to ensure that this scarce resource is valued by all citizens.

National Groundwater Strategy (2002)

Groundwater is a strategic resource in many parts of South Africa, especially in rural areas. It also plays an important role in the supply of water to small towns and villages in the drier parts of the country. There is considerable potential for additional development of groundwater resources to augment existing resources. The need for improved groundwater management to ensure sustainable and efficient use of the resource was recognised in NWRS-1 and led to the formulation of a National Groundwater Strategy through which strategic actions were undertaken.

Reuse Strategy

The DWS has developed a water reuse strategy to encourage informed decisions relating to water reuse. Reuse could be increased significantly with return flows in coastal cities, where it would otherwise drain into the sea. In coastal cities, water reuse and desalination compete as two options for water conservation. Reuse is becoming increasingly acceptable and feasible owing to increasing shortages, improved purification technology and decreasing treatment costs. Membrane technologies, also used for desalination of seawater, have become more affordable and have improved. The reuse of treated waste water would be managed to ensure public health safety.

Desalination strategy

The department has developed a supporting desalination strategy, which also includes desalination as a technology for treating water other than seawater for water reuse. Desalination of seawater could potentially provide an unlimited resource of fresh water. However, the rising cost of energy may be a deterrent. As with other infrastructure projects with potential environmental impacts, the planning for a desalination plant will have to undergo an environmental impact assessment in compliance with Nema of 1998. The DWS will ensure that desalination is considered as an option for meeting future water requirements, in particular in coastal cities where there is sufficient electricity for desalination. The target is not only to implement desalination in several locations in South Africa, but also to become an international knowledge centre in this particular field.

National Water Quality Management Framework Policy (2002)

The water quality management framework policy applies to all components of the water resource, that is, watercourses, surface and groundwater bodies, wetlands and estuaries. The policy also covers marine resources in so far as the water quality of these resources could be affected by water use. This policy builds on the Department's water quality management policy entitled, "Water Quality Management Policies and Strategies in the RSA" which was released in 1991. This policy is also aligned with related overarching policies and legislation. It takes into consideration not only the latest global trends in water quality management but also the current political, social and economic imperatives of South Africa.

Strategic Framework for National Water Resource Quality Monitoring Programmes

The Department of Water Affairs and Forestry developed the framework to ensure that national water resource quality monitoring programmes comply with the requirements of the National Water Act (Act No. 36 of 1998) and that these programmes are effectively implemented. This framework is to serve as a basis for reviewing the design of current programmes and for designing new programmes. A description is also given of the roles and responsibilities of the different tiers of water management institutions with respect water resource quality monitoring. The framework clarifies how national monitoring programmes fit into the bigger scheme of water resource quality monitoring. The strategy also addresses the issue of establishing the capacity required to develop and maintain programmes and to provide some generic guidelines for designing monitoring programmes.