ANNUAL NATIONAL STATE OF WATER REPORT

FOR THE

HYDROLOGICAL YEAR 2012/2013

water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

THE ANNUAL NATIONAL STATE OF WATER RESOURCES REPORT

OCTOBER 2012 TO SEPTEMBER 2013

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Date: 24/04/2014

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Date: 2014/06/05

ACKNOWLEDGEMENTS

The Directorate: Water Resource Information Programmes (WRIP) under the Chief Directorate: Water Resource Information Management of the Department of Water Affairs is responsible for facilitating the production the annual national state of water resources report.

The report is a collaborative effort of all the Directorates within the Chief Directorates: Water Resources Information Management (WRIM) namely; Resource Quality Services (RQS), Spatial and Land Information Management (SLIM) and Hydrological Services (HS). The Directorates from the Chief Directorates: Integrated Water Resource Planning (IWRP), Resource Directed Measures (RDM), Water Regulations and Water Services also contributed to this report. South African Weather Service provided some information and maps. The WRIP would like to thank all the people who contributed towards the production of this report.

EXECUTIVE SUMMARY

In South Africa freshwater is a scarce resource with high temporal and spatial variable rainfall. The situation is exacerbated by the increasing water demand, pollution, unsustainable use, and climate change. Water is critical for sustainable economic and social development as well as for maintaining healthy ecosystems. With the available water the Department of Water Affairs (DWA) has to ensure access to water for all and reallocate water to allow equal opportunities. The challenge the DWA has is to get water where it is most required. It is therefore crucial that water be conserved, managed and developed in an environmentally sound manner to achieve socio-economic development. To address some of the problems the DWA is developing infrastructure for bulk water to transport and transfer water. For effective management of challenges in water resources, water must be managed and developed in an integrated manner.

This report presents the status quo of the country's water resources for the hydrological year 2012/13. In general, 2012/13 experienced more rain than the previous year but was low if compared to previous five years excluding 2011/12. Less rainfall resulted in most areas in the country experiencing dry to very dry conditions. This resulted in low dam storages in areas such as North West, Free State and Northern Cape Provinces. Although the country generally experienced less rainfall, there were selected areas that were hit by flooding. This was due to heavy rains that fell during December, January and April. Temperatures have been gradually increasing over the years and 2012/13 was no exception. At the same time very low temperatures resulted in snow fall in Western Cape Province.

The less rain received, accompanied by high temperatures and high evaporation rates, translated into less runoff resulting in low national water storage levels. However, heavy rainfall in isolated areas increased the runoffs resulting in high to very high dam storages in those areas. However, the national water storage for 2012/13 was still low compared to the last six years. The low dam levels resulted in some areas imposing water restrictions as an effort to conserve water. The general trend in groundwater levels is that they are declining due to over-abstraction in some parts. The decline could also be due to the less rainfall and very dry conditions. However, groundwater situation in some areas is dependent on local conditions and abstractions, and can deviate from general trend.

The land based activities such as agriculture, industries, mining, and human settlements impact ecosystems by introducing pollution that alter the quality of water resources. The pollutants alter the biological, chemical and physical characteristics of water; often rendering it unfit for use and/or consumption. Pollution also compromises the health of riverine biota; indicators of the health of the river. Runoffs from irrigation bring nutrients and salts from fertilisers used in farming into the resource. Defunct mines discharge acid water into the environment which might end up in the river. It is therefore important that water resources are monitored for quantity, quality and use to ensure protection for sustainable use. The DWA has established monitoring networks and/or programmes which collect data on the quality of surface and groundwater resources.

The main water quality problems experienced in the country are eutrophication, microbial pollution, salinisation and acid mine drainage. More dams are either hypertrophic or eutrophic. Observations have been that few dams improve during winter and others during summer. The Crocodile West/Marico, Olifants, Berg, Gouritz are some of the WMAs most affected by the microbial pollution and there is high potential health risk when drinking, irrigating and using water for recreation. The problem of salinisation is significant in the western and southern parts of the cape and is mainly due to saltwater intrusion. In the Lower Vaal the problem is caused by mining activities and runoff from agricultural activities. The quality of groundwater is of acceptable standards. However areas such as the western part of the Northern Cape and the northern part of the Western Cape Provinces show very high electrical conductivity. Significant strides have been taken by the Department of Water Affairs in dealing with the problem of acid mine drainage in the Witwatersrand Basin. In Newcastle, Dundee, Utrecht and Vryheid, defunct mines are discharging acid mine water in the streams and not much is being done to protect the environment.

The Department has put in place measures to ensure the protection of water resources and sustainable use. These include Resource Directed Measures (RDM), Source Directed Controls (SDC) and river health programmes. The RDM aims at achieving a balance between protection and use of water in order to achieve socio-economic development. Classification process has started in few WMAs. The reserves are undertaken in the catchments of priority. Few comprehensive reserves have been undertaken and completed because the process is complex and time consuming. The majority of reserves undertaken during this period are Desktop.

The Waste Discharge Pricing Strategy and the Green Drop Certification Programme are some of the strategies put in place to protect water resources and ensure sustainable use. The Blue Drop programme aims at improving the functioning of Water Treatment Plants to ensure they supply good quality water to communities. Every year there is an improvement observed in the performance of municipalities and in the quality of water.

Water Use licensing is done to ensure water is used sustainably and equitably. A total of 91 licences have been completed and signed off during this period. About 1/5 of total licences were for Historically Disadvantaged Individuals. The backlog for licence issuing has been reduced but there is a challenge in eliminating it totally as applications with incomplete information are submitted all the time. All the information on water use is stored in the Water Authorization Registration Management System. The available data still show agriculture as the major user of water followed by domestic use. The Upper Vaal Water Management Areas has registered the highest volumes of water use and the Thukela has the lowest volume of water use.

The report only provides a synopsis of the status of water resources in the country. This form of reporting is important as it provides an overview of the county's water situation thus enabling managers to make prompt and informed decisions with regards to the management of the resource. The report is also aimed at informing the stakeholders and the general public of the status of the country's water resources.

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ACRONYMS AND ABBREVIATIONS

AMD	Acid Mine Drainage
BBBEE	Broad Based Black Economic Empowerment
CMA	Catchment Management Agency
CSIRO	Commonwealth Scientific and Industrial Research organisation
DWA	Department of Water Affairs
EC	Electrical Conductivity
E. Coli	Escherichia Coli
ET	Evapotranspiration
FSC	Full Supply Capacity
GA	General Authorization
GCM	Global Circulation Models
GRA	Groundwater Resource Assessment
GWP	Global Water Partnership
HDIs	Historically Disadvantaged Individuals
IGRAC	International Groundwater Resources Assessment Centre
IWRM	Integrated Water Resources Management
IWRP	Integrated Water Resources Planning
IPCC	Intergovernmental Panel on Climate Change
KZN	KwaZulu-Natal
LHWP	Lesotho Highlands Water Project
LMWL	Local Meteoric Water Line
MCM	Mixing Cell Model
NEMP	National Eutrophication Monitoring Programme
NESMP	National Estuarine Monitoring Programme
NGA	National Groundwater Archive
NGIS	National Groundwater Information System
NMMP	National Microbial Monitoring Programme
NRMP	National Radioactivity Monitoring Programme
NRW	Non-Revenue Water
NTMP	National Toxicity Monitoring Programme
NWA	National Water Act
NWRS	National Water Resources Strategy
RDM	Resource Directed Measures
RHP	River Health Programme
RQOs	Resource Quality Objectives
RQS	Resource Quality Services
RSA	Republic of South Africa

SADC	Southern African Development Community
SANBI	South African National Biodiversity Institute
SAWS	South African Weather Service
SDC	Source Directed Controls
SLIM	Spatial and Land Information Management
SPI	Standardised Precipitation Index
TDS	Total Dissolved Solid
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN	United Nations
UN SD	United Nations Sustainable Development
WARMS	Water Authorisation Registration Management System
WAS	Water Accounting System
WC/WDM	Water Conservation and Water Demand Management
WfW	Working for Wetlands
WMA	Water Management Area
WMS	Water Management Systems
WRC	Water Research Commission
WRCS	Water Resource Classification System
WRIM	Water Resource Information Management
WRIP	Water Resource Information Programmes
WWTW	Wastewater Treatment Works

1. Introduction

1.1 Purpose of the report

The aim of the report is to give an overview of the status and trends of the country's water resources during the hydrological year. The objectives of reporting are to provide information on factors that have impact and sustainable use of the country's water resources; highlight issues that need to be addressed, emerging water problems and important information gaps and promote better management and protection of our water resources.

The report is driven largely by the national and international expectations for reporting on the water situation in the country. The information on the report could be used to contribute to the World Water Development Report for the World Water Assessment Programme.

1.2 Setting the scene

South Africa is a water scarce country with high temporal and spatial variable rainfall. This has resulted in water being in surplus in other areas and in deficient in others. In South Africa, availability and demand patterns differ substantially between catchments further emphasizing the need to understand and manage water resources with active user participation at the catchment level. The water demand, which is increasing due to economic growth and development, is also a factor in the availability of water as it is more than the supply. As a developing country, South Africa has to grow its economy and that comes with certain demands on natural resources. With the available water the Department of Water Affairs (DWA) has to ensure access to water for all and reallocate water to allow equal opportunities. Also, the DWA has to ensure efficient use, protection, development and management of water resources. The challenge the DWA has is to get water where it is most required. In most cases water is in surplus where it is not desperately needed as those areas are not developed to warrant big demand. To address the problem the DWA has embarked in the development of infrastructure for bulk water such as building pipelines for transporting of transferring water from one catchment to another.

One of the major issues in water management is sustainable development, which is typically assessed by managing the level of abstractions and diversions within an area against the level of entitlements and total water resource. Most abstractions and diversions are licensed however there are notable exceptions such as farm dams, interception of runoff, recharge by forestry and flood harvesting. The country is facing various challenges with regard to its water resources and its management. Various concerns have been raised regarding pollution and resource quality, water security for both social and economic development. Land use, especially the land based activities and their poor management practices impacts directly on the quality and quantity of water resources in the catchment. The land based activities such as mining, agriculture; waste disposal, industries, and development are contributors to the water quality problems for both surface and groundwater. Contamination from these activities is mainly diffuse and is therefore wide spread. It is usually difficult to detect pollution before it has impacted the water resources.

To effectively address the challenges in water resources management, it is important that water is managed and developed in an integrated manner. The adopted integrated water resources management (IWRM) approach is geared at addressing the challenges. The IWRM is defined as a process that 'promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems " (GWP, 2000). It implies that all the different uses of water resources are considered together (*World Water Development Report, 2012*).

Population growth in the country is projected to increase and putting a lot of pressure on the country's already dwindling resources. At the same time urban populations are increasing significantly. The situation is exacerbated by the migration of people from rural areas to look for work in the cities. This is creating a problem in terms of housing, inadequate access to sanitation and safe water to name the few. The informal settlements are coming up at an alarming rate and are the main source of point-source pollution. Urban wastewater is particularly threatening when combined with untreated industrial waste.

Access to safe water and adequate sanitation services has proven to be one of the most efficient ways of improving human health. Investment in improved water supply and sanitation yield gains in terms of economic costs. Also, the availability and water supply of satisfactory quality is the key in the health and well-being of humans and ecosystems, and for social and economic development. However, it has been noted that water quality is becoming a concern of increasing significance, as risks of degradation translate directly into socio-economic impacts and increased water treatment costs to name a few. Poor water quality can incur many economic costs such as degradation of ecosystem services; health-related costs; impacts on agriculture, industrial production and tourism (*World Water Development Report, 2012*.)

The Department of Water Affairs is entrusted with ensuring water security in the country. Water security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems (UN-Water, 2013). The millennium ecosystems assessment provides compelling evidence that human activity is reducing both the resilience and bio-capacity of ecosystems. The over-abstraction of surface and groundwater and pollution from water users clearly contribute to the problem for water related ecosystems (UN Cap-Net newsletter 2010). State investment in water security is a long-term pay-off for economic growth and human development (UN-Water, 2013). A multidisciplinary and inter-sectoral approach is required to address the scarcity and manage water resources. This helps to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. Water security is one of the fast growing social, political and economic challenges of today. It underpins and connects the food, climate. As the country's economy grows, the demand for energy, industrial and urban systems also increases. The aspects of water security are improving drinking water and sanitation services, balancing water supply and demand, mitigating water resources degradation and improving health of water resources, adapting to extreme events (UN SD, 2011).

Water and energy are closely interlinked and interdependent. Water resources are used in hydropower and cooling in thermal and nuclear power plants. The water produced during this process could have far-reaching effects on aquatic ecosystems since the water temperature is affected. The production of bio-fuels also results in increase in water demand. The production has a potential to increase pollution through increased used of fertilisers and agricultural chemicals. South Africa must ensure water sustainability despite the challenges it faces in managing water resources.

The Department of Water Affairs as a sole custodian of water resources of the country is mandated to monitor and manage it in a manner that supports socio-economic development without compromising the ecological integrity of natural systems. Chapter 14 of the National Water Act (NWA) calls for the establishment of monitoring and information systems to monitor, record, assess, and disseminate information on the quantity and quality of water resources. The key prerequisite for the accurate assessment of the status of water resources and the magnitude of water problems is the information which is based on effective monitoring programmes. The collected data must be reliable and trusted so that decision-making based on the information is not questionable and will stand in the court of law.

Generally the country's rivers are under threat from destruction of river banks, pollution, invasive alien vegetation and fish, climate change, changing flows and poor management of land use. Freshwater ecosystems are affected by everything that occurs within their catchments, so all activities beneficial and detrimental ultimately impact on freshwater environments. Rivers such as Berg and Breede have high levels of threat and require rehabilitation to prevent further degradation. Meanwhile others such as Umzimkhulu and Mvoti Rivers are less threatened because there is very little development taking place. Large rivers such as the Olifants and Vaal are also under threat as they are over-utilised and polluted by land based activities in the catchment. Mining and agriculture seem to be the main land based activities that are causing pollution.

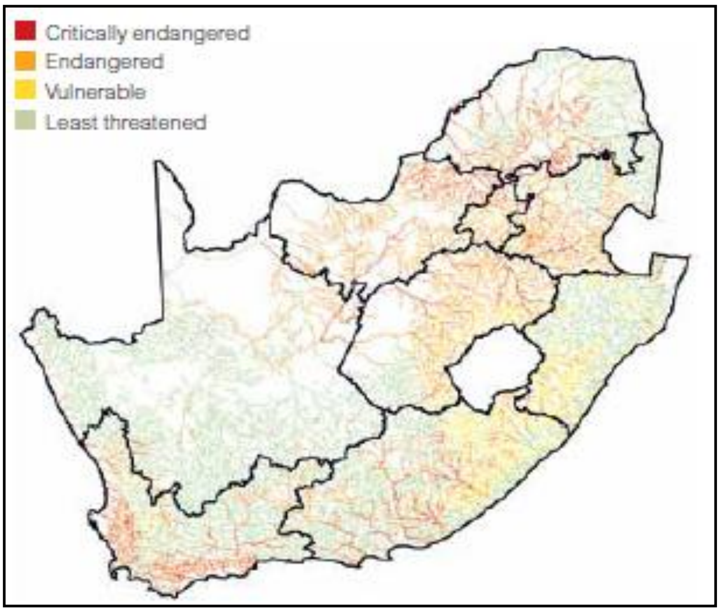


Figure 1.1: Map showing endangered river ecosystems (SANBI, 2013)

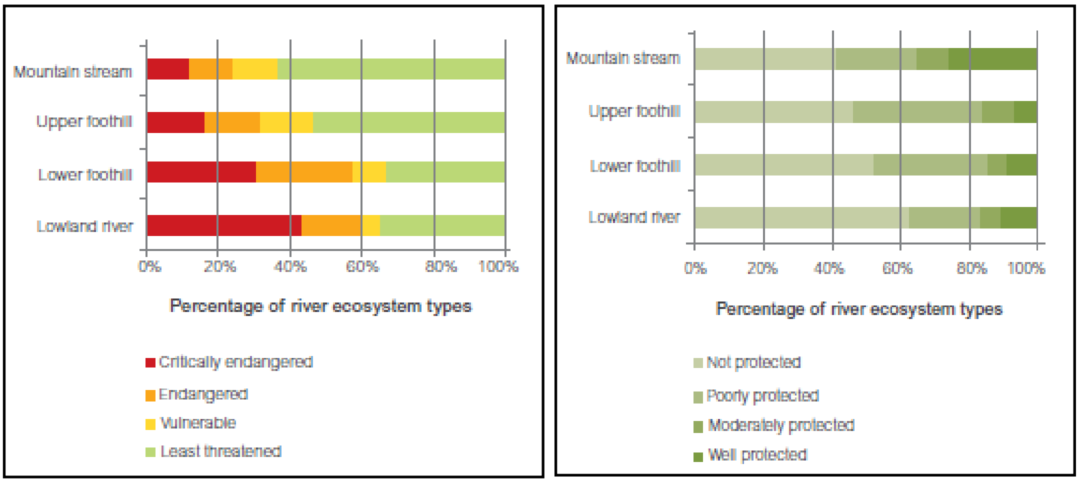


Figure 1.2: The status of threat to rivers and how protected they are in South Africa.

(State Biodiversity Report, 2012)

1.3 Monitoring of water resources

The water resources are impacted by a wide range of land based activities such as agricultural irrigation, mining, industries, urbanisation etc. These activities impact the quality of water in rivers, dams, estuaries and groundwater. They also affect the health of riverine biota, which is a good indicator of the health of the river ecosystems. Uncontrolled and excessive water abstractions and use; treated sewage effluents not returned to the river system impact on the availability of water and aquifer recharge. For the DWA to be able to protect and regulate water resources, monitoring and assessments become critical to acquire data and assess the status of water resources in the country. To be effective monitoring must have well designed implementation plan, and information systems in place to capture and capture data, and reporting. Monitoring is done for various reasons including assessment of impacts of climate change and compliance by waste dischargers into the environment.

The purpose of monitoring is to produce information on water quality, rainfall variability, water availability, establish compliance to set standards and early warnings for floods and drought. Information is also important for water resources planning and decision making.

The DWA is running various monitoring programmes such as River flows, dam levels, rainfall and evaporation, microbial, chemical, eutrophication, aquatic ecosystem health, groundwater quality and quantity to ensure data are collected, assessed and disseminated in the form of data, information and knowledge products that could be used by stakeholders and public in general. The same information is important for reporting at international level when the need arise. Monitoring is also done for compliance and enforcement. The water quantity and quality data are collected for both surface and groundwater resources. These monitoring programmes have been consolidated to improve efficiency and ensure that they are effective. However, their progress has not been without challenges as there is dwindling funding, reduction in gauging stations and disappearance of required skills because of staff turnover. Some gauging stations have been damaged by floods and have not been repaired. Reduction in the number of sampling sites and frequency of monitoring means less available data or no data at all and in some cases might not be very useful in making good decisions and planning.

The DWA is facing a challenge in maintaining and securing monitoring equipment in the field because of vandalism and theft thus hindering the monitoring processes. This has resulted in data gaps or erratic data as the problem could be detected late.

There are currently 1631 active surface water monitoring stations (Figure 1.3a) and 1862 for groundwater (Figures1.3 b). There are 412 groundwater quality monitoring geosites (Figure 1.4).

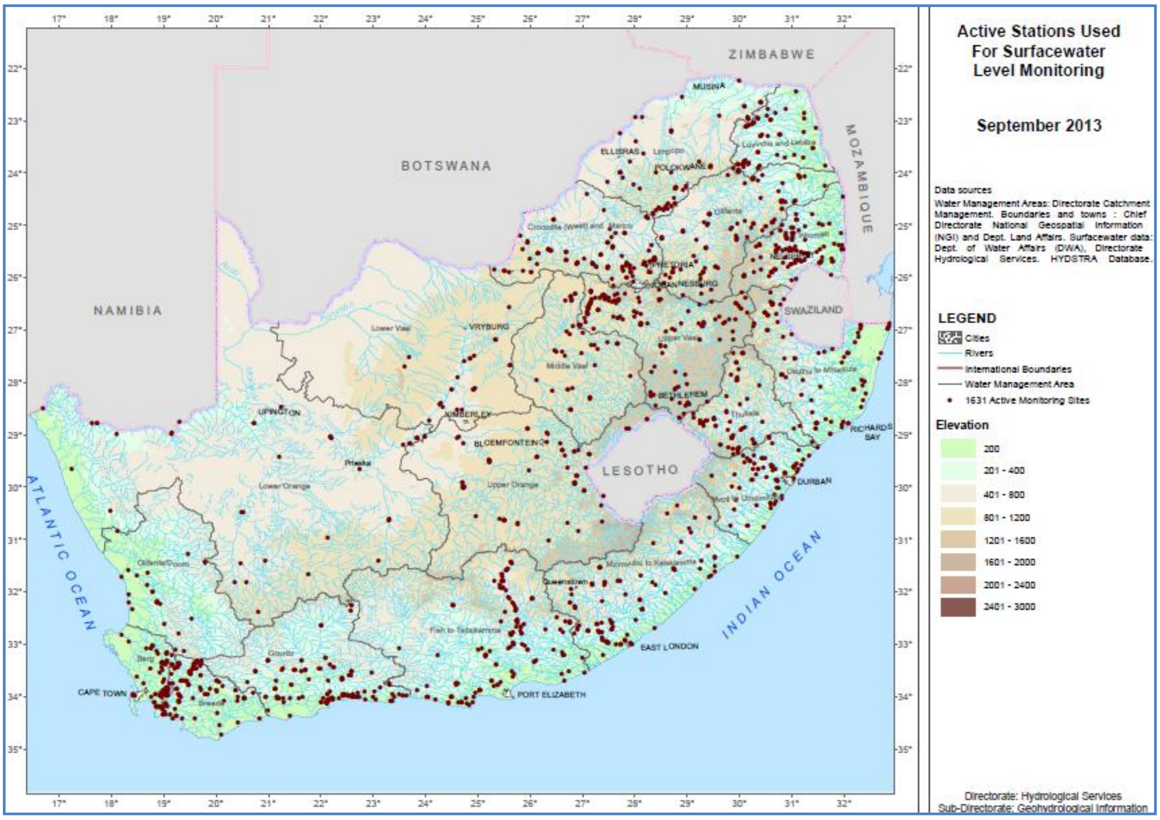


Figure 1.3(a): Active stations for surface water monitoring

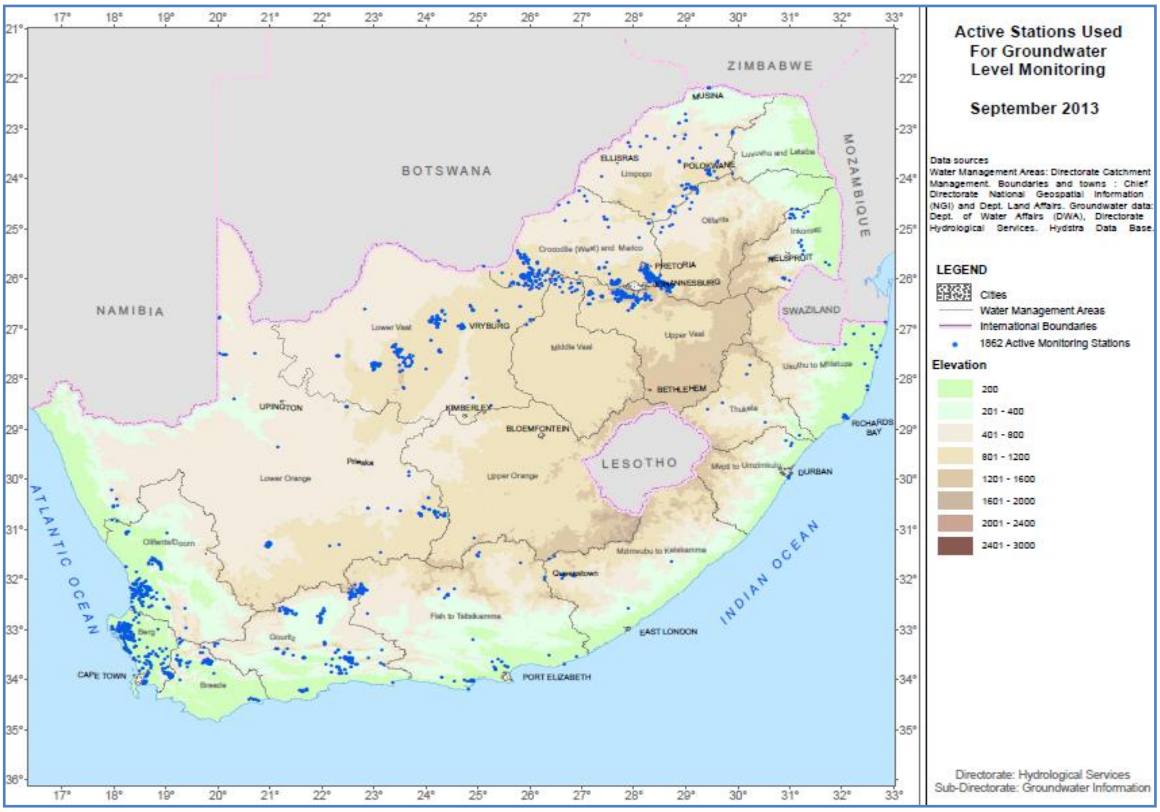


Figure 1.3(b): The hydrological monitoring networks in South Africa

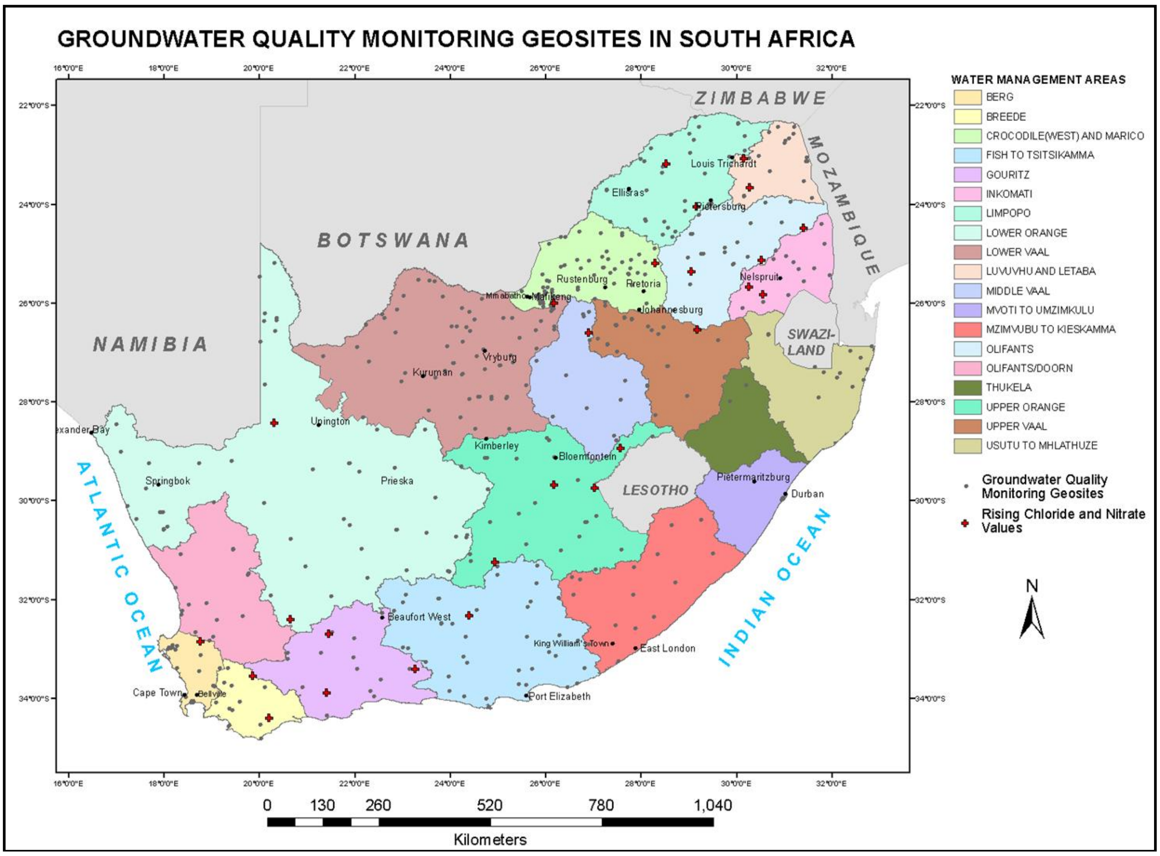


Figure 1.4: Groundwater quality monitoring geosites

1.4 Data/Information Management

Security of water supply is critical for economic growth, job creation and food security in the country. Therefore collection of data and information on water underpin strategic planning and could reduce uncertainty and cost. Also data sharing and cooperation with other departments and institutions could further reduce the cost. Collecting hydrological data, analysing and interpreting information are key factors of water management. Without the information a detailed picture of the water situation cannot be known and policy formulation and implementation will be difficult. Water information relates to quality, quantity, availability, distribution, actual use, licensing and registration.

Data management is an important link between effective monitoring efforts and informed data analysis for assessing water quality. Monitoring and data management is also an important link between water quality restoration activities and determining their effectiveness. It is the process of organizing, storing, retrieving and maintaining the data you collect. Having a data storage, management, and retrieval system is essential for every monitoring program. Figures 1.5 and 1.6 show a road map to data management and an example of dashboard. Data management starts with collection of a sample, analysis in a laboratory to generate data, storage and analysis to produce information. The DWA collects data, analyse, capture and store in different databases such as Water Management Systems (WMS) for surface &

groundwater quality, HYDSTRA for surface water & ground water quantity, National Groundwater Information system (NGIS), and WARMS for water use. The DWA is in the process of developing a national integrated water information system that will draw data from existing databases and present information in the form of dashboards. This system is aimed at providing information structure that will facilitate effective and efficient reporting, planning, analysis and reporting on water situation in and around South Africa.

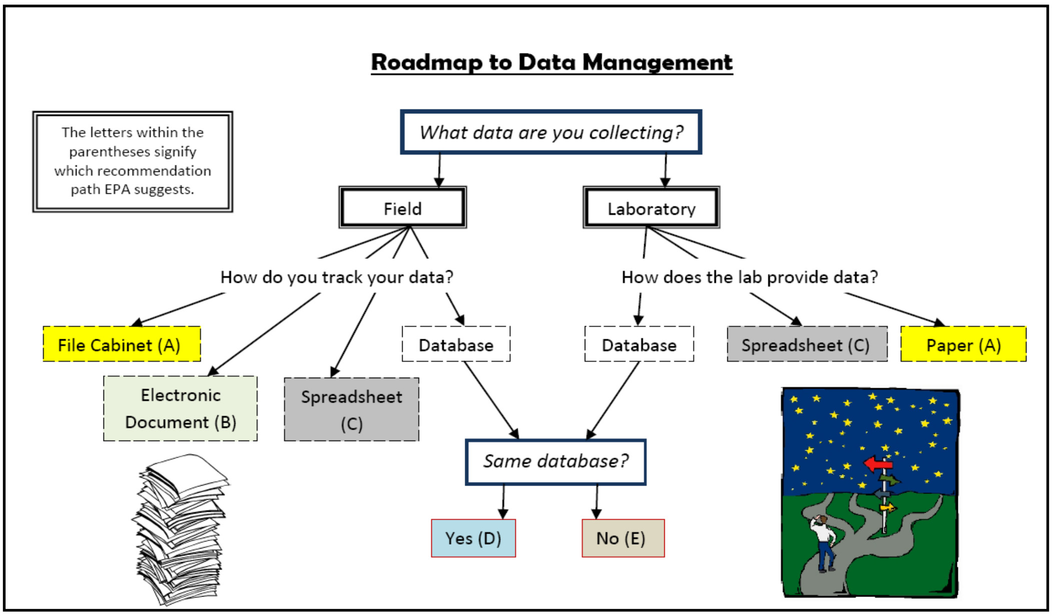


Figure 1.5: Roadmap to data management (http://epa.gov/region9/water/tribal/cwa-reporting.html).

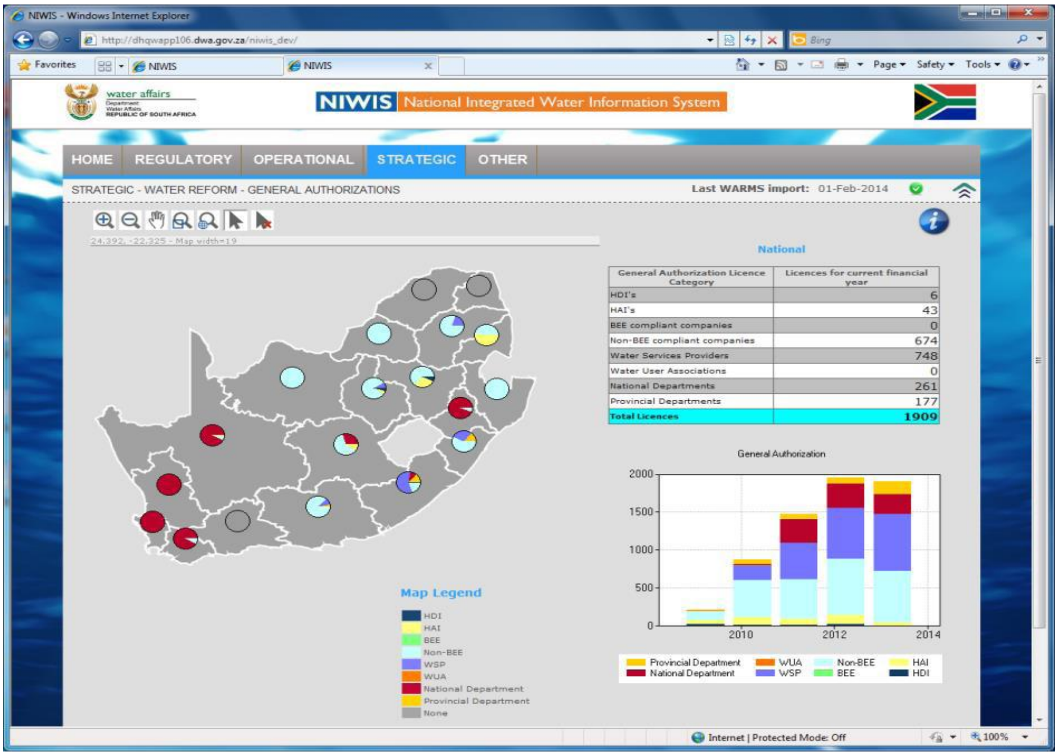


Figure 1.6: An example of a dashboard (DWA, 2013).

1.5 Water Management Areas

The 19 Water Management Areas (WMAs) have been consolidated into 9 WMAs (Figure 1.7). The boundaries of the proposed WMAs are not aligned with the provincial boundaries. They consider the catchment and aquifer boundaries, equity consideration, financial viability and interest of participating stakeholders. The DWA is in the process of establishing the Catchment Management Agencies (CMAs) that will be responsible for water resources management at a regional or catchment level through the participation of local communities and other stakeholders in the water sector. They are established to protect and control the use of raw water through authorisation processes. The Inkomati and Breede/Overberg CMAs are the two currently operational CMAs but will be realigned into the Inkomati-Usuthu and the Breede-Gouritz CMAs, respectively. The process of CMAs establishment has been fast-tracked with the intention to have all the CMAs established by 2016. The CMAs are expected to develop their own catchment management strategies.

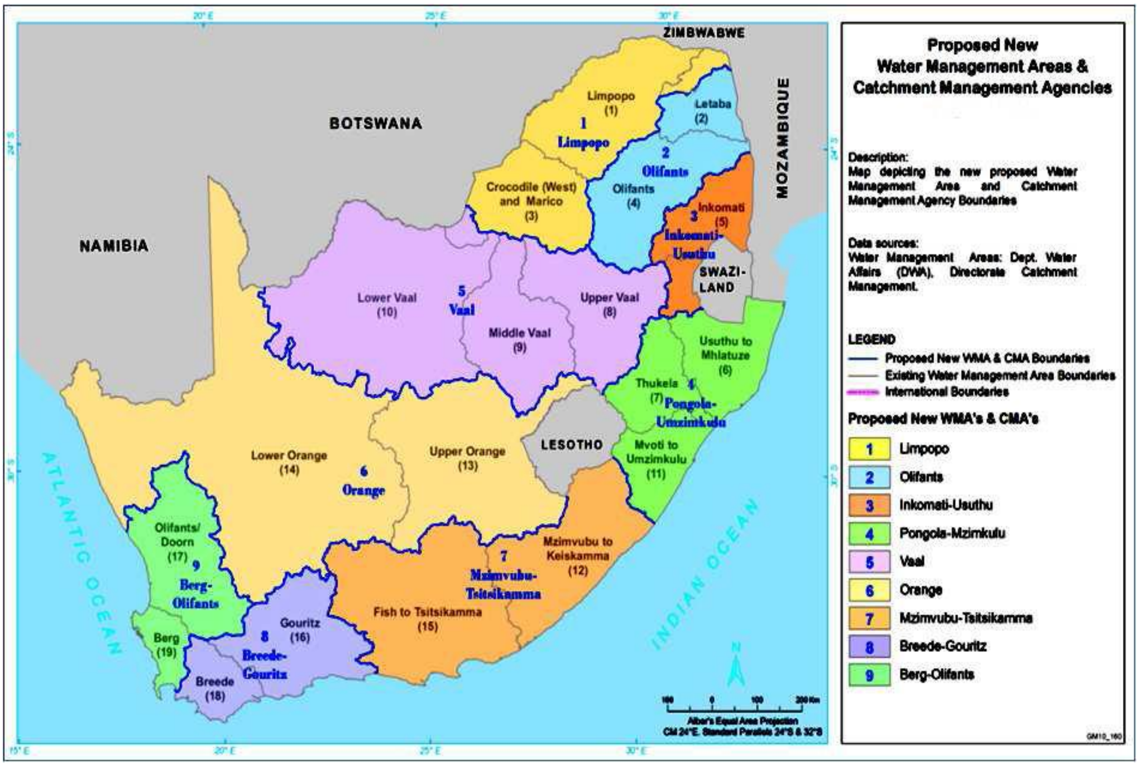


Figure 1.7: Map showing the 19 WMAs consolidated into 9 WMAs in South Africa.

1.6 Transboundary water resources

The transboundary basins and aquifers link populations of different countries. All transboundary water bodies create hydrological, social and economic interdependencies between societies. They are vital for economic development, reducing poverty and contributing to the attainment of the Millennium Development Goals. They provide opportunities for cooperation and promotion of regional peace and security as well as economic growth. Potential transboundary impacts and conflicting interests can best be solved by cooperation, adequate legal and institutional frameworks, joint approaches to planning and sharing of benefits and related costs (*Sources: Transboundary Waters,: UN-Water Thematic Paper Sharing Benefits, Sharing Responsibilities, 2008; UNESCO, 2013*).

1.6.1 Transboundary groundwater resources

It is estimated that the SADC Member States (including South Africa) have 2491 m^3/capita/year in renewable groundwater and yet only 1.5 % (~37.4 m^3/capita/year) of it is utilised. Access to groundwater and its quality directly affect the wellbeing of households and livestock, as well as productivity of subsistence farming considering that groundwater is the primary source of water for 70 % of the 250 million people in the region. South Africa shares some aquifers with some neighbouring states as depicted by the map of Figure 1.8.

Figure 1.8: Transboundary aquifers of South Africa (IGRAC, 2012)

1.7 Legislation

The National Water Act 1998 ((Act No 36 of 1998) and the Water Services Act 1997 (Act No. 108 of 1997) are being reviewed and combined to one act ensure that there is equity in water allocation, to improve water resources management and the provision of water services. The National Water Resources Strategy (NWRS) 1 has been reviewed to NWRS 2 to ensure that the national water resources are managed and used in an efficient and sustainable manner in order to achieve the country's development priorities. The review took into consideration the support of broad national economic and social development goals while at the same not compromising the long-term sustainability of water resources.

2. Climatic Conditions

Climatic conditions refer to various aspects and patterns of weather such as rainfall, drought, floods, temperature, snow and evaporation. In South Africa climatic conditions generally range from mediterranean in the south western part of the country to temperate in the interior plateau, and subtropical in the northeast. Because the climatic processes are variable, these can have implications on biodiversity, water supply for drinking, agriculture, dam storages, groundwater and forestry. Reduction in rainfall or its variability, increase in temperatures and evaporation have serious impacts on already limited or scarce resources.

2.1 Rainfall

The poor spatial distribution of rainfall has an effect of the natural availability of water resources across the country, which is highly uneven. This is compounded by the strong seasonality of rainfall over virtually the entire country, and the high within-season variability of rainfall. Although rainfall patterns have been highly seasonal, changes have been observed in the past few years with winter rainfall areas receiving it during summer months. Seasonal rainfall distribution in South Africa depicts all year round rainfall in the southern coastal part of the country (part Eastern and Western Cape). The summer rainfall is mainly in the Eastern half of the country and is due to moist air circulating anti-clockwise from high pressure systems over the Indian Ocean into low pressure zones generated over the inland regions. The middle part of the country receives late summer rain. Winter rainfall, particularly in Western Cape, is brought about by cold fronts that regularly approach from the west and south-west. Spells of less rainfall have resulted in drought stricken areas in the country.

Increased rainfall intensity could exacerbate soil erosion especially on the river banks as water put pressure on unstable banks resulting in sedimentation in dams in some cases. Areas with sandy soils are the most affected thus increasing sedimentation. This has an impact on water quality and the health of aquatic ecosystems.

In June 2013 the Western Cape experienced extreme weather with very cold and heavy rains which lead to flooding in low lying areas. More rain was experienced in the better part of the country during December 2013 (Figure 2.1). In general, the North West, Northern Cape and Free State Provinces experienced less rainfall as shown in Figures 2.1, 2.2 and 2.3 resulting in very dry conditions during this reporting period. This has lead to very low levels of water storages especially in the North West Province.

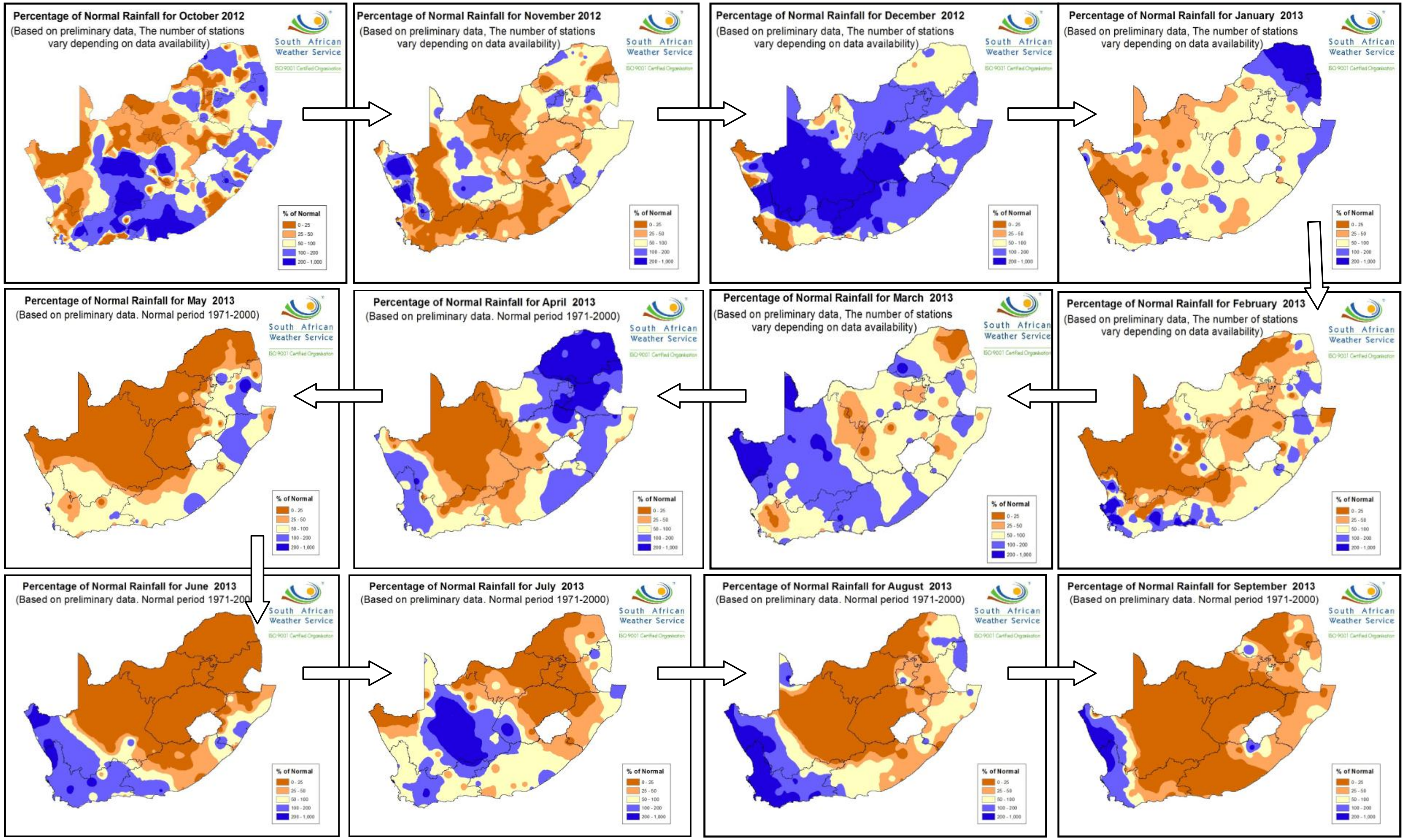


Figure 2.1: Monthly Percentage of Normal Rainfall for the period between October 2012 to September 2013

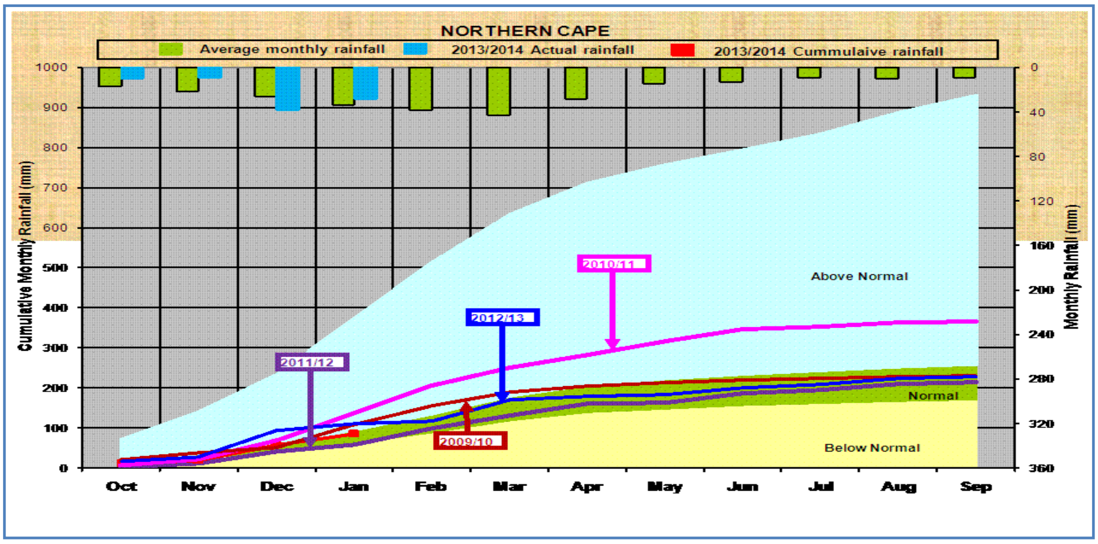


Figure 2.2: Northern Cape rainfall versus mean for 2012/13 (DWA, 2013)

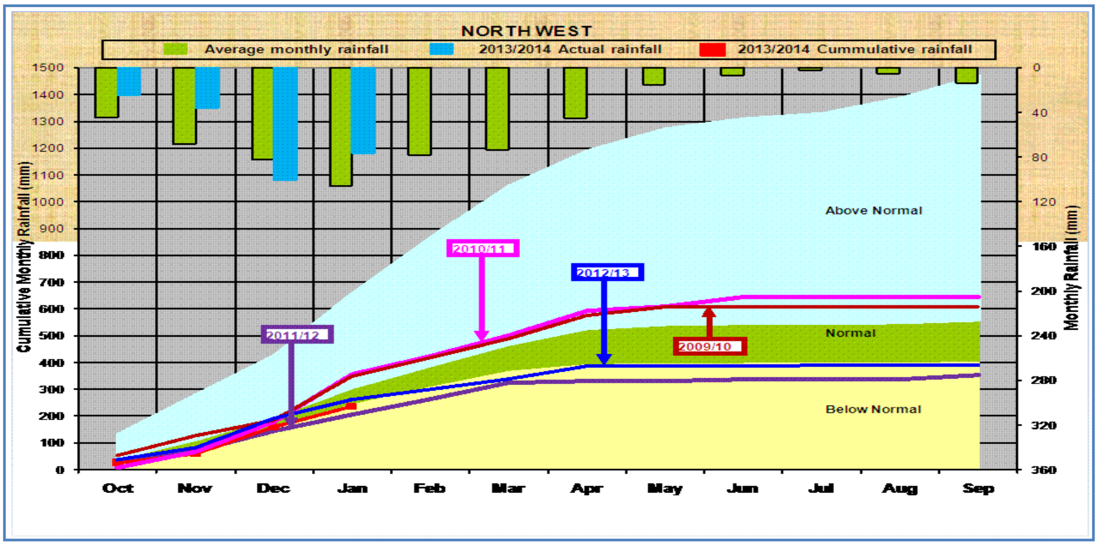


Figure 2.3: North West rainfall versus mean for 2012/13 (DWA, 2013)

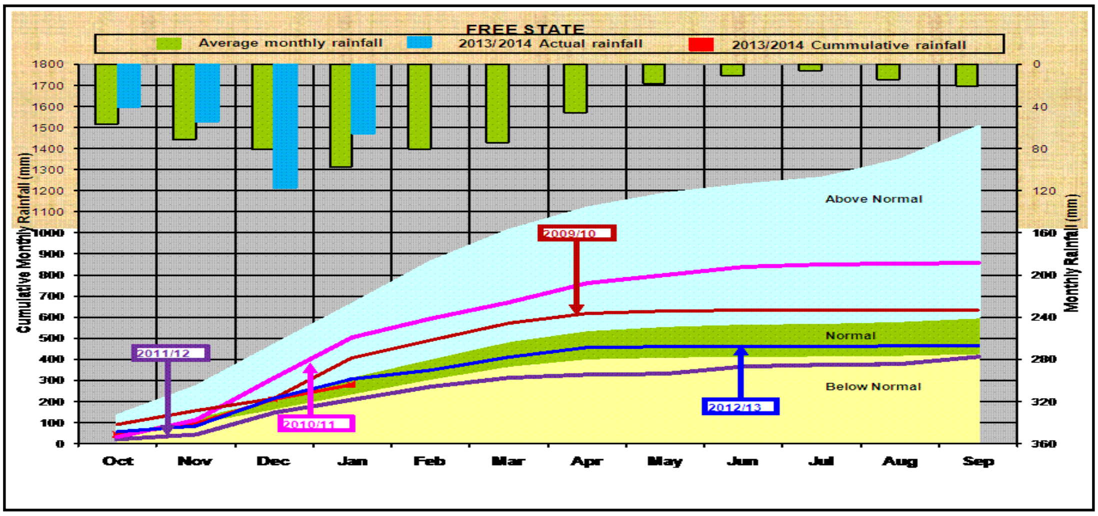


Figure 2.4: Free State rainfall versus mean for 2012/13 (DWA, 2013)

The comparison of the percentage of normal rainfall shows that more rain fell in the major part of the country for the hydrological season 2012/13 than 2011/12 (Figure 2.5). However, the North West, Free State and Eastern parts of the Northern Cape Provinces experienced very little rain. On average the Mpumalanga, Limpopo and KwaZulu-Natal Provinces have been receiving more rainfall than others over the period of 13 years (Figure 2.6). Rainfall variability has been observed in past few years and climate change could be the main contributor.

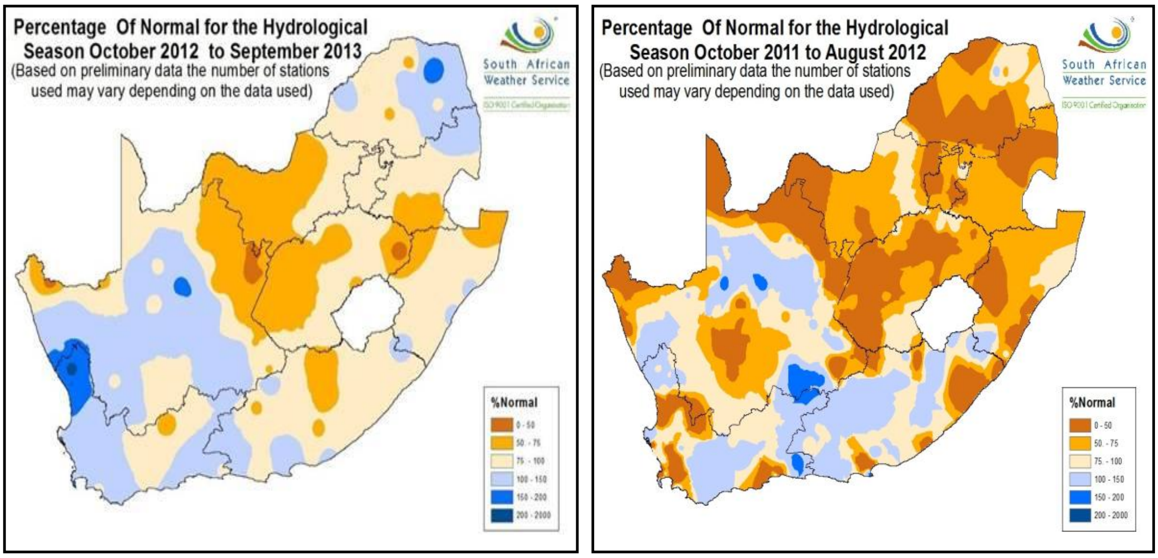


Figure 2.5: Comparison of the percentage of normal rainfall for the hydrological season 2011/12 and 2012/13 (SAWS, 2013).

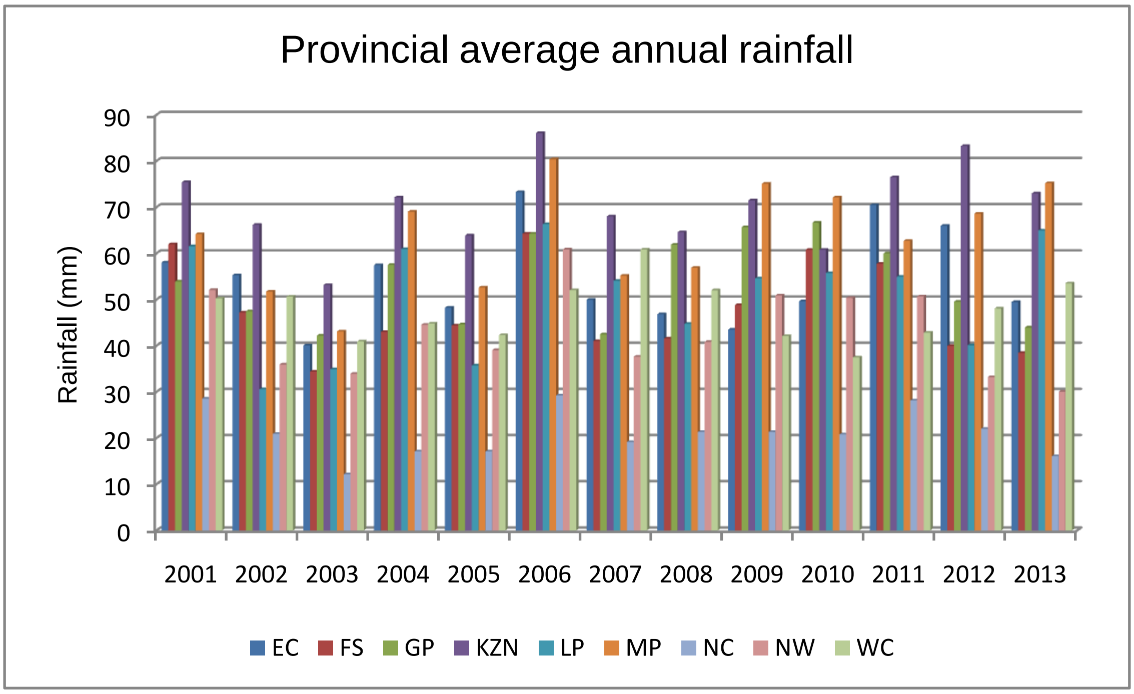


Figure 2.6: Comparison of the annual average rainfall per province over the period of 13 years.

2.2 Surface water runoff

When there is a storm or heavy rain, water gushes down into rivers, lakes and wetlands as runoff and part of it seeps into the ground and replenish groundwater. Runoff can be powerful that it can move boulders, uproot trees and change the landscape of a catchment. It can be affected by meteorological factors such as rainfall intensity, amount, duration and distribution over a catchment. Factors such soil type, land use and topography can also affect runoff. Where the volumes of runoff are high, soil erosion can result and flooding can occur. Runoff can influence the rate of flow in the river as water comes gushing from land. It must however be noted that increased runoff does not necessarily translate to more water as some water may infiltrate into the ground, evaporate in areas where there is high evaporation rate or discharge into sea.

Increased run-off could damage areas with shallow water tables. A rise in water table may affect agricultural use and damages building. Replaced vegetation can reduce the area where infiltration to groundwater can occur resulting in more runoff. Runoff especially in agricultural area can also carry excess nutrients, bacteria, pesticides and sediments into rivers and dams creating a potential for water quality degradation.

Figure 2.7 was used to map Strategic Water Source Areas which cover 8% of land surface but provide 50% of water to South Africa, Lesotho and Swaziland (Nel et al., 2013) supporting growth and development.

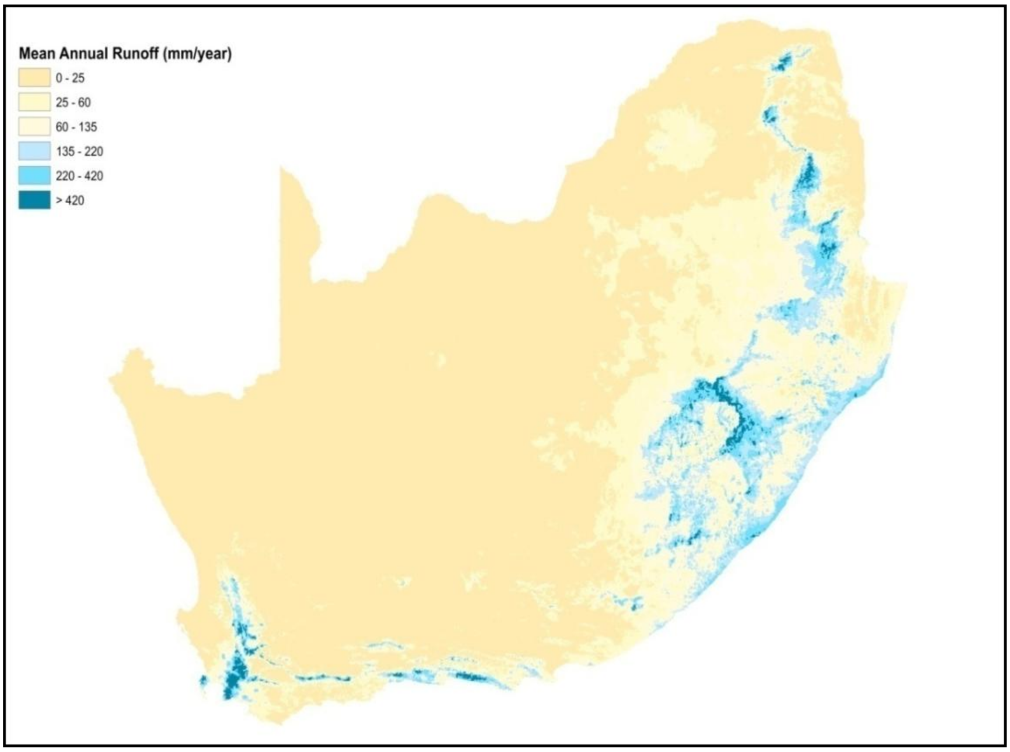


Figure 2.7: Mean annual runoff for South Africa (Nel *et al.*, 2013)

2.3 Temperature

South Africa has been experiencing a warming trend at the same time cold spells brought snow. Higher temperatures warm air and water, and could contribute to faster evaporation rates. Warm water could increase the decomposition rate of organic matter resulting in decreased oxygen levels. This could increase the risk of extension of certain species. Increased temperatures could change stratification and mixing in dams thus affecting the nutrient balance thus increasing plant biomass and algal blooms.

Figure 2.8 shows the annual mean temperature anomalies, that is, the difference from the average over 1961-90, of the 27 climate stations in South Africa. In 1999 South African mean temperature anomalies were at the highest levels ever recorded. In general there has been an increasing trend in temperatures.

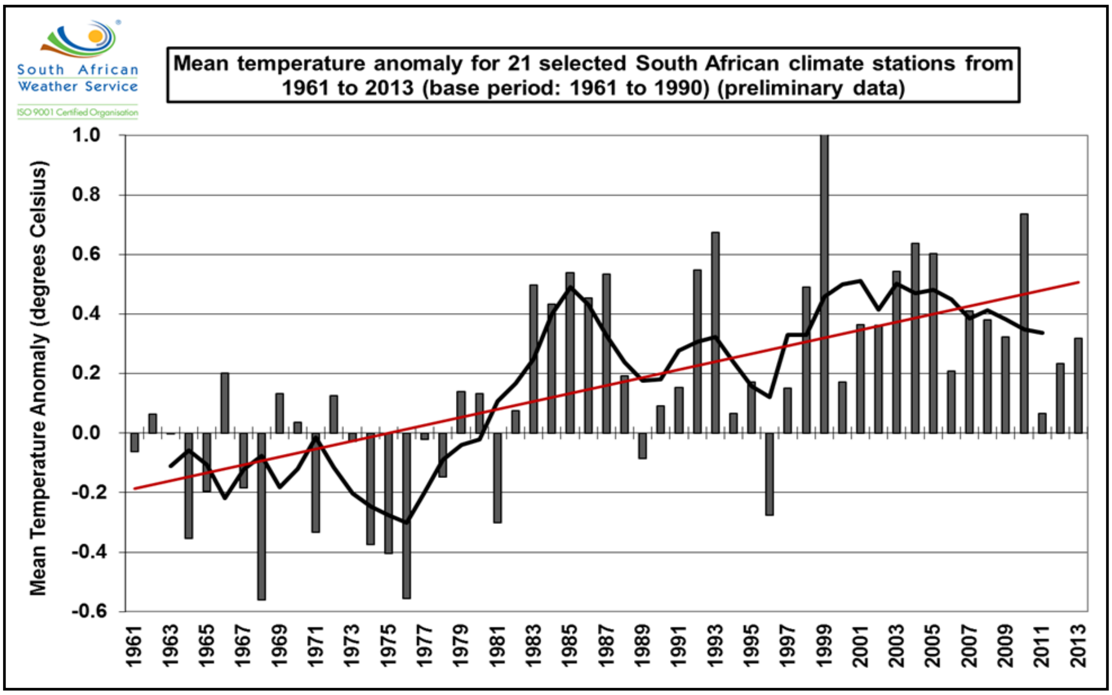


Figure 2.8: Annual mean temperature anomalies (difference from the average over 1961-90)

The Northern Cape Province is the most affected by very temperature. The highest temperature of 47.5°C was recorded at Viooldrift in the Northern Cape Province (Figure 2.9). The lowest temperature was recorded at Buffelsfontein near Molteno in the Eastern Cape measuring -20.1°C in August 2013 and is recorded as the lowest in the country since 1996.

In June 2013, the Western Cape was hit by a series of cold fronts, bringing with them hail storms, strong winds and plummeting temperatures. Places affected included the low-lying areas of the Cape Peninsula, Agulhas, Hout Bay, Gugulethu and Langa Townships. Places like Sutherland and Matroosber, near De Doorn, saw heavy snowfall. The storms caused damage to property amounting to millions of rands. Photo 1 below shows snowfall in parts of Western Cape.

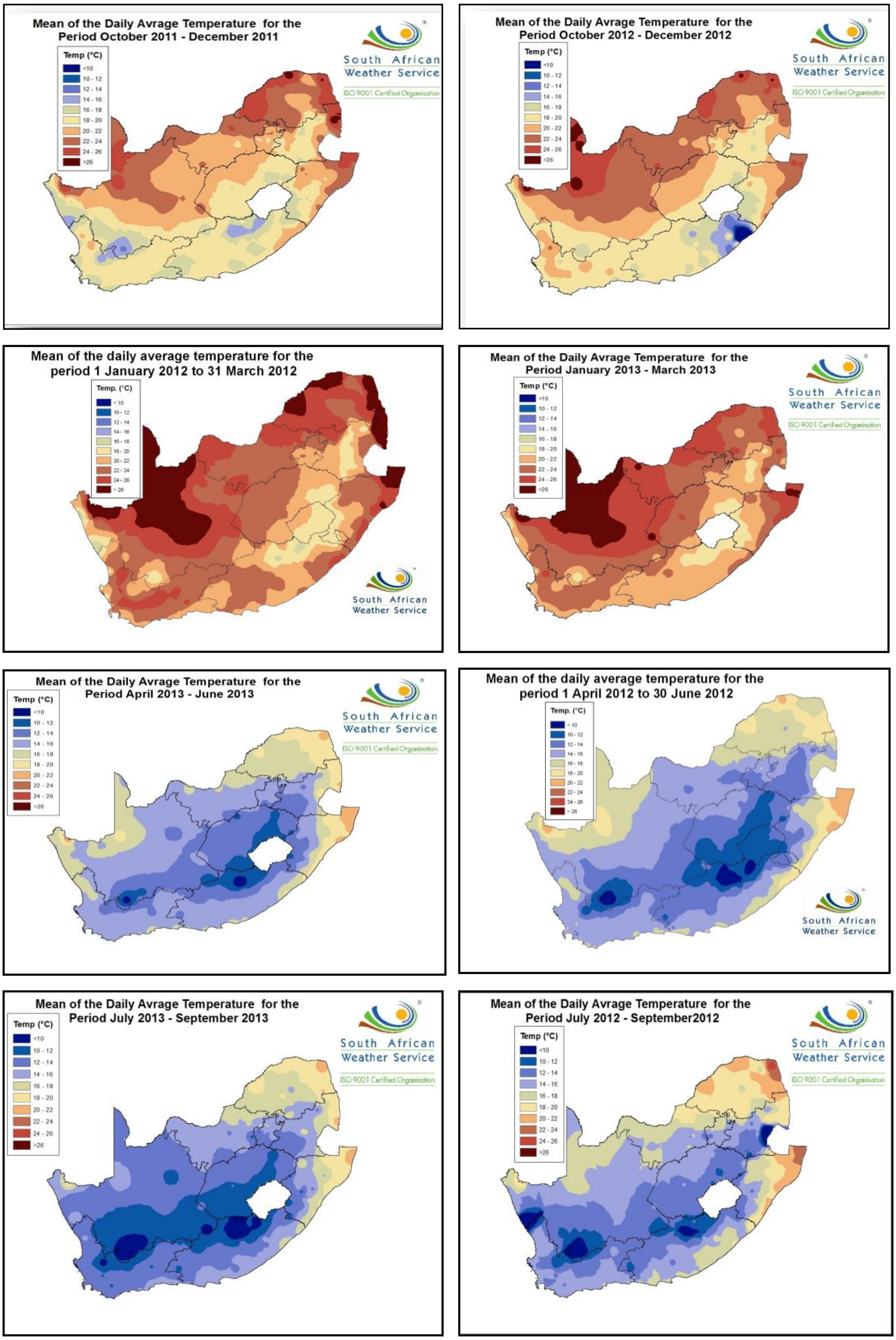


Figure 2.9: Comparison of the mean daily temperatures for period of October 2012 to September 2013.

Snowfall in Western Cape and Table Mountain (www.thecelestialconvergence.blogspot.com).

2.4 Evapotranspiration

Evapotranspiration (ET) is a collective term for the transfer of water as water vapour to the atmosphere from both vegetated and non-vegetated land surfaces. A significant percentage of precipitation/rainfall is returned through ET to the atmosphere thus impacting water yield. The process of evapotranspiration is shown in Figure 2.10. Evaporation rates vary depending on a number of factors such as temperature, humidity, soil type and wind speed.

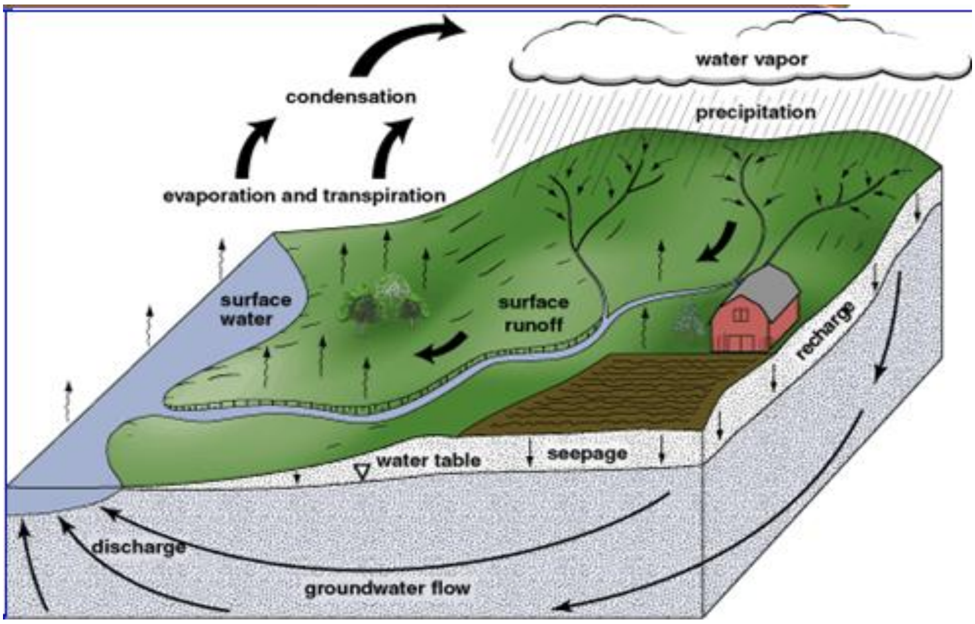


Figure 2.10: The process of evapotranspiration

The DWA monitors evaporation using S-Pan at few evaporation stations across the country. During this reporting period, very high evaporation rates were observed in the Northern Cape and North West Provinces and high in the Free State (Figure 2.11) compared to the previous year (Figure 2.12). Such were attributed to the high temperatures experienced (Figure 2.9) which in turn could also account for low storage recorded that year.

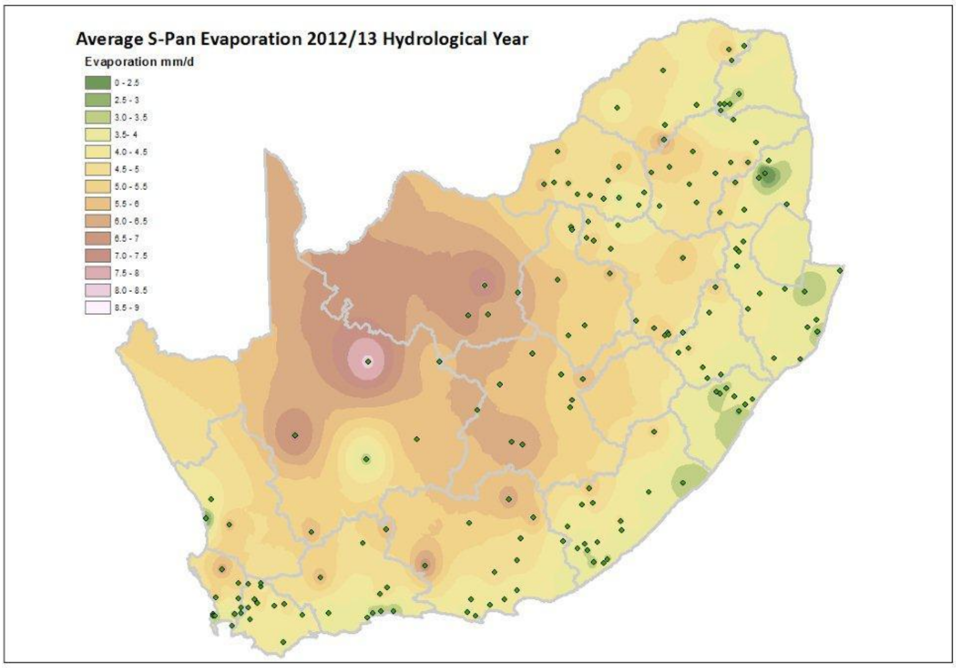


Figure 2.11: Average S-Pan Evaporation 2012/13 hydrological year

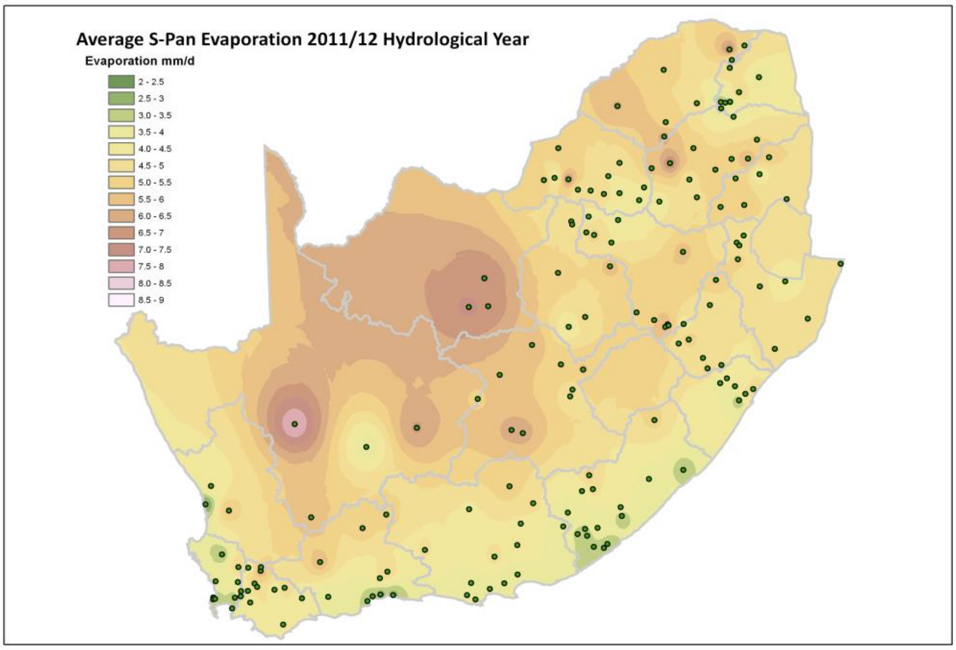


Figure 2.12: Average S-Pan Evaporation 2011/2012 hydrological year

2.5 Water availability

South Africa shares four of its major river systems with six neighbouring countries. These four shared catchments amount to approximately 60% of South Africa's surface area and approximately 40% of the average total river flow (SANBI, 2013). Areas where water demand is high are located in areas with few rivers which are usually stressed. The uneven distribution of water resources has resulted in water transfers within catchments and trans-boundaries to augment available water to ensure social and economic development and sustainability.

2.5.1 Surface water availability

The amount of water available in the country to meet the needs of people and to sustain the water environment varies greatly between different places and seasons, and from one year to another. Farm dams, runoffs (overland flows) and large scale plantation forestry could have significant impact on catchment yields. This is due to the high water requirements for growth of new forests in first 4-10 years (Daamen et al., 2001) as well as the higher interception and transpiration rates of forest over grassland. In addition to the seasonal flows of water that occur through natural runoff and groundwater recharge, water is stored in dams.

Farm dams, defined as small on or off-stream storages, play an important role in agriculture as they capture runoff that can be used during dry periods of low or no rainfall. Small dams may store low water volumes for stock and domestic use, while larger dams may be used for wide scale irrigation purposes. While in most cases the impact of an individual farm dam is relatively small, the cumulative impact of the large number of farm dams on stream-flows can be significant. It is therefore important that they are monitored as they can diminish water availability to existing and future downstream users and the environment.

2.5.1.1 Surface water storage

The trend for the national dam water storage levels for the reporting period shows that levels were the lowest since 2006/07 (Figure 2.13). This could be linked to very dry conditions experienced by the major parts of the country due to less rainfall (Figure 2.1). The National total water storage for 2012/13 was below 80% and the 6th lowest out of 15 years (Figure 2.14).

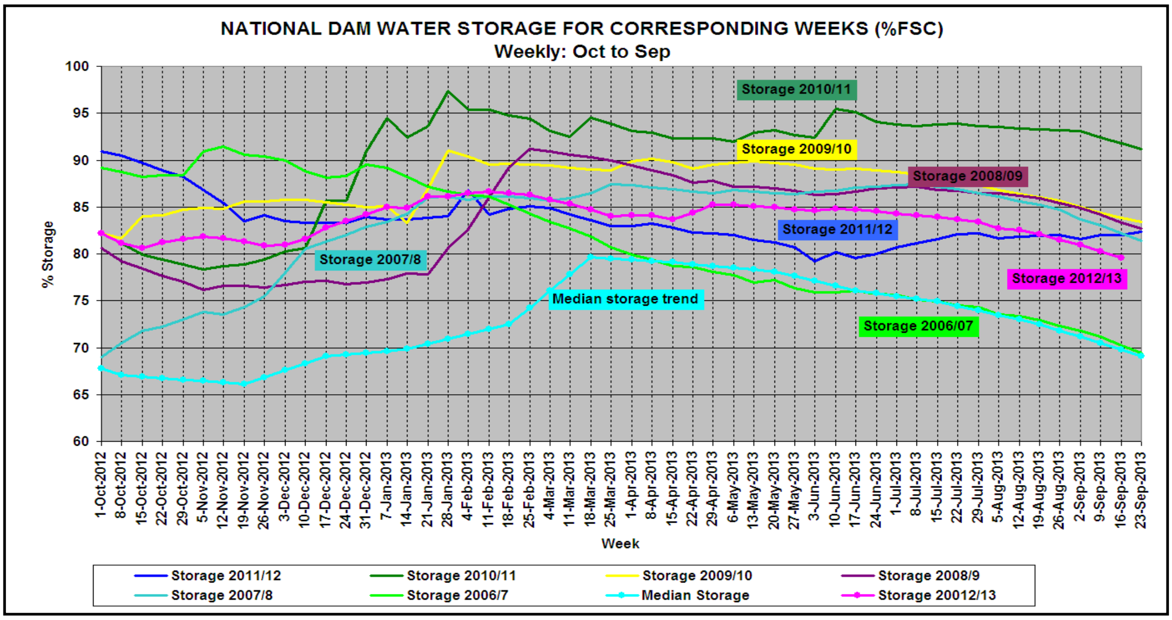


Figure 2.13: Comparison of the national dam water storage levels between 2006/07 and 2012/13

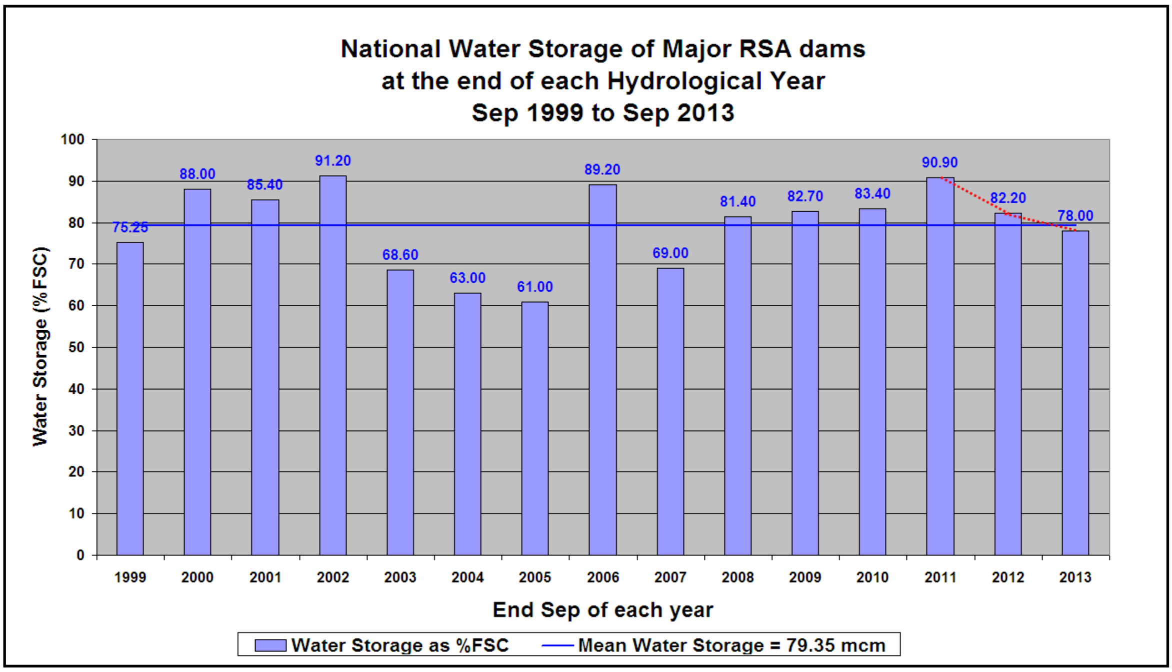


Figure 2.14: National total water storage at end September from 1999 to 2013

Provincial storages

The provincial total storage levels at the end of September 2012 and 2013 are shown in Figure 2.15. The Western Cape Province experienced very low storage levels between January and February 2013 whilst the North West Province was very low in July and in September 2013.

In most provinces, the dam total storage levels were slightly lower compared to the same period in the previous year. However these storages were still above the median, with the exception of the North West, Limpopo and Gauteng Provinces. The Western Cape normally receives rains during winter and heavy rains were experienced in June and August 2013 resulting in high storage levelsas at end September 2013. Low storage levels were caused by very dry conditions experienced in some parts of the country as shown in Figure 2.16.

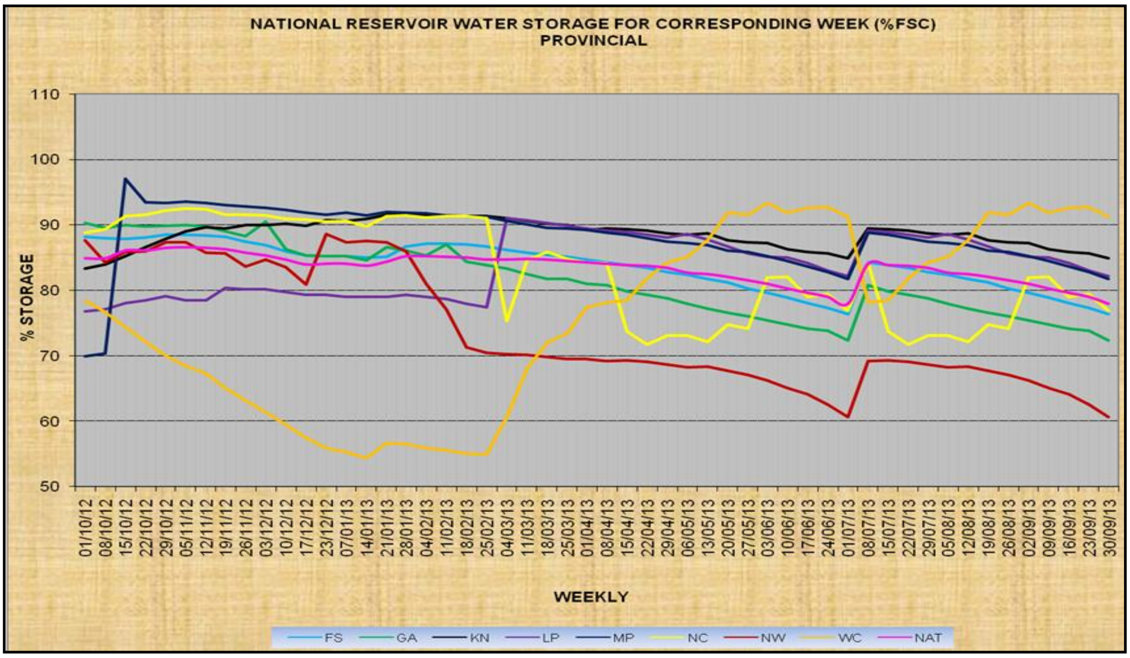


Figure 2.15: The provincial water storage levels from October 2012 to September 2013

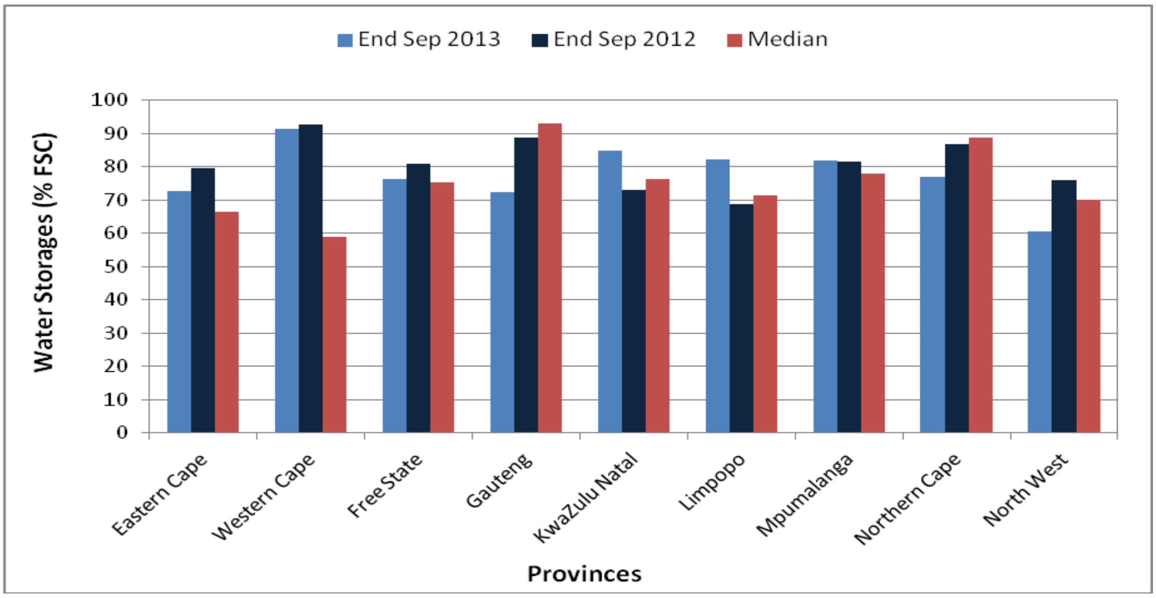


Figure 2.16: A comparison of provincial dam storage levels at end September 2012 and 2013.

Water Management Area storages

The Crocodile-Marico West, Fish-Tsitsikama and Middle Vaal WMAs recorded storages below 60% with the Middle Vaal showing the lowest storage of 31% FSC; almost half of the previous year's storage (Figure 2.17). The Lower Orange and Berg WMAs had the highest storages. Six dams in the Crocodile-Marico West experienced low dam storage levels, a drastic reduction compared to the previous year. Three dams in the Middle Vaal had low storage levels and in the previous year levels the same dams were at ±50% FSC.

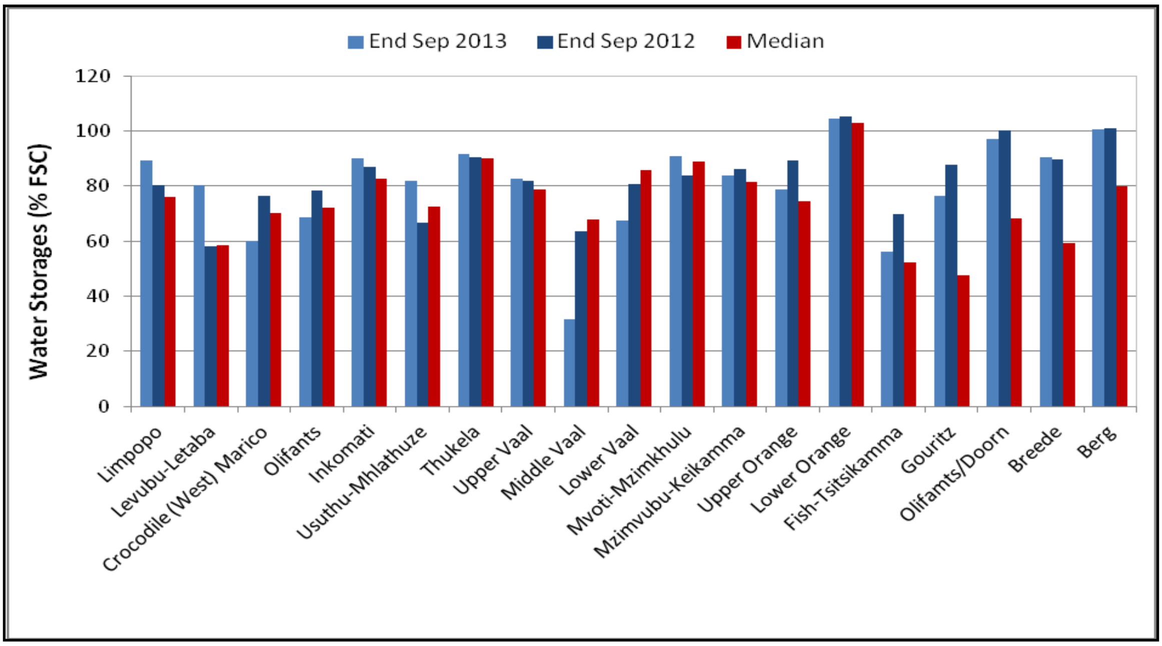


Figure 2.17: A comparison of dam storage levels per water management area at end September 2012 and 2013.

2.5.2 Status of major dams

The status of dams across the country is shown in Figure 2.20. The DWA is undertaking to ensure assurance of supply by constructing more large dams and raising walls of already existing infrastructure to increase storage capacity.

Table 2.1: List of dams with capacity below 40% as of September 2013

Dam	River (source)	WMA	% Level as in September		
			2011	2012	2013
Lindleyspoort	Elands	3	98.0	71.7	20.4
Warmbad	Buffelspruit	3	75.5	105.4	29.0
Koster	Koster	3	96.8	73.5	32.1
Swartruggens	Elands	3	101.1	100.5	29.1
Vaalkop	Elands	3	76.4	38.7	52.9
Marico-Bosveld	Groot-Marico	3	97.1	82.1	32.2
Kromellenboog	Klein-Marico	3	95.6	72.5	28.9
Molatedi	Groot-Marico	3	77.0	44.6	19.2
Sehujwane	Sehujwane	3	84.3	48.5	38.6
Middleburg	Little Olifants	4	90.6	57.1	28.3
Middle-Letaba	Middle-Letaba	2	10.4	0.9	44.2
Allemanskraal	Sand	9	91.4	47.2	22.1
Erfenis	Groot-Vet	9	94.2	51.0	26.7
Bloemhof	Vaal	9	97.3	67.7	32.1
Tierpoort	Tierpoort	13	97.0	54.5	15.6
Rustfontein	Modder	13	93.6	53.1	34.3
Armenia	Leeu	13	93.9	53.6	24.2
Loerie	Loerie Spruit	15	100.5	100.6	34.9

2.5.3 Very Low Storage Dams

Numerous factors attribute to reduction in catchment yield or aquifer recharge, the most common being activities previously known not to require license application (schedule 1). Less rainfall and decreased runoff also contributes to yield reduction. The Crocodile West/Marico WMA had the most number of significantly low to very low storage levels followed by the Upper Orange and the Upper Orange WMAs with drastic reductions in storage levels (Table 2.1). This could be attributed to very low rainfall during the reporting period as shown in Figure 2.1 & 2.3. This has resulted in limited water available for use in these areas. The Middle Letaba Dam storage increased from 0.9% to 44% (Table 2.1).

Table 2.2: Dams with very low storages as of September 2013

Dams	Rivers
Beervlei	Groot
Prinsrivier	Prins
Impofu	Krom
Armenia	Leeu
Middlebag	Little Olifants
Disaneng	Molopo
Setumo	Molopo
Ngotwane	Ngotwane

2.5.4 Water transfers

The natural availability of water resources across the country is highly uneven due to poor spatial distribution of rainfall and water may not always be available in satisfactory amounts where needed. To address this challenge water is transferred from one catchment where there is surplus to another catchment within WMAs and internationally to augment the available water. The international transfers and inter-basin transfer schemes are shown in (Figure 2.17).

Table 2.3: Major S.A. Water Transfers in the year 2012/2013

TRANSFER SCHEME	CUMULATIVE VOLUME (Mm3/a)	
	TARGET	ACTUAL
From LESOTHO	712	709
THUKELA - VAAL (Woodstock –Sterkfontein)	-	44.65
VRESAP PIPELINE	160	109.18
ORANGE –FISH (Gariep-Darlington)		620
WESTOE - JERICHO	46.78	37.20

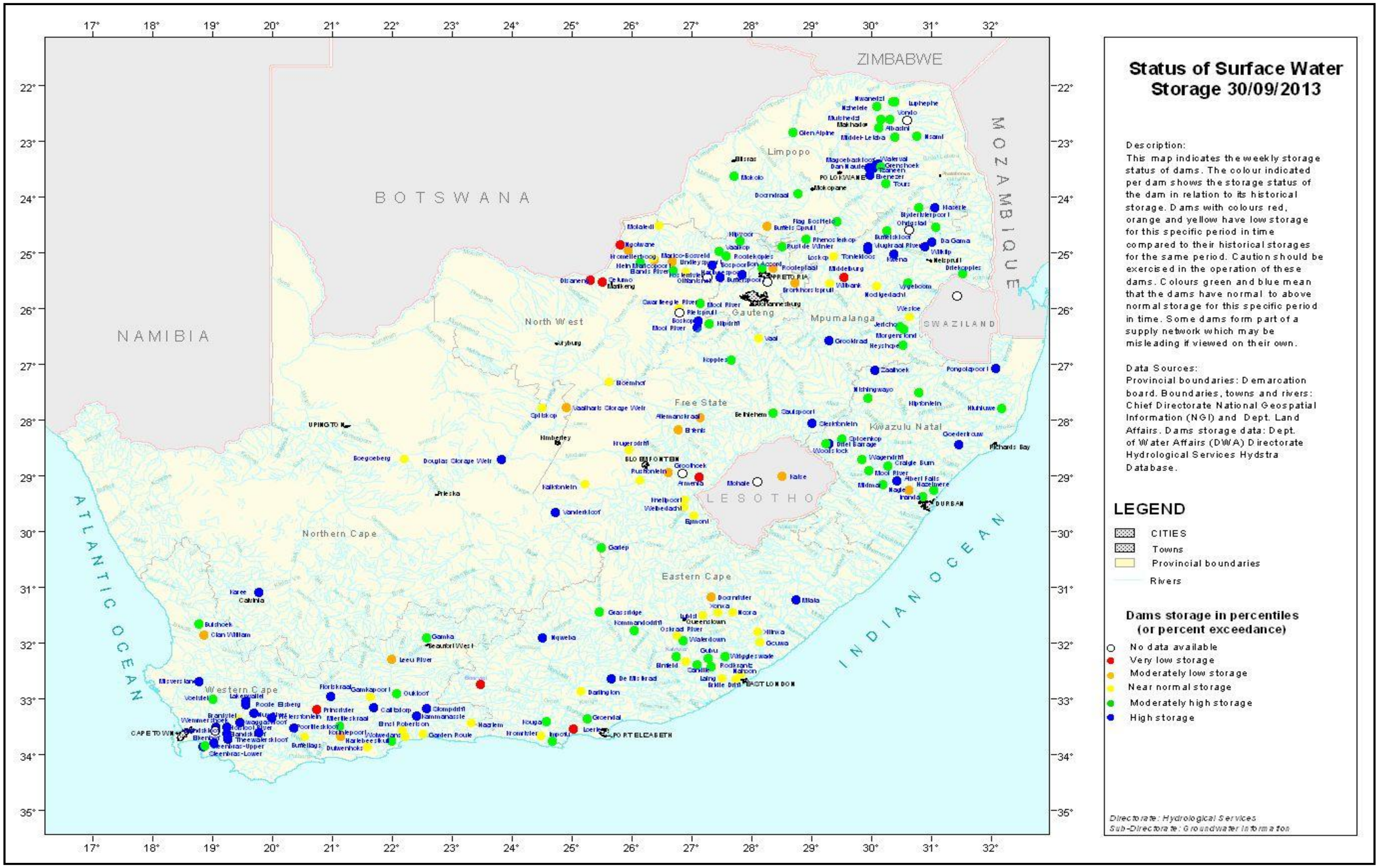


Figure 2.18: Status of surface water storage levels as at September 2013

2.6 Groundwater availability

Groundwater is the water found in the subsurface in the saturated zone below the water table. The amount of water that an aquifer (a geological formation which has structures or textures that hold water or permit appreciable water movement through them) may yield is dependent upon the porosity and permeability of the material found in the earth layer.

The aquifer is replenished naturally by the groundwater recharge process mainly from precipitation in order to maintain volumes stored underground, countering the impacts of abstraction, evapotranspiration, and other effects. The recharge map of South Africa is depicted in Figure 2.19 with Namaqualand, the south-western and the northern-most parts of the country indicating the lowest recharge rates. These are the areas which also precedingly experienced very high evaporation rates. Figure 2.22 shows groundwater occurrence in the country for different aquifer types based on yield classes. Recharge could also be the principal vehicle for leaching and transporting solid and/or liquid contaminants to the water table.

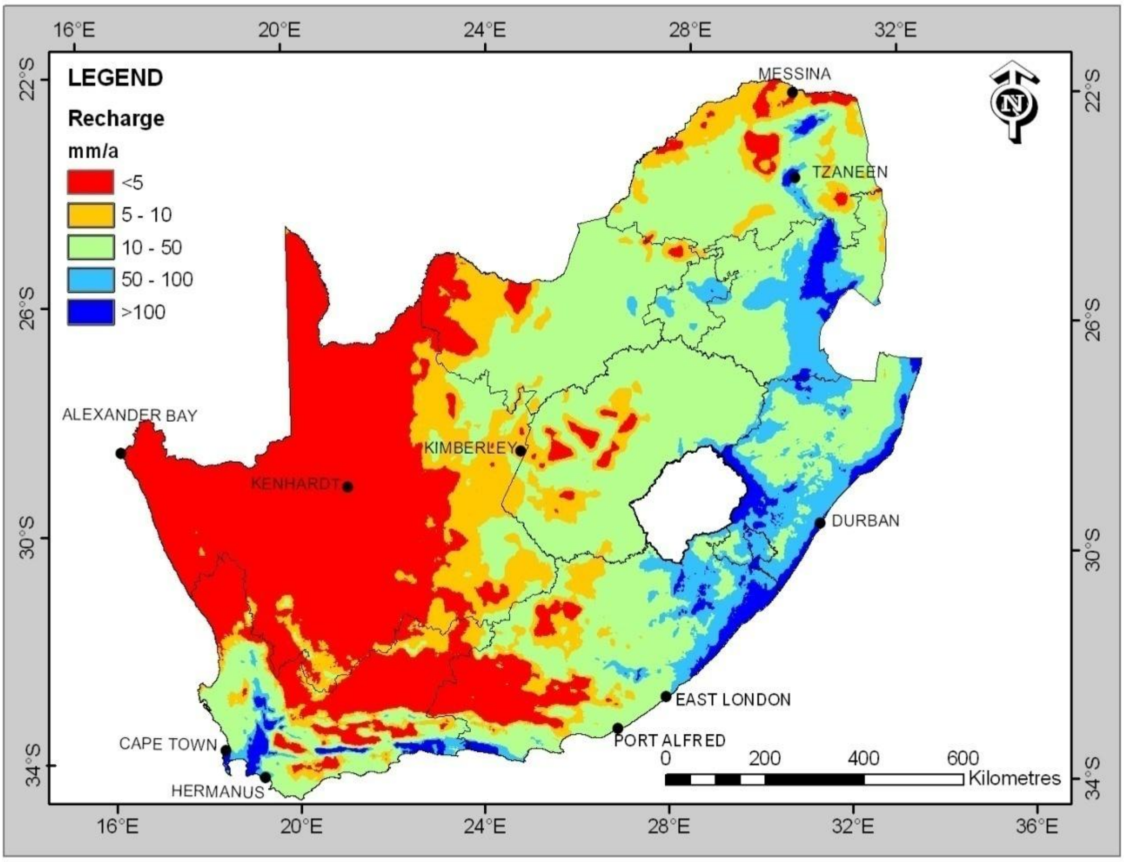


Figure 2.19: The status of aquifer recharge in South Africa (Musekiwa, *et al.*, 2013)

The Utilizable Groundwater Exploitation Potential in South Africa is estimated 10 353 Mm³ per year, allowing for factors such as physical constraints on extraction, potability and a maximum allowable drawdown (GRA II, 2005). The country currently uses approximately 2 000 – 4 000 Mm³ per year of groundwater, which is approximately 13% contribution to total water use.

For drought conditions the groundwater resource availability is 7 500 Mm^3, an indication that there should be sufficient groundwater to increase the use by approximately 5 500 Mm^3 per year.

Based on the UNESCO project (UNESCO, 2007) which utilised GRA II data and information; South Africa implemented some of the groundwater resource sustainability indicators. Those include; Groundwater renewable resource per capita, Groundwater abstraction as part of groundwater recharge, and Groundwater abstraction as part of exploitable groundwater resources. Calculations of these indicators are presented on Table 2.4 together with parameters GRA II parameters used in the calculations.

Table 2.4: Groundwater resources sustainability indicators for RSA based on UNESCO (2007)

Parameter	Value	Source/Comment
Groundwater renewable resources (m^3/a)	11 702 000 000	GRA II (2005)
Groundwater renewable resource per capita (m^3/a/inhabitant)	225	GRA II (2005), UNESCO (2007), RSA population Census 2011
Total groundwater abstraction (m^3)	1 771 000 000	GRA II (2005)
Groundwater recharge (m^3)	30 520 000 000	GRA II (2005)
Exploitable groundwater resources (m^3)	10 353 000 000	GRA II (2005)
Groundwater abstraction as part of groundwater recharge (%)	5.8	GRA II (2005), UNESCO (2007)
Groundwater abstraction as part of exploitable groundwater resources (%)	17.1	GRA II (2005), UNESCO (2007)

With the population increase to 52 million (Census 2011) since then, Groundwater renewable resource per capita has decreased from 261 in 2007 to 225 m^3/a/inhabitant in 2013. Nonetheless, percentages of Abstractions as part of recharge and Abstractions as part of exploitable resources still imply that in South Africa, groundwater recharge and exploitable groundwater resource are higher than the abstraction rate, indicating that the country still has a potential for further resource development.

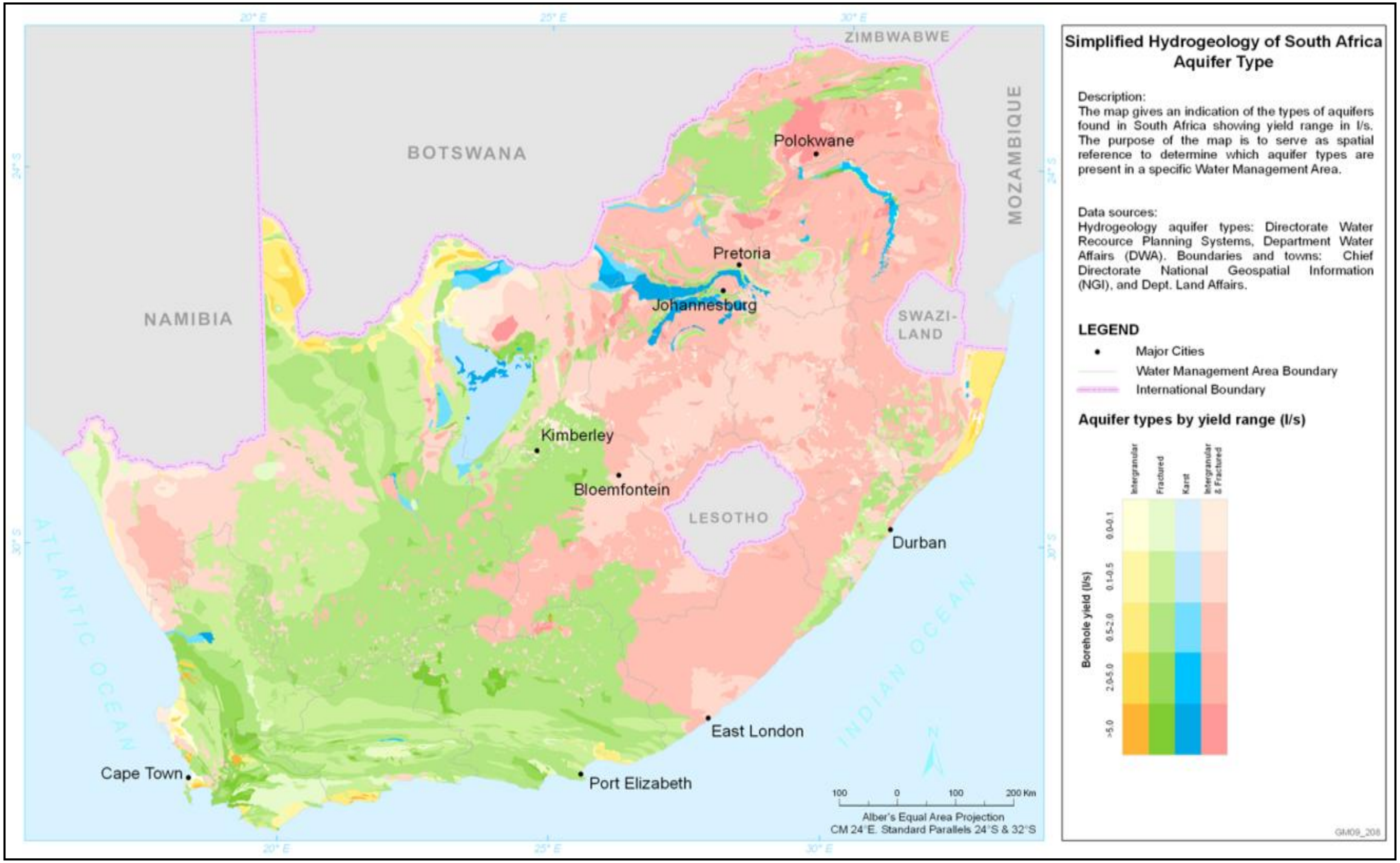


Figure 2.20: The aquifer media and groundwater yield classes in South Africa (GRA II, 2005)

2.6.1 Groundwater levels

The prevailing general trend in the country is that water levels are declining due to over-abstraction in some parts, especially in major Karst aquifers, as well as extensive plantation of Eucalyptus mainly in the coastal regions of the KwaZulu-Natal Province. Although the national trend is slowly declining, it is not a cause for concern yet since this is regarded as a long term cycle which could stabilised. An intense and high rainfall incident over a short period was experienced in January 2013 over most of the northern and north-eastern parts of the Limpopo Province and this led to some dramatic responses in groundwater levels in that area. However, groundwater situation in some areas is dependent on local conditions and abstractions, and can deviate from general trend. According to Figure 2.21, winter rainfall regions show some increase which could be the response to the rains experienced in the last two quarters of the hydrological year.

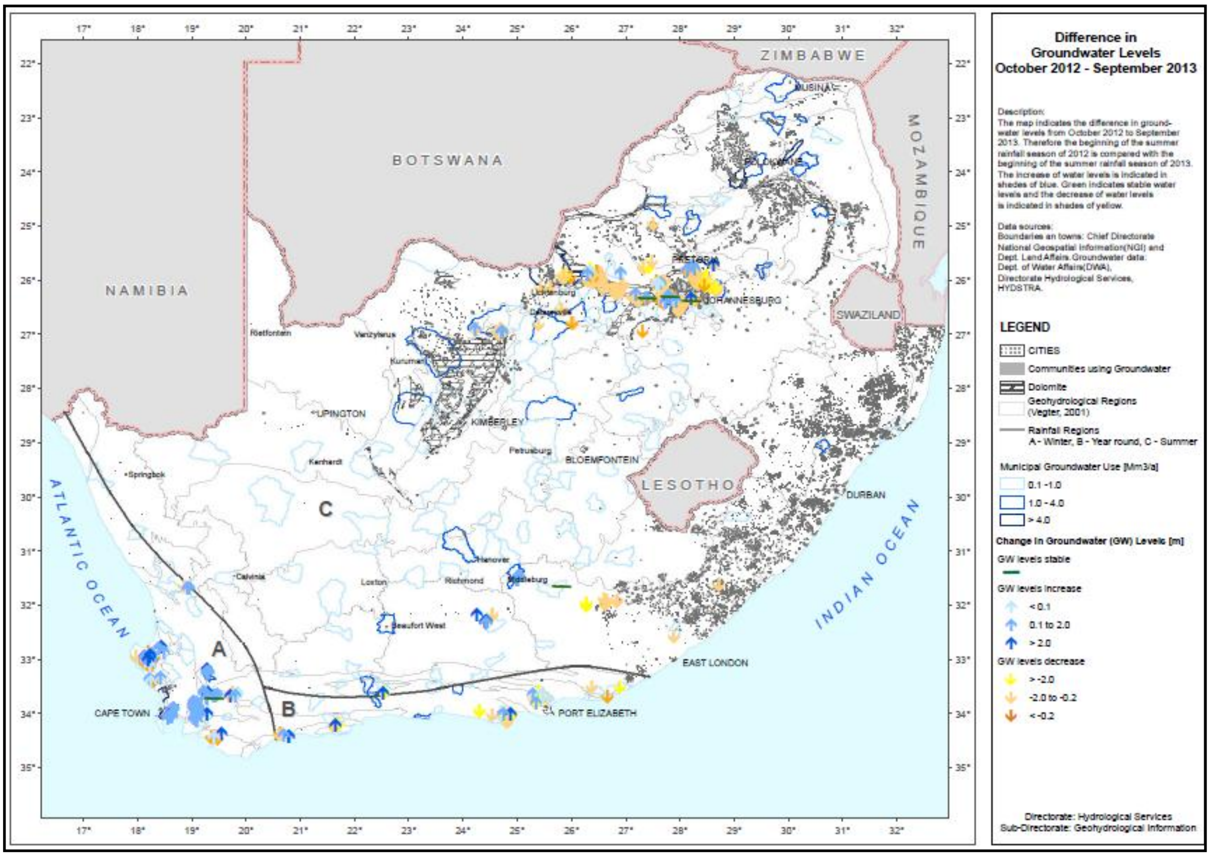


Figure 2.21: Annual groundwater level difference for the period 2012/13

2.6.1.1 Declining storage levels in dolomitic aquifers

Groundwater in the Karstic aquifers (dolomitic aquifers) of South Africa is under pressure. An ongoing WRC study found that groundwater levels in the North West, specifically the Mafikeng's Grootfontein wellfield, have dropped due to over-abstraction mainly for irrigation (Cobbing, WISA Newsletter, 2013). The same applies to the Steenkoppies Dolomite Compartment where the very high groundwater use for irrigation has resulted in flow reduction discharging from the Maloney's Eye and the groundwater levels dropping.

To further illustrate the gradually declining trends, two examples of karstic aquifers, Tarlton and Rietvallei in Gauteng were selected (Figures 2.22 and 2.23). The graphs show a declining trend for the past three hydrological years. When compared to the previous cycle, the water levels have dropped by about 0.6 m in Tarlton and 0.9 m in Rietvallei according to these graphs. In the Western Cape Province, the Vanrhynsdorp Karst Aquifer (E33F) showed a decline in groundwater levels over years (Figure 2.24). A study by Brits and Dyason, 2013 suggests groundwater over-abstraction.

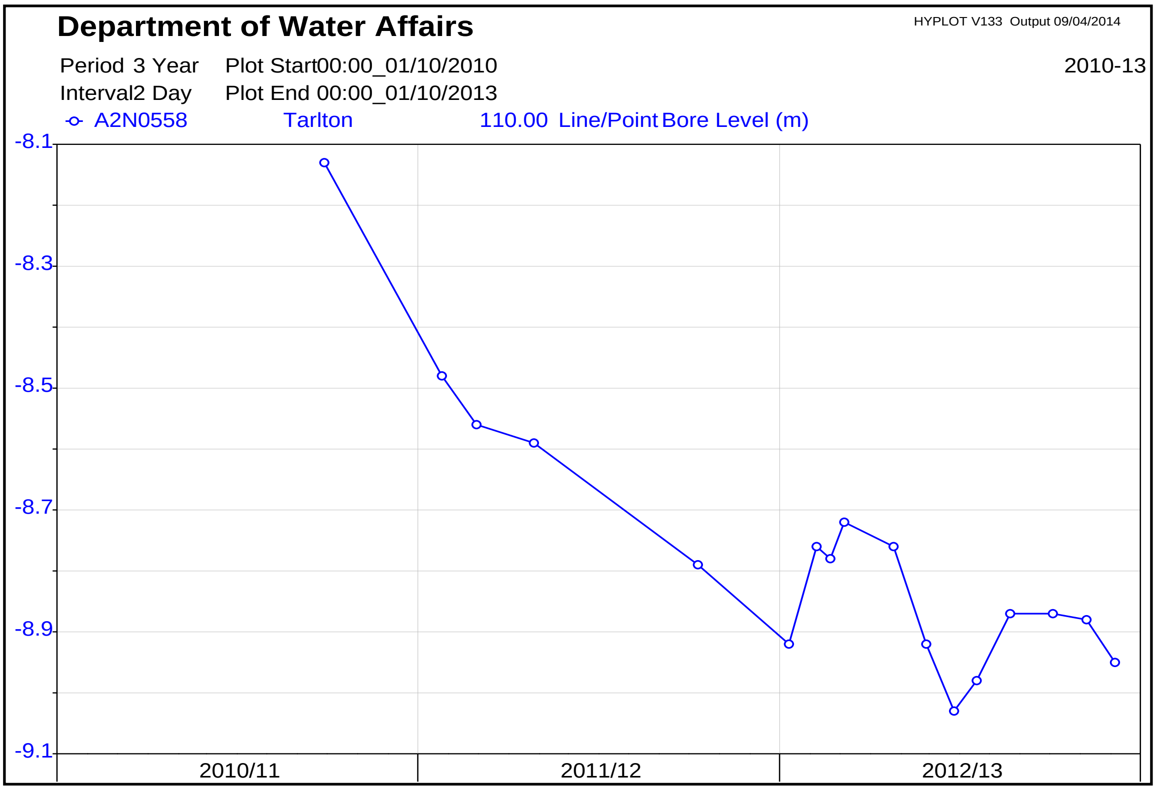


Figure 2.22: Declining groundwater levels in Tarlton (a dolomitic aquifer) during the past three hydrological cycles.

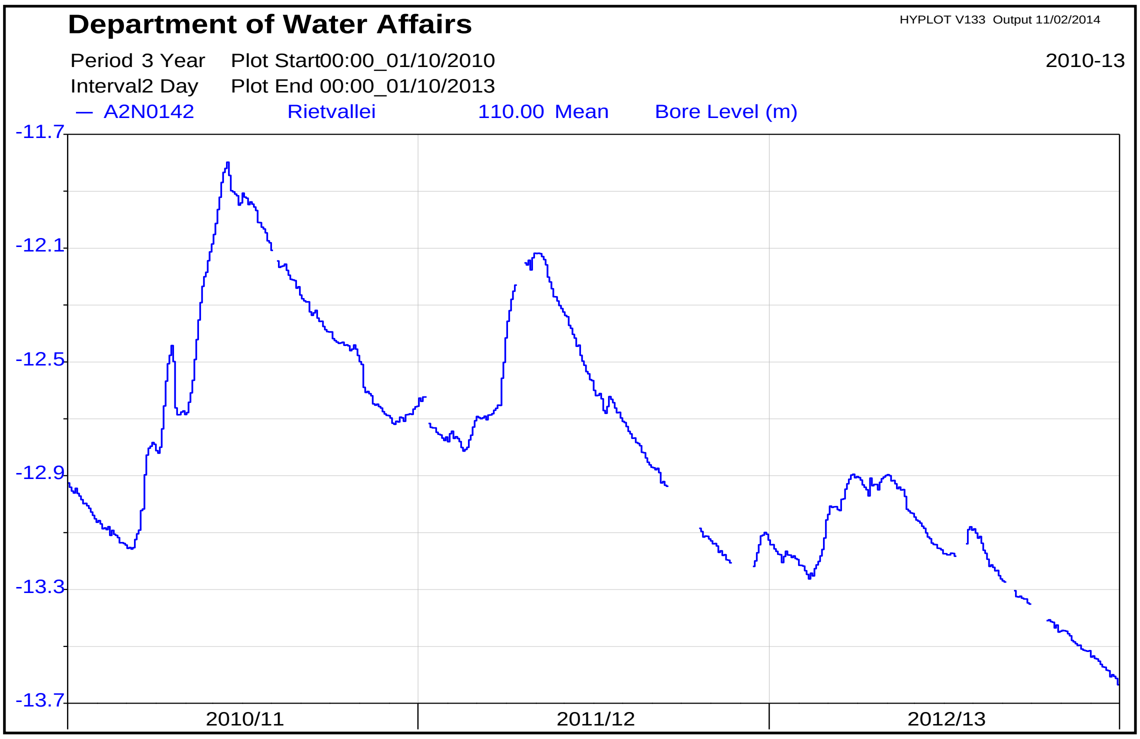


Figure 2.23: Declining groundwater levels in the Rietvallei (a dolomitic aquifer) during the past three hydrological cycles

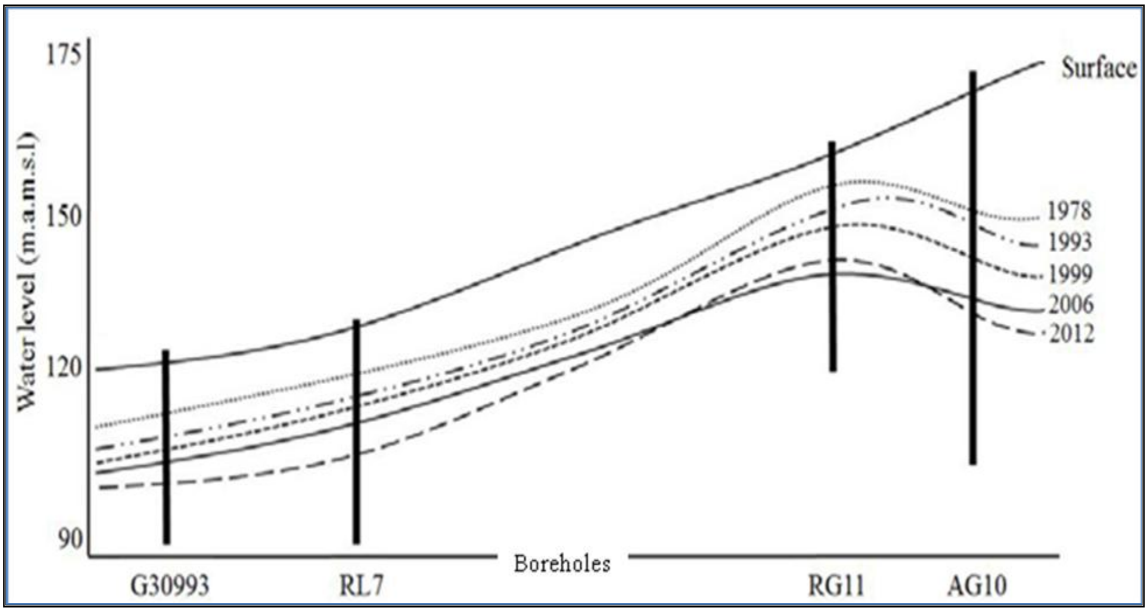


Figure 2.24: Groundwater level comparison profile for the Vanrhynsdorp karst aquifer (Brits & Dyason, 2013).

2.7 Hydrological extreme conditions

In South Africa the main common extreme events are drought and floods, mainly as a result of climate change. The impacts of climate change are increasing evaporation rates; frequent flooding and drought occurrence; changes in soil moisture; increased runoff; increasing climate variability and changes in water quality and groundwater flow recharge processes in shallow aquifers (Chen *et al.*, 2002).

Floods can be destructive causing damages to infrastructure, lose of life, diseases etc. Drought conditions put severe pressure on the already scarce water resources, society and the economy, in particular food production and water security, sanitation, energy, industry, and the functioning of freshwater ecosystems (UN, 2010). This contributes to poverty, malnutrition and poor health.

Water is the primary medium through which climate change influences Earth's ecosystem and thus the livelihood and well-being of communities. Studies have shown significant trends in some indicators of river flows, significant links with trends in temperature or rainfall. Higher temperatures and changes in extreme weather conditions could affect availability or yield and distribution of rainfall, snowmelt, river flows and groundwater, and further deteriorate resource quality.

2.7.1 Climate Change

The country has been divided into six hydro-climatic zones to assess the water related impacts of climate change (Figure 2.25).

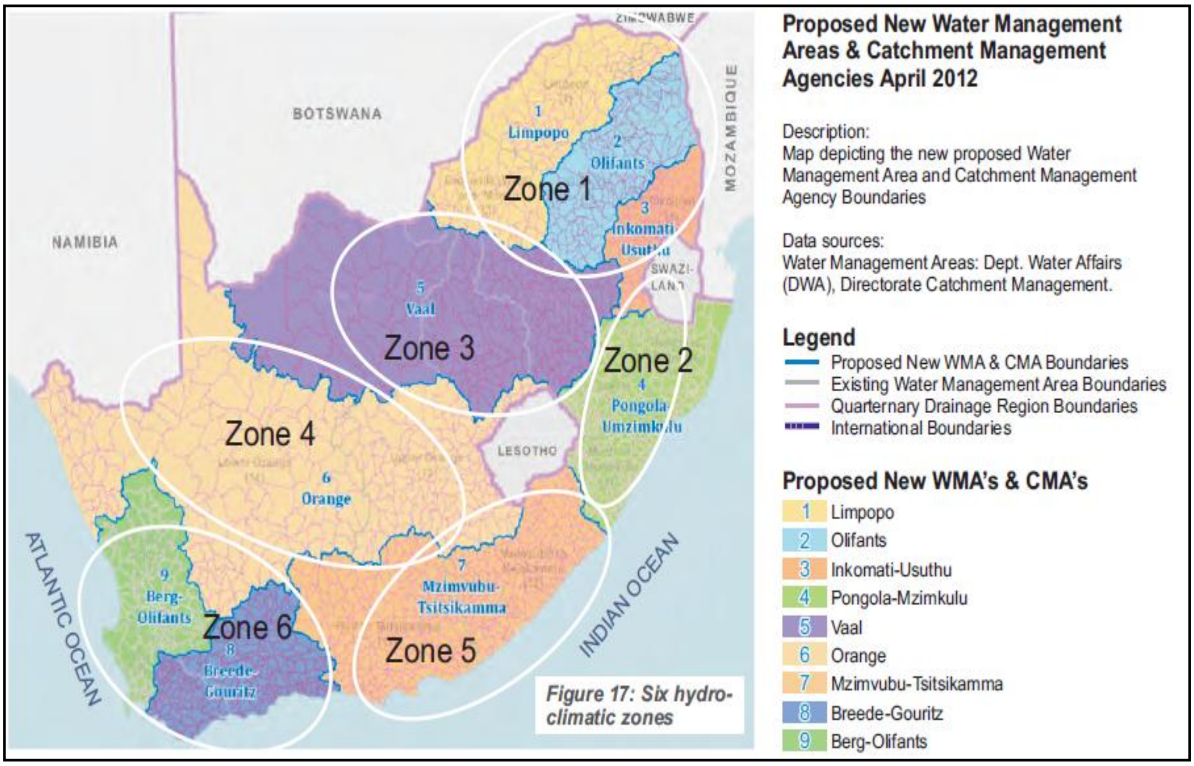


Figure 2.25: Map showing the six hydro-climatic zones

The Department of Water Affairs has developed a policy “National Climate Change Response” White Paper that presents the vision of South African Government for an effective climate change response. A strategy, which will provide guidance on adaptation to water-related impacts of climate change, is still in its development stage. Based on the Global Circulation Models (GCM) surface air temperature in South Africa is expected to get warmer throughout the country with the interior getting even higher temperatures. The increase is likely to result in increased water demands and increased evaporation.

2.7.2 Floods

Flood processes are influenced by a variety of climatic and non-climatic processes. These processes include intense and or long-lasting precipitation, dam break or storm. Floods depend on precipitation intensity, volume and dams. They are highly destructive to infrastructure, cause water contamination as water washes down all dirt that has accumulated on land. Contamination of water increases the risk of epidemics of waterborne diseases such as dysentery, cholera etc.

The DWA has a Flood Management System that is used to generate information for the management and mitigation of flood events in the Vaal-Orange River, Limpopo and Olifants River Systems. The main objectives of management are to ensure infrastructure is operating well especially during high flows; minimize loss of human life and damage to property and infrastructure.

Heavy rains were experienced in the in the KwaZulu-Natal and Eastern Cape Provinces, specifically in Port Alfred and Grahamstown during October 2012. Heavy rains were also experienced in the north and north eastern parts of the country in the Limpopo, Olifants and Inkomati River systems in January 2013. The rapid increase in water levels resulted in flooding along the Limpopo, Olifants, Levuvhu, Sabie, Crocodile and Komati Rivers. During the floods three people were killed as their car was swept away. The Tugela River burst its banks in February 2013 flooding the area. Photos 1 and 2 show damages caused by floods in different areas of the Limpopo and Mpumalanga provinces.

Floods in Limpopo and Mpumalanga (www.bdlive.co.za; timeslive)

In April 2013, Gauteng experienced heavy rains causing flooding in Kliptown in Soweto. In June 2013, the Western Cape was hit by a series of cold fronts, bringing with them hail storms, strong winds and plummeting temperatures around the Cape Peninsula, Agulhas, Gugulethu, Hout Bay and Langa. Sutherland and Matroosber, near De Doorn, received heavy snowfall. The Western Cape experienced heavy rains in August 2013 also resulting in dams filling up and some spilling.

The Western Cape recorded almost double the amount of rain for the month of August 2013, compared to the average for the area. The heavy rains were accompanied by gale-force winds and cold temperatures. Several communities required assistance after a number of rivers burst their banks and roads were closed due to localised flooding (Photo 1). All dams were recorded full to capacity. The pass between Franschhoek and Villiersdorp and Chapman's Peak were closed after a mudslide and a rock fall.

Flooded roads and rivers in the Cape Province (www.news24.com).

2.7.3 Drought

Although droughts can persist for several years, even a short, intense drought can have a substantial impact on ecosystems, agriculture and economy. Drought is brought about by lack or limited rainfall with high temperatures speeding the process of dryness. There are three types of drought namely; hydrological, meteorological and agricultural drought. The SAWS considers meteorological drought to assess dry conditions. The Hydrological Extremes functional environment uses the Standardized Precipitation Index (SPI) to monitor and characterize droughts in South Africa. The SPI provides an indication of rainfall conditions based on the historical distribution of rainfall.

The 12- and 24-month SPI maps (Figure 2.26) give an indication of areas where prolonged dry conditions exist because of below-normal rainfall recorded over a period of one year or longer. The most noticeable are the severely to extremely dry areas in the North West, Free State and Northern Cape Provinces. The North West and the Free State Provinces presented with 7 and 9 dams respectively that had very low storages an indication of very low rainfall that lead to dry conditions (Table 2.5). These conditions have resulted in critical shortages of safe drinking water and damages to crops. Northwest Province was declared a state of disaster for the drought.

Two year SPI shows that the drought has been creeping on us over time even though there may have been months when the rain was near or even above normal. These indicate that the areas experiencing severe to extreme dry conditions have the hydrological systems and surface water resources severely impacted. Figure 2.27 shows the status of dry conditions form October 2012 to September 2013.

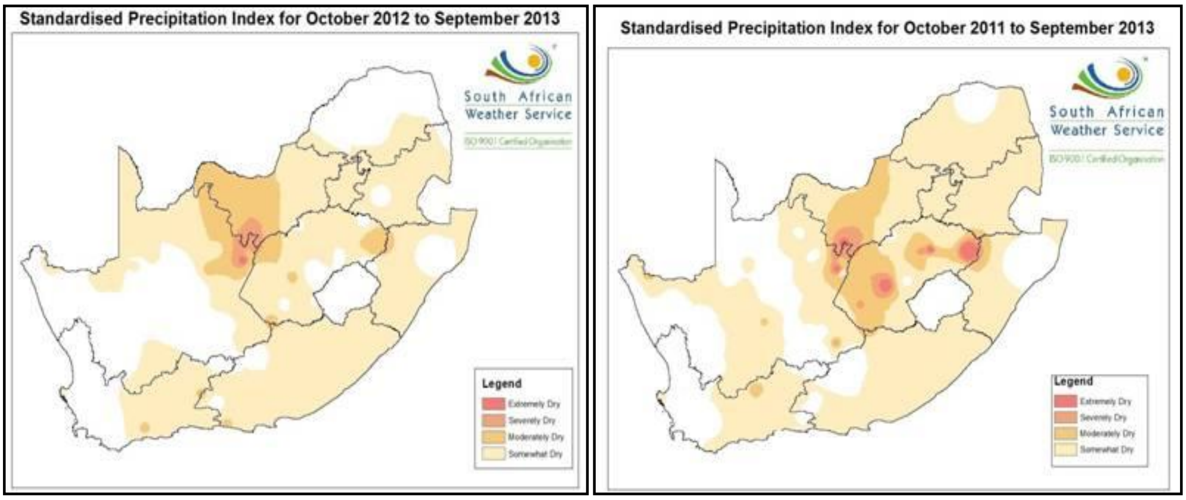


Figure 2.26: The 12- and 24-month SPI maps showing areas with prolonged dry conditions

Table 2.5: Dams with very low storage at end September 2013

WMA	Province	River	Dams
3	NW	Ngotwane	Ngotwane
		Groot Marico	Moletedi
		Klein Marico	Kromellenboog
		Elands	Lindleyspoort
		Koster	Koster
		Sehujane	Sehujane
		Molopo	Disaneng
13	FS	Kgabanyane	Groothoek
		Tierpoort	Tierpoort
		Leeu	Armenia
		Modder	Rustfontein, Krugersdrift
		Riet	Kalkfontein
		Caledon	Welbedacht
9		Sand	Allemanskraal
		Groot-Vet	Erfenis
		Vaal	Bloemhof

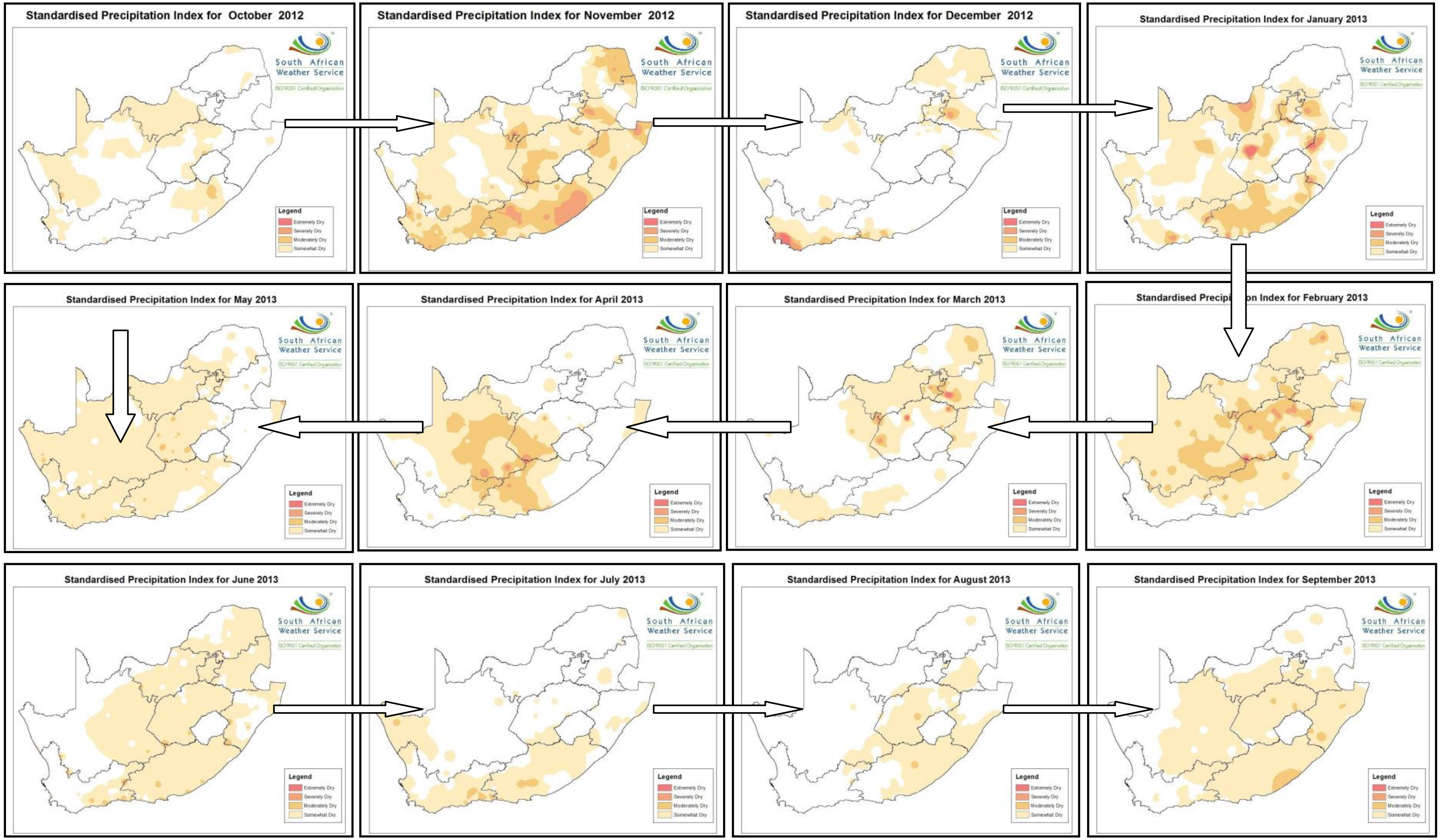


Figure 2.27: Monthly SPI maps showing changes during the hydrological year 2012/13

2.8. Water restriction

The imbue-effect of dry condition, low rainfall and low storage levels motivated the imposing of restrictions on some dams in the North West and Free State Provinces (Table 2.6). Restrictions recommended in the Free State were much higher this reporting year than the previous year. Storage at the Erfenis and Allenmanskraal dams dropped to 5% and 10% respectively.

Table 2.6: Dams with low storages where restrictions were recommended

Dam Name	River	Province	%Restrictions
Koster	Koster	NW	100% for irrigation, 50% domestic
Lindleyspoort	Elands	NW	10% irrigation
Erfenis	Groot-Vet	FS	65% irrigation
Allenmanskraal	Sand	FS	72% irrigation
Marico Bosveld			50% irrigation
Middleburg	Olifants	Mp	15% on all uses
Algoa System		EC	10%
Kromellenboog	29.1	2.601	50% irrigation

2.9 Sedimentation of Dams

The DWA conducts sedimentation surveys every five years to establish impact on storage capacity. Dams like the Welbedacht are severely affected by sedimentation (Figure VV). Sediments in rivers can also shorten the lifespan of dams and reservoirs. The problem is exacerbated by the soil structure that is very sandy and easily washed off by heavy flows. Clearance of alien vegetation, areas where there is mining, erosion, and donga are common contributors to sedimentation issues.

The Yellowwoods River with eroded banks and sand mining

3. WATER RESOURCE QUALITY

Surface water plays a critical role in sectors such as domestic, agriculture, industries, mining and power generation and contributes socially and economically to the country. Water quality describes the physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses and for the protection of the health and integrity of aquatic ecosystems (Department of Water Affairs and Forestry, 1996). The quality of water in the country is impacted by various land based activities that take place on a catchment. The impact comes in the form of diffuse on non-point source and point source pollution. The diffuse pollution is a challenge as the extent of impact is difficult to determine. Irrigation is the largest water user in the country and has a huge potential for wastage and pollution of water. Mining and some industries have a potential of releasing harmful chemicals that could have devastating effects on ecosystems. The lack of basic services, such as provision of sanitation facilities, to communities is also contributing to the problems of poor water quality.

South Africa is currently faced with the problems of eutrophication, salinisation, faecal pollution, and acid mine drainage (AMD) which adversely affect the quality of water. Although these processes do occur under natural conditions, they are exacerbated by anthropogenic activities, such as:

- Agriculture: results in sedimentation, salinity and the introduction of nutrients (phosphorus and nitrogen) which contribute to eutrophication;
- Industries: industrial effluent contains a cocktail of chemicals and toxicants;
- Mining: leachate and decant from both operational as well as closed and abandoned mining activities contribute to AMD and metals;
- Urbanisation: storm water runoff containing land-deposited human and animal waste could result in to faecal pollution;
- Untreated or partially treated waste effluents from Wastewater Treatment Works (WWTW) are complex and could introduce high levels of nutrients and microbial contamination into the water.

The Department of Water Affairs is running monitoring programmes namely: Eutrophication (NEMP), Microbial (NMMP), Chemical (NCMP), Toxicity (NTMP), Radioactivity (NRMP), National Aquatic Ecosystem Health Programme (NAEHP) and Estuarine, which collect data to assess the status and trends of water resources in the country as well as made good decisions in managing the resources.

3.1 Eutrophication

South Africa is hugely dependent on water stored in dams for socio-economic uses. Some of these dams are experiencing excessive amounts of nutrients which are introduced by raw or partially treated effluents or run-off from irrigated land that had fertiliser applied. Dams that have been affected by high levels of nutrients present with Blue-green algae (cyanobacterial blooms) which produce cyanotoxins (microcystin). These cyanotoxins can pose a health-risk to both humans and animals (including aquatic animals) if ingested. The affected dams are classified as either hypertrophic (excessive levels of nutrients) or eutrophic (high levels of nutrients). Algal and cyanobacterial blooms, and particularly surface scums that might form, are unsightly and can have unpleasant odours. This is often a problem in urban impoundments where people live close to the affected water body. The high level of nutrients in dams is referred to as eutrophication and has become a huge water quality problem in the country. The problem decreases the fitness for use of the water for water sports such as skiing, yachting and fishing. Eutrophication has an economic impact in that algal or cyanobacterial scums increase the costs of water treatment as excessive blooms can clog filters and increase maintenance costs. The levels of oxygen are depleted and biodiversity is lost and only the tolerant species survive the deteriorated conditions.

The nutrient enrichment of surface water is the main contributor to the problem of eutrophication. The nutrients come from discharges of partially treated or untreated wastewater from overloaded or malfunctioning WWTWs. Other contributors are agricultural and urban runoffs carrying fertilisers and industrial wastewater. Plant growth is also fuelled by the release of nutrients, absorbed in the sediments, during the dam mixing. Eutrophication has negative effects on ecosystems, human health, economy, aesthetics and recreation. It can cause bad taste and odour, increase in treatment costs, loss of biodiversity due to toxic cyanobacterial blooms.

The DWA runs the National Eutrophication Monitoring Programme (NEMP) which was created specifically to monitor rivers, lakes and dams for the potential and effects of eutrophication. The programme is active in 18 water management areas and is still to be implemented in the Fish to Tsitsikamma WMA within specific to dams.

Photo of Water hyacinth upstream of the Bridledrift and Laing Dams in the Buffalo River.

The trophic status of some of dams is shown in Table 3.1. The most dominant algae species were *Aulacoseira*, *Ceratium*, *Cryptomonas*, *Microcystis* and *Pediastrum*. *Ceratium* and *Microcystis* were most dominant in Modimola, Klipvoor, Roodeplaat, Hartebeespoort, Roodekopjes and Belfast dams as well as Civic, Florida and Kalkfontein lakes. *Cryptomonas* was the most dominant species for the Bruma Lake. The rivers draining into these resources showed high nutrient content. Excessive algal blooms and nuisance growths of invasive aquatic weeds were amongst symptoms noted in these dams and lakes.

Table 0.1: Trophic status of some of the dams as at September 2013

Dam	River	Status
Roodekoppies	Crocodile	Hypertrophic
Klipvoor	Pienaars	
Belfast		
Olifantsnek	Hex	
Bospoort	Hex	
Outlet Kleinfontein (at Benoni)		
Cooke Lake	Molopo	
Lotlamoreng	Molopo	
Modimola	Molopo	
Disaneng	Molopo	
Hartebeespoort	Crocodile	
Roogekopjes		
Allemanskraal		
Vaalkop		
Laing	Buffalo	
Bruma Lake	Juskei	
Roodeplaat	Pienaars	Eutrophic
Bon Accord	Apies	
Olifantsnek		
Civic Lake		
Briddledrift	Buffalo	

The Bon Dam appears to have improved from hypertrophic in summer to eutrophic in winter 2013 whilst the Reitvlei Dam has vastly improved to mesotrophic status. Dams such as the Leeukrall, Bullhoek, Bothasfontein and Blaanplan Lake that were hypertrophic in summer have showed improvement during winter while others remained hypertrophic.

Although there is a lot of time and both financial and human resources, very little or no improvement at all observed as the dam continues to be hypertrophic. The challenge is that polluted water from overflowing manholes and waste washed down into the river continuously enter the Haartesbeespoort Dam. An effective solution would be to deal with source of pollution. Most of the dams affected by eutrophication problem mainly receive effluents from the sewage works and few from irrigation runoffs. These sewage works discharge effluents that do not comply to set standards.

Figure 3.1 shows eutrophication potential and trophic status of dams and rivers for the period October 2012 to September 2013. A majority of dams and streams in the Crocodile-West Marico WMA are ranging from mesotrophic to hypertrophic with significant to serious eutrophication potential. These are water systems downstream of highly developed/economical areas which results in the introduction of excessive nutrients. Water systems in the Olifants, Upper and Middle Vaal also showed serious eutrophication potential.

Staff turnover, delays in procurement of sampling materials and equipment are some of the challenges experienced with the monitoring network and this has led to the decline in sampling compliance. There are processes in place to expand the monitoring programme to cover all priority areas.

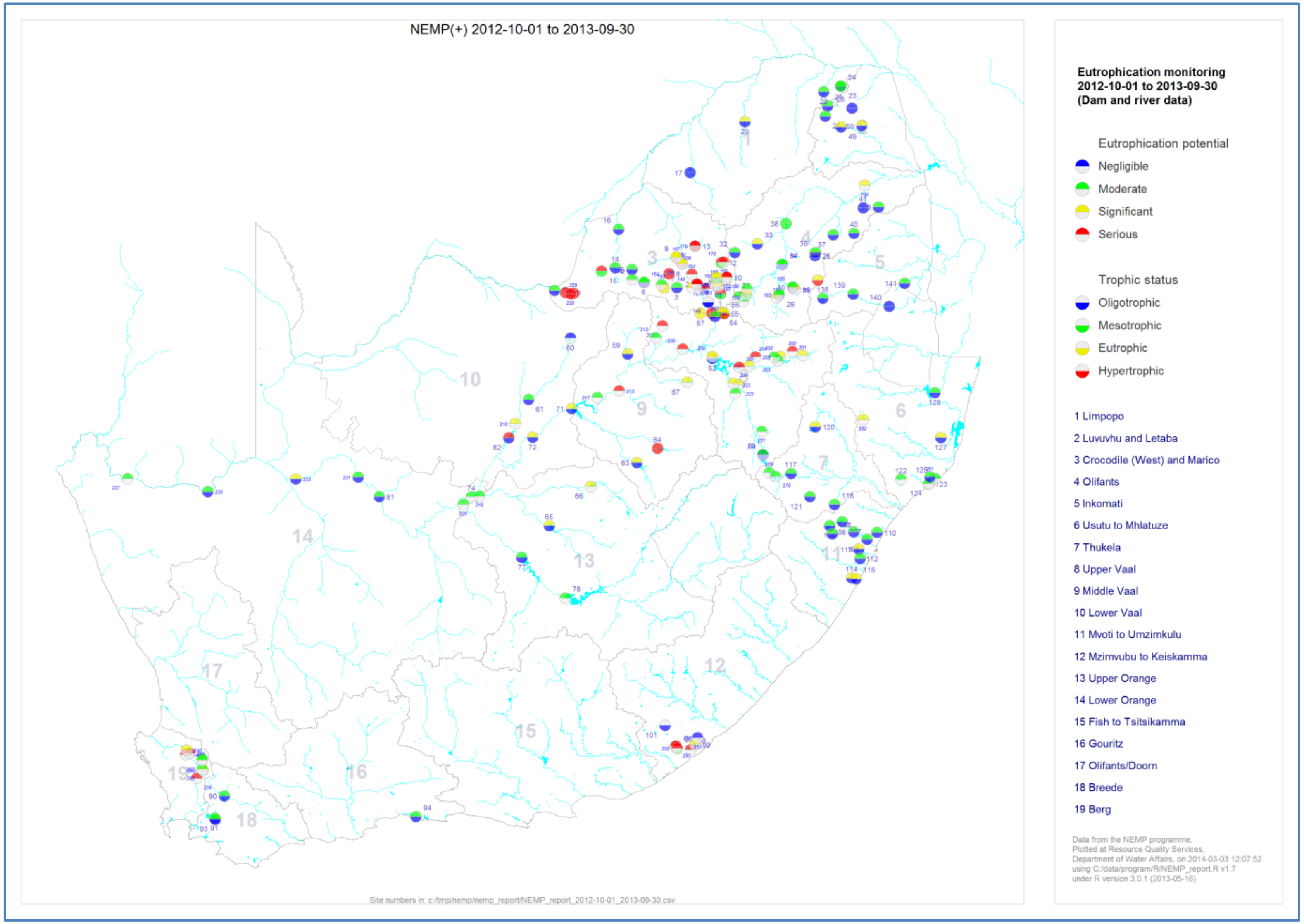


Figure 0.1: National trophic status and eutrophication potential in dams and rivers as at end September 2013

3.2 Microbial pollution/contamination

The water quality is impacted by faecal pollution that comes from the absence of sanitation facilities (mainly informal settlements) as well as partially and/or untreated sewage effluents. In some cases, raw sewage from malfunctioning pump stations flow into the river thus introducing faecal pollution. Where there are feedlots near a river, the chances of waste being washed down into the river are high bringing with it faecal contamination. The presence of faecal pollution is assessed using micro-organism *Escherichia coli* (E. coli) as an indicator. The presence of the organisms in water can cause water-borne diseases such as cholera, typhoid fever and viral gastroenteritis.

The department currently monitors, through the national microbial monitoring programme (NMMP), the status of microbial pollution in selected areas that are considered “priority areas” where faecal pollution will pose serious health problems. The monitoring of priority areas has its own problems because some areas that have problems with faecal pollution do not appear on the map creating an impression that there are no problems. The fact that samples for microbial pollution testing must done within 24 hours has created a challenge for the DWA as some laboratories across the country are not accredited and therefore cannot analyse samples.

There is a serious problem with faecal pollution country wide. Effluents discharged from WWTWs appear to be the main contributors to the problem. This could be due to poorly treated or untreated wastewater as municipalities are struggling with the operation and management of WWTWs. According to Figure 3.2, rivers in the Crocodile West/Marico, Olifants, Berg, Gouritz, Mvoti to Umzimkhulu and Mzimvubu to Keiskamma WMAs are the worst affected. In some of the rivers there are dams from which water is abstracted by Water Purification Plants for domestic supply. The Blue Drop and Green Drop Programmes have been designed to encourage municipalities improve the performance of Water Purification Plants and WWTWs. The main purpose of the Blue Drop Programme is to improve drinking water quality while the Green Drop Programme is to ensure discharge effluents that comply to set effluent standards. Both programmes have shown improvements in the operation or performance of the works and effluent compliance and quality of drinking water.

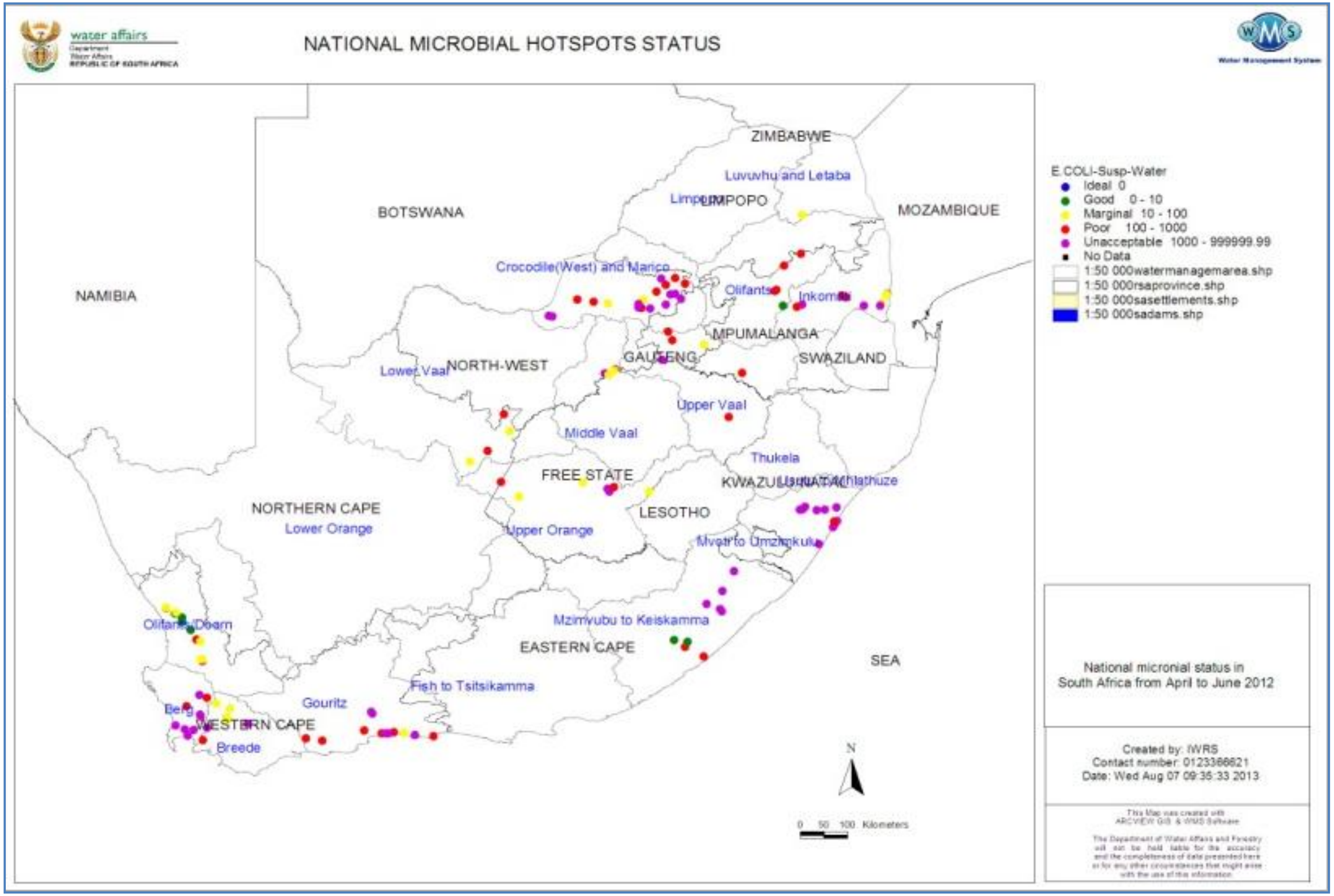


Figure 0.2: The national status of faecal pollution in the country

Table 0.2: Guidelines for assessing the potential health risk for the four water uses

	Potential health risk		
	Low	Medium	High
Water use	*E. coli* counts/ 100ml		
1. Drinking untreated water	0	1 - 10	> 10
2. Drinking partial treated water	< 2 000	2000 – 20 000	> 20 000
3. Full contact recreational	< 130	130 – 400	> 400
4. Irrigation of crops to be eaten raw	< 1 000	1 000 – 4 000	> 4 000

The microbial data for the period indicated on the map show that the rivers in the WMA's where the NMMP are active pose posed a high risk of infectious diseases if it is untreated and used for drinking. There are two sites in the Mpumalanga province namely the Belfast and Mahlebe Dams (Figure 3.3) that showed low health risks. These risks become lowered in most cases when the water undergoes limited treatment. A number of water management areas show a high risk to moderate risk when using the water for recreational purposes with a few areas showing low risk. Areas in the Berg, Mvoti to Mzimkhulu and Crocodile West Marico WMA's posed a high health risk to users when irrigating crops that are to be eaten raw.

Table 0.3: List of rivers affected by microbial pollution and associated risk to users

WMA	Affected areas	High Risk Status
Upper Vaal	Standerton Sakhile downstream of STW Rietspruit at Kaalplaats Klip River – upstream Durban deep mine	Risk on all uses Drinking without treatment Full or partial contact Drinking without treatment
Olifants	Kwaguqa Delmas Middleburg Steelpoort	Risk on all uses
Crocodile West and Marico	Waterval on Hex River Maboloka on Phuleng River Rustenburg Correctional Services (whole river impacted with certain areas having high risk with all uses	Risk to all uses
Middle Vaal	Skoonspruit Goedenoeg	Drinking without treatment Full or partial contact
Breede	Grabouw	Drinking without treatment

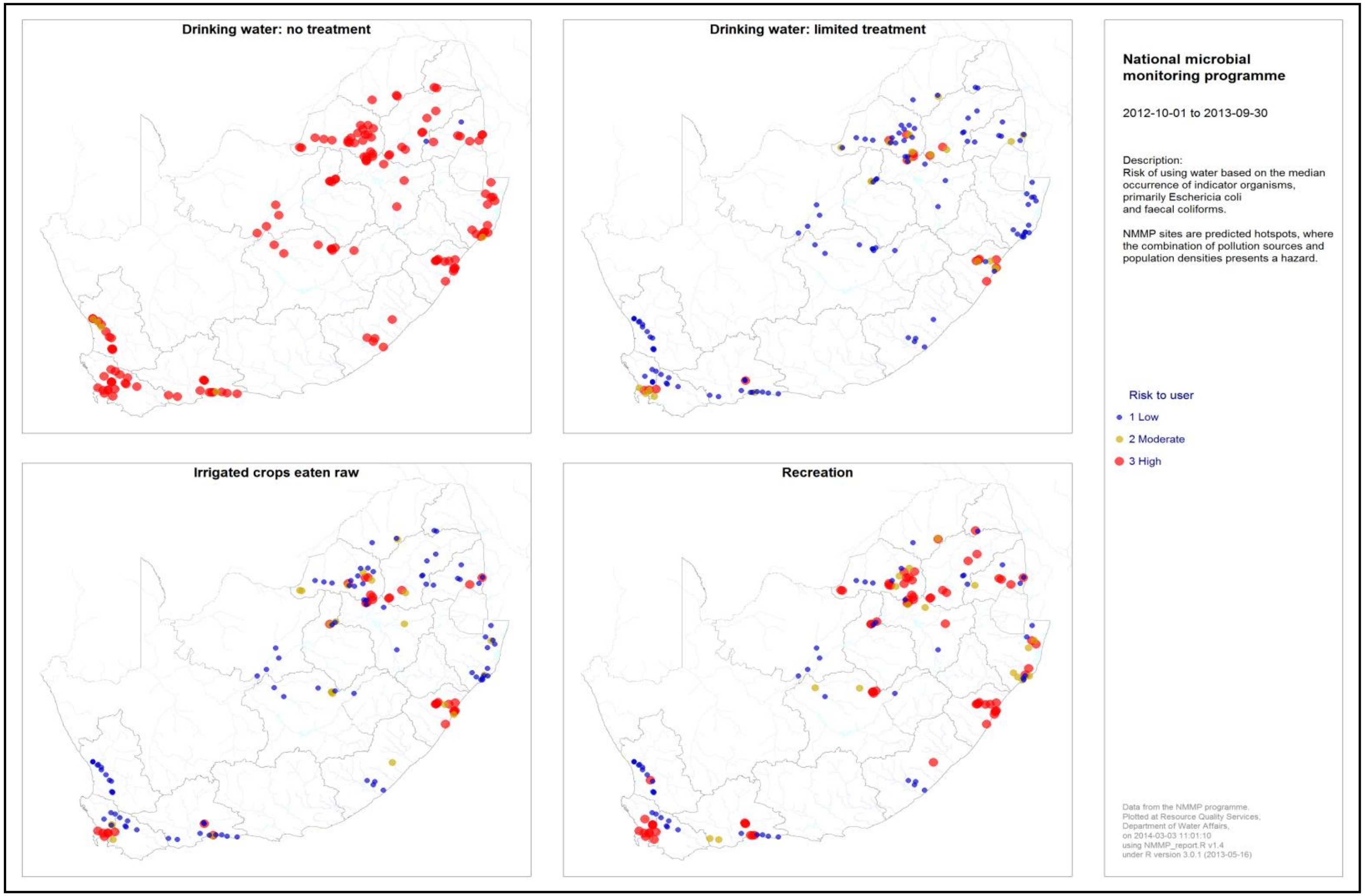


Figure 0.3: Health risk associated with each water use

3.3 Chemical water quality

Salinisation is a serious water quality problem. It is mainly caused by discharges from land based activities such as mining, agricultural runoffs, tannery and industries. Salinity mainly affects crops and stock watering. It can also affect riverine biota as most organisms are sensitive to high levels of salt in water. Discharges of effluents from textile and pulp and paper manufacturing are known to increase salinity in the river since their effluents produce sulphates, sodium, chlorides etc. Mining also especially coal mining produce high levels of sulphates. Tannery factory do contribute to salinity. Marine geology and possibly the intrusion of salty water from the sea in the Western and Southern Cape coasts might be contributing to the water with elevated salinity levels.

The DWA collects data through the National Chemical Monitoring Programme (NCMP). Inorganic chemical water quality attributes of concern for domestic use are: electrical conductivity (EC) or the comparable Total Dissolved Solids (TDS) – these both are measure of the level of salinity; nitrate and nitrite as nitrogen (NO_3 + NO_2 as N); ammonium (NH_4 as N); pH; fluoride (F); calcium (Ca); magnesium (Mg); sulphate (SO_4); chloride (Cl); sodium (Na); and potassium (K). For irrigated agricultural use; sodium adsorption ratio (SAR), EC, pH and Cl are the variables of concern. South African Water Quality Guidelines were used for the interpretation of the current fitness for use for both domestic use and irrigated agricultural.

According to Figure 3.4, high levels of salinity have been very high in the western and southern cape, and water is dominated by sodium and chlorides. However there has been a general decrease in concentrations of EC during this period compared to previous years as shown in Figure 3.4. The high salinity is due to the intrusion of salty water. The Lower Vaal appears to be impacted by the mining activities mainly in the Upper Vaal and agricultural return flows.

Sodium adsorption ratios across the country are generally favourable for crop yield. The pH for irrigated agricultural uses is within the target range throughout large parts of the country; in many cases pH levels shown on the map as not being in the ideal range may only be slightly outside of this range (Figure 3.5).

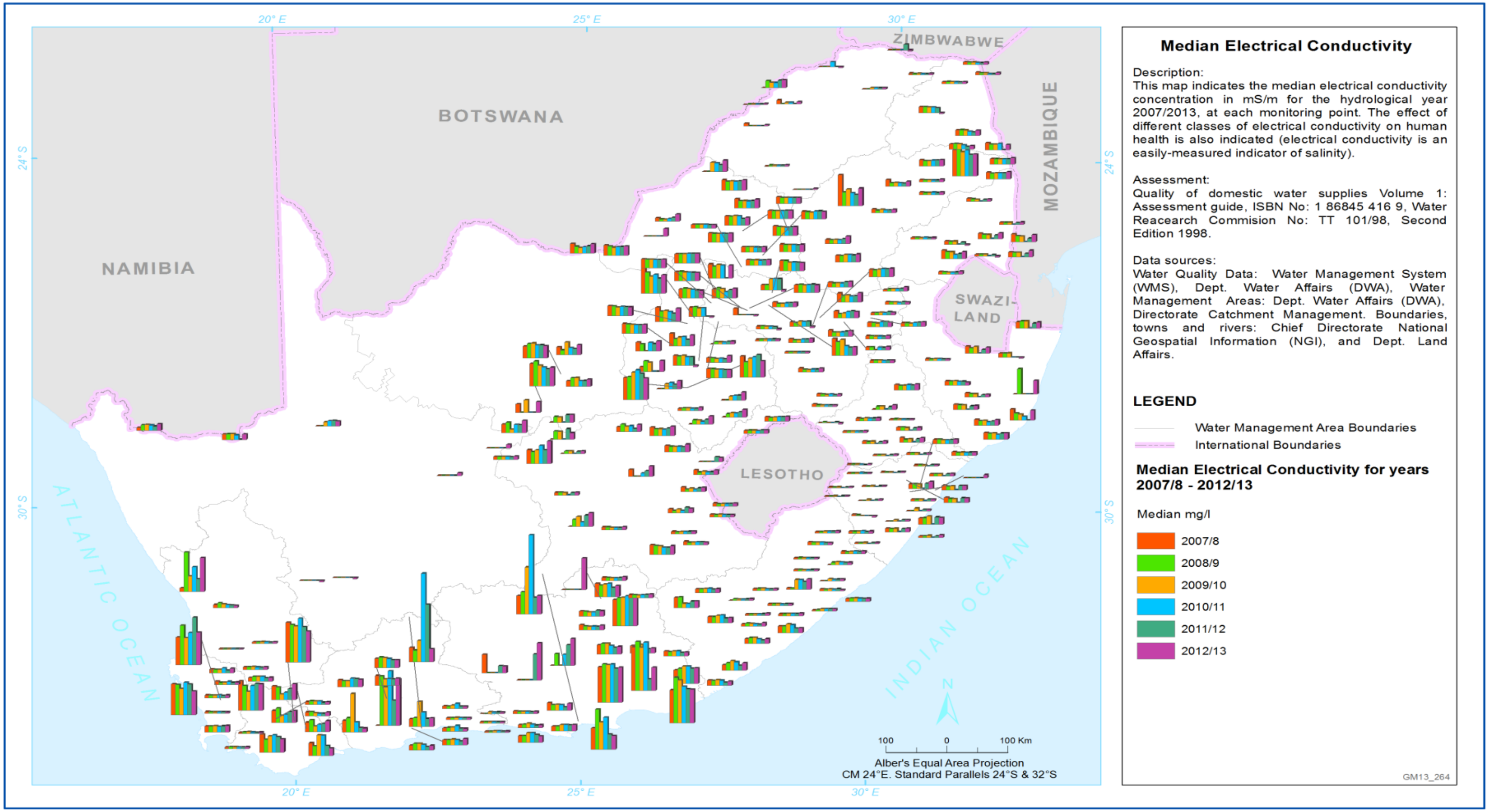


Figure 0.4: Median Electrical Conductivity for surface water from 2007/08 to 2012/13

Figure 0.5: The chemical analysis for salinity and its risk to various users during the 2012/2013 hydrological year

Currently the effects of toxicity in water are monitored through the National Toxicity Monitoring Programme (NTMP) using Endocrine Destructing Compounds (EDCs) as indicators and trace metals for selected sites on the Juskei River. Only seven site sites, N14, Kayalami, Malboro (Old sites), Midrand, Buccleuch Bruma and East Bank newly established sites), in Gauteng are monitored (Figure 3.6). The organochlorine pesticides such as Aldrin and Dieldrin, as well as DDT and its metabolites which are still used on a limited basis for malaria mosquito vector control; Phthalates from plastics, Triazine herbicides (Atrazine), Organ-phosphorus pesticides (Dichlorvos); some Polycyclic Aromatics Compounds such as Naphthalene and Polychlorinated Biphenyls compounds, are monitored. Most of the organic chemicals investigated were detected at all the selected sites water samples. Water in the N14, Midrand, Malboro, Kayalami, Buccleich, Eastbank and Bruma Lake sampling sites show the probability to cause high level acute harzardous effect on the environment.

To assess the status of water quality and effects of waste entering the resource, *Daphnia pulex* mortality test and *Danio rerio* embryo mortality test were done. There was growth stimulation of *Daphnia pulex, Selenastrum capricornutum and Vibrio fischeri* at all the sites*,* showing that the water medium was enriched with nutrients. *Danio rerio* embryo mortality test showed significant responses in increasing order from Marlboro, Kayalami, Eastbank and Bruma with 29.5%, 50%, 50% and 51.7 % response respectively.

Most organic pollutants were present at low levels at all the sites, below the 1996 water quality guideline values for compounds. The current data indicate that potential organic toxicants are present at low concentration in the water resources in the Gauteng area, and that more monitoring points need to be identified. Further monitoring is also required to establish whether there is a trend in the presence of toxicants in our rivers.

Moving forward with toxicity identification in our river, the Olifants WMA will be used to investigate the effect of the application of the field toxicity screening kit. The kit will be used to conduct a preliminary screening of the proposed hotspot sampling sites before samples are taken for laboratory analysis. The results of the investigation will guide the extension and the implementation of the toxicity monitoring programme to other WMAs in the country, and also to determine national baselines in toxicant concentrations so as to assist the water resources managers and industry to make informed decisions.

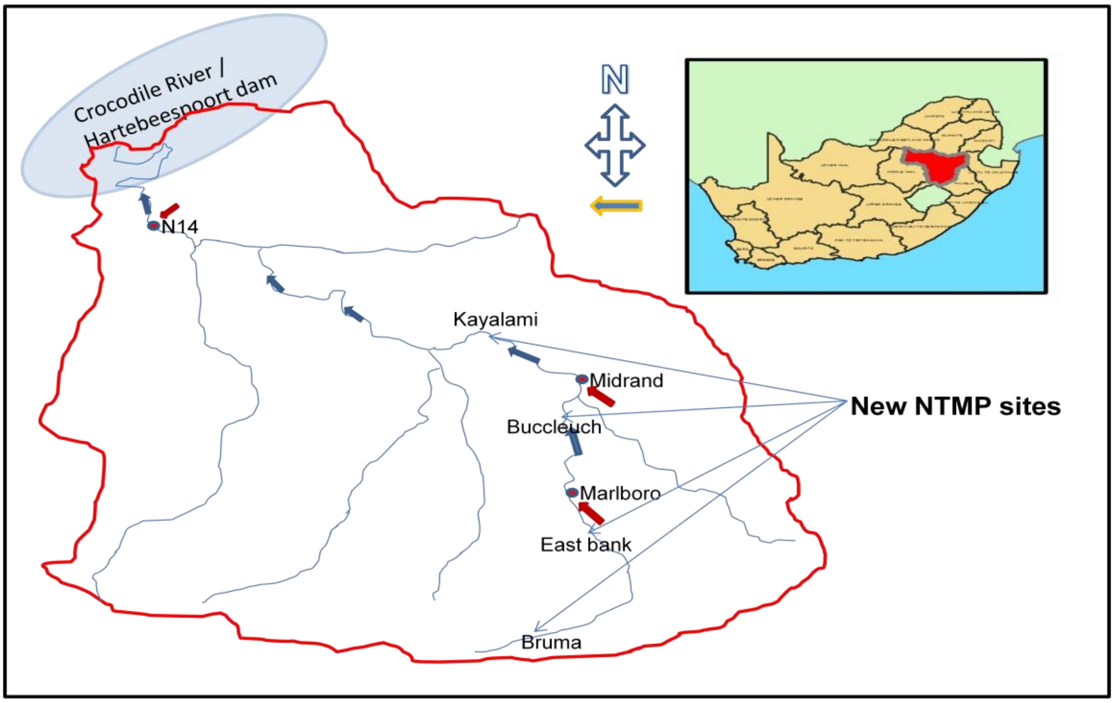


Figure 0.6: Location of monitoring sites for the NTMP

3.4 Groundwater quality

The data is collated from the National Groundwater Quality Monitoring Program on a bi-annual interval, based on a “before/after” rainfall season sampling program for the summer and winter rainfall regions of South Africa. Salinity trends are obtained from field measurements of the groundwater’s electrical conductivity taken during the bi-annual sampling exercises.

The nature and extent of the chemical, physical, and biological processes that control the fate and transport of microorganisms in South African aquifers have not been investigated fully and consequently the health risk to humans exposed to infectious organisms from groundwater, used for drinking, is also not well understood (du Preez et al., 2013). With the projected increase of groundwater demand, it is imperative that this resource is protected from possible impacts by pollutants such as microbial (bacteria, viruses, parasites) and chemical contaminants.

3.4.1 Groundwater quality status

The current groundwater quality map based on the Electrical Conductivity is shown in Figure 3.7. The map indicates that most WMAs have good groundwater quality as the concentration levels fall between marginal and ideal categories, implying acceptable limits according to the DWA guidelines for domestic use. Therefore, salinity trends for the larger part of the country were stable. The quality of groundwater in South Africa is classified as generally good potable drinking water with very little or no need for treatment at large scale.

In the Olifants/Doorn WMA some individual boreholes recorded maximum concentrations of 850 mS/m, 500 mS/m, and 450 mS/m; falling within the Unacceptable Limit category. Groundwater quality becomes very saline towards the north and the north-western part of the WMA and this is attributed to the proximity to the coast, the low groundwater recharge rates and the geological setting. The same applies to the Berg and Breede WMAs, with winelands probably contributing further to these high conductivity levels. The Lower Orange and the Fish to Tsitsikamma WMAs still indicate high concentrations and that is part of a long term trend of declining water quality by about 15 mS/m per year. Proximity to the sea, mining and some agricultural activities are the contributing factors to these high levels of concentration. These could also be an indication of sporadic local pollution due to local recharge events after a long dry period; especially those in the Gouritz, Fish to Tsitsikamma and the Mzimvubu to Keiskamma catchments.

The general groundwater quality map of South Africa which incorporates historical data is shown in Figure 3.8. Very high EC levels are mainly in the western part of the Northern Cape Province and the northern part of the Western Cape Province, that is, the Lower Orange catchment. Mining (copper, iron, etc) and agricultural activities are taking place in this catchment which could be the main contributing factor to such levels. However, it is not clear what the cause is around the Nossob area, but for the larger Molopo-Nossob basin, ORASECOM reports that the groundwater is unsuitable for human consumption in 41% of the basin in South Africa and unsuitable for livestock in 5% of the area due to high salinity levels. Cases of high EC levels in the coastal regions can be attributed to the proximity to sea water, geological settings and agricultural activities to some extent. The high salinity level in the other parts of the country is part of a long-term decreasing water quality trend in the order of about 15 mS/m per annum.

There are serious cases of localized pollution in some parts of the country, especially in the vicinity of mining and industrial activities. Local pollution on surface and poorly managed discharges of untreated effluents from sewage and other waste water treatment facilities pose a serious threat to groundwater systems. This is evident in the Thukela and Usuthu to Mhlathuze and Olifants WMAs where historical coal mining has resulted in AMD in areas such as Vryheid, Dundee, Newcastle and others (see Photos below).

AMD from a defunct Bannockburn Mine in Dundee and Vryheid Coronation Colliery

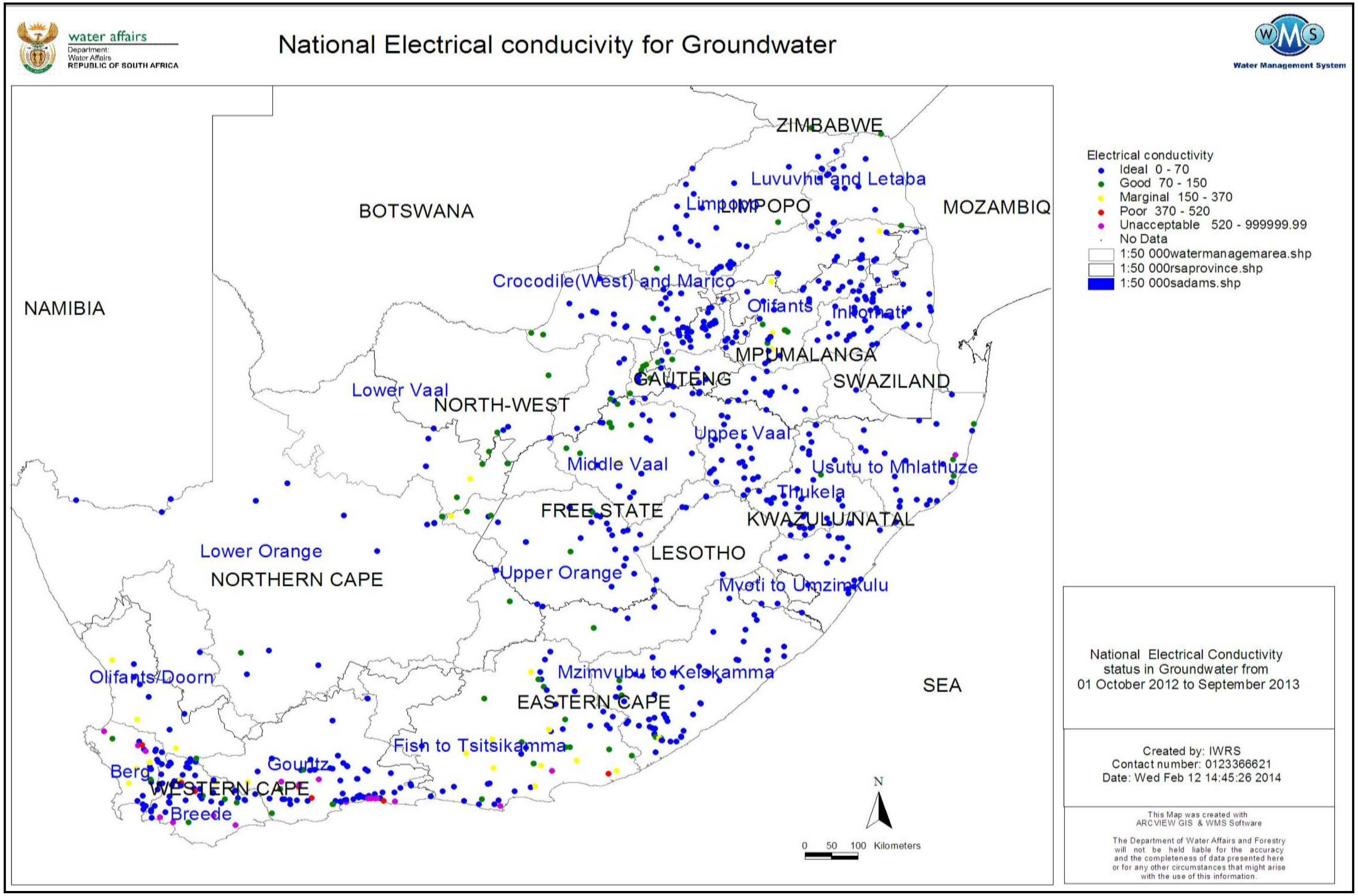


Figure 0.7: Status of Electrical Conductivity in groundwater

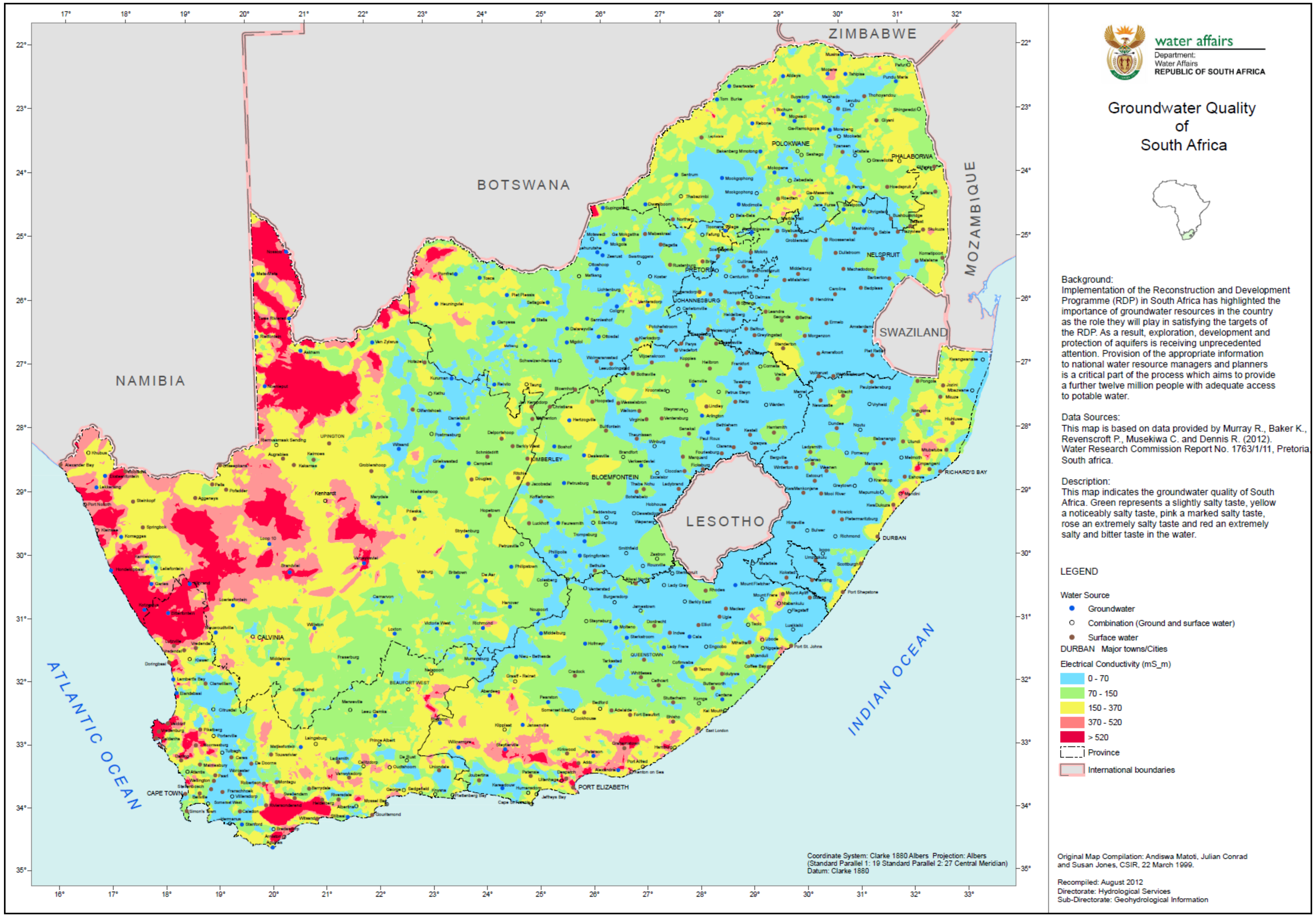


Figure 0.8: General groundwater quality map for South Africa based on the Electrical Conductivity status

Nitrates present in large areas of the aquifer system can also limit groundwater use. Most of these nitrates are of natural origin extending to the artesian part of the aquifers via the overlying Kalahari Beds. The Nitrate concentration map is shown in Figure 3.9. Nitrate concentration in groundwater can vary over a very wide range depending on the aquifer and its recharge characteristics. During extreme rainfall events, large areas are flooded and the groundwater recharge processes are modified, causing leaching of nitrates and other salts that had collected in the unsaturated zone over many years. This may affect the groundwater quality to such an extent that it becomes toxic, even to livestock. Local quality degradation due to anthropogenic nitrate pollution also imposes problems in some areas, largely due to stock watering localities within the proximity of the boreholes. The Northern Cape, North West and the Limpopo provinces show signs of marginal to high nitrate concentrations. These are areas with high agricultural activities, both stock and crop.

The Aquifer Vulnerability Map of South Africa in Figure 3.10 indicates aquifer systems that have to be protected from possible negative impacts. Those impacts include, among others, improper management of agricultural activities and wastewater treatment systems, mismanagement of mine water, and salt-water intrusion due to over-abstraction. Groundwater vulnerability is described as the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer or on earth surface. According to the map, the most vulnerable are dolomitic aquifers, aquifers in the Upper Orange catchment and most of the coastal aquifers especially in the Western Cape Province. Most of the Karoo falls within the moderate vulnerability level.

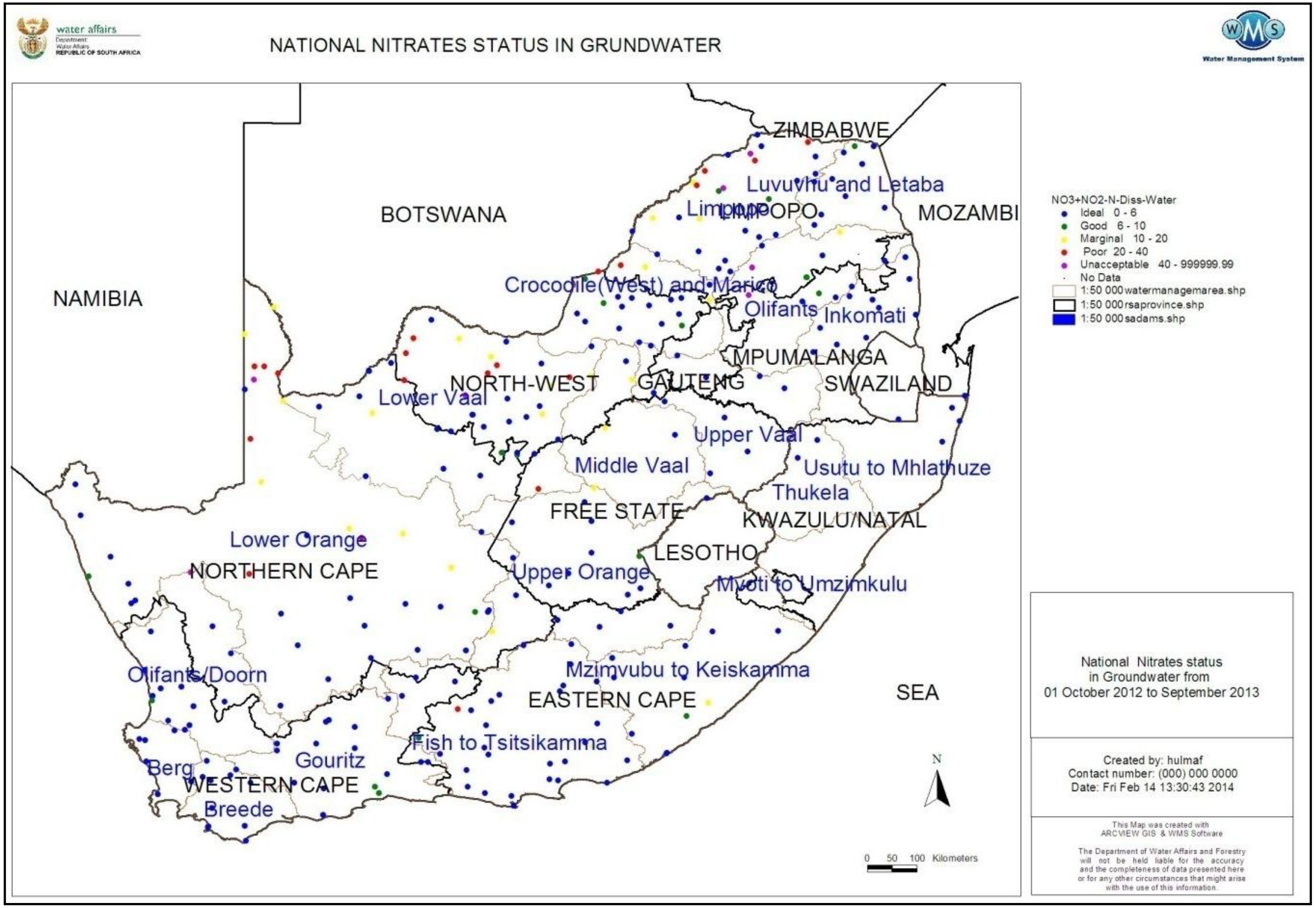


Figure 0.9: Status of Nitrates in groundwater

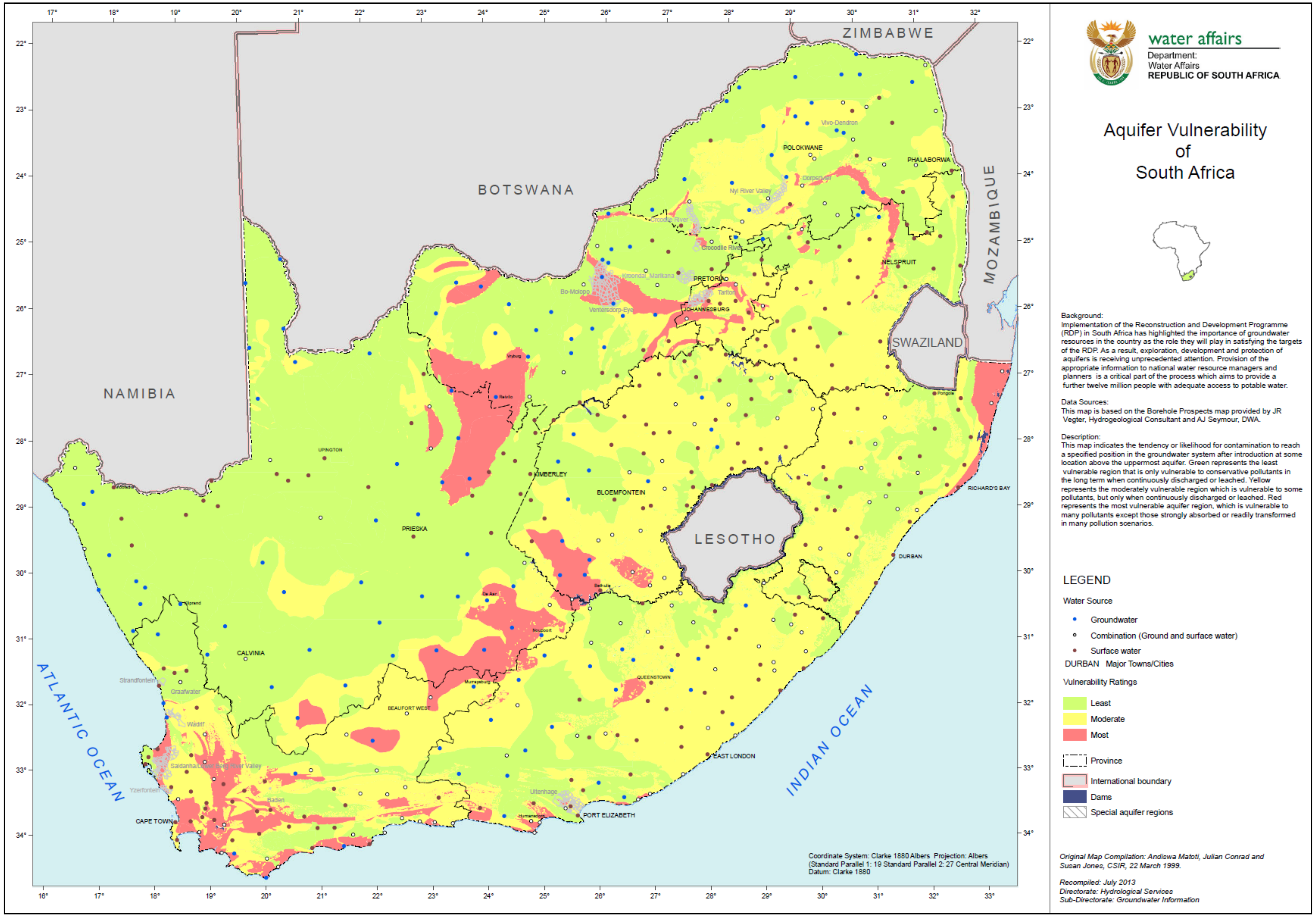


Figure 0.10: Groundwater Vulnerability map of South Africa (Compiled by Hydrological Services)

3.5 Acid Mine Drainage

With regards to the Witwatersrand Basin AMD problem, there has been progress on short-term solution recommendations. The surface decant of AMD into the environment has been eradicated in the Western Basin. In the Central Basin, an AMD pumping station and a neutralisation plant have been constructed. Different potential avenues where raw and treated water from these plants could be utilised have to be identified, as outlined in Figure 3.11.

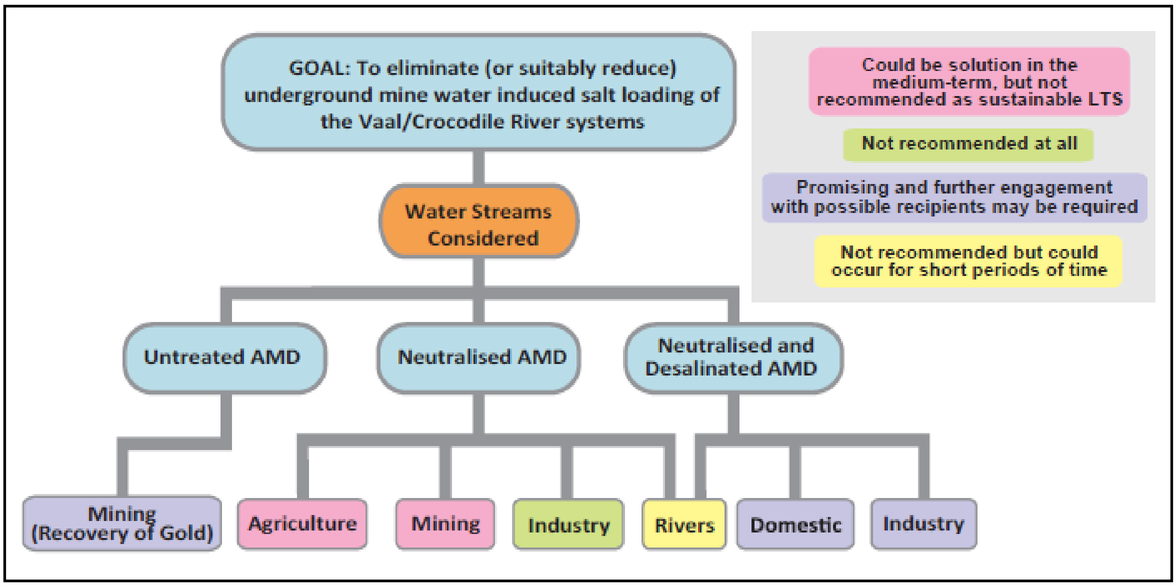


Figure 0.11: Potential applications of raw and treated AMD (AMD Newsletter, 2013)

As mining is one of the potential users of this water, SASOL has expressed interest in the potential use of treated AMD from the Central and Eastern Basins. The treated AMD would replace raw water supply from the Vaal River system and would be utilised for industrial purposes (i.e. mainly steam production and cooling) at two locations. The mine could utilise estimated 50 Ml/d from the Central Basin and 90 Ml/d from the Eastern Basin; and these volumes could supply the mine for about 15 years with further extension still under investigation (DWA, 2013).

The coal mining in Witbank is impacting on water resources. The eMalahleni Local Municipality is operating a mine water treatment plant. In Newcastle, Dundee, Utrecht, and Vryheid the defunct mines such as Bannockburn, Rooipoint, Cubaan Kirbarclan, Ballengeich etc., are discharging acid mine water into the streams that lead to main rivers including the Buffalo River. These discharges are impacting on water resources. The total dissolved salt concentrations are very high in areas such as Wasbank especially in the Biggarsgat River as indicated in Figure 3.12. However there has been a decreasing trend in salt concentrations. The Upper Thukela River shows very high levels of sulphate.

Decant runoff from Kilbarchan mine and AMD pond at Ndumeni mine in Dundee

AMD from Vryheid Coronation into the stream and decant channelled from Rooipoint mine.

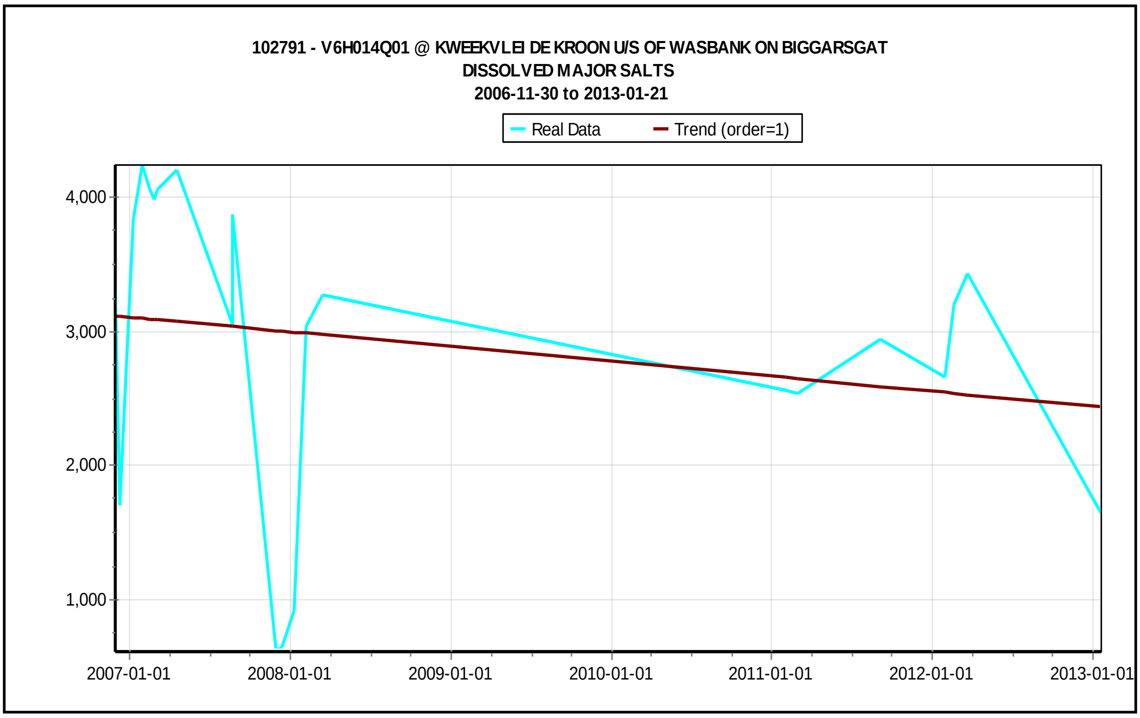


Figure 3.12: Total Dissolved Solids on Biggarsgat in Wasbank

4. Water Protection and Use

The country's water resources are facing ever increasing pressures from pollution, over-utilization, climate change, population growth etc. There is a need to strengthen the protection and restorations of natural ecosystem and enhance ecological production capacity. Also, there is a need to promote water-saving and pollution control. Healthy water ecosystems are imperative to sustain the water resource, which in turn, provide the goods and services for the livelihood of communities. To keep the ecosystems healthy the resource must be protected and used efficiently. Identification of key ecosystems as priority areas for conservation and the development of programmes to monitor and manage ecosystems health are very important.

Environmental flows are critical for the maintenance of freshwater ecosystem functions but can be seasonal and site-specific. High flows of different frequencies are important for channel maintenance and wetlands flooding, while low flows of different magnitudes are important for algae control, fish spawning, and maintaining the diversity of aquatic habitats ((UNEP, 2011) or Boelee 2011). Therefore environmental flow management is very important for rehabilitating of degraded freshwater ecosystems.

Water use regulation ensures that there is no wastage and water is used effectively and efficiently. Regulation as indicated in the NWA includes registering and licensing water use, prescribing standards and norms, restricting use where necessary, wastewater discharged back to water resources comply with standards, etc. For regulation to be effective monitoring and prescribed procedures and standards are crucial that are in place.

4.1 Protection of water resources

The protection of water resources entails determining resource direct measures by classifying water resource systems, determining reserves, conducting resource quality assessments and determining source directed controls by developing pollution control guidelines and rehabilitation measures and protocols. There is also development of a Pricing Strategy that will provide incentive based protection and the Green Drop Certification programme that aims to encourage municipalities manage sewage works well.

4.1.1 Resource Directed Measures

Resource-directed measures (RDM) aim to achieve a balance between protecting the water resources and utilising the water resources for social and economic development. RDM comprises three main measures, namely: classifying water resources using a promulgated Classification System for Water Resources, the establishment of water Reserves (ecological water requirements), and the setting of Resource Quality Objectives (RQOs). Water resource protection is strongly linked to measures for water conservation and water demand management by reducing pollution discharge load in order to achieve or maintain resource objectives for a catchment.

4.1.1.1 Classification

The Water Resource Classification System (WRCS) was formally established in September 2010 whereby water resources are categorised according to specific Classes that represent a management vision of a particular catchment. The WRCS takes into account social, economic, ecological and environmental landscape in a catchment in order to assess the costs and benefits associated with utilization versus protection of a water resource defines three water resource classes, reflecting a gradual shift from resources that will be minimally used to resources that are heavily used. The classification of water resources represents the first stage in the protection of water resources and determines the quantity and quality of water required for ecosystem functioning as well as maintaining economic activity that relies on a particular water resource.

The WRCS is progressively implemented in major river systems such as the Vaal, Olifants, Olifants-Doorn where proposed Classes have been determined. Other river systems where classification of water resources has commenced is the Crocodile (West) Marico, Mokolo and Matlabas catchment, Letaba and Mvoti to Umzimkhulu WMAs.

4.1.1.2 Reserve Determination

The DWA determines reserves for both surface and groundwater. Reserves are determined as Desktop, Rapid, Intermediate or Comprehensive depending on the need. Reserve Determination is a complex process, especially comprehensive reserves, that requires various skills such as water quality, morphology and invertebrates. Reserves are done per quaternary. Some of the catchments are not fully meeting the ecological reserve due to various reasons.

The status of reserve determinations is shown in Figures 4.1 and 4.2. A total of 161 surface water and 1141 groundwater reserves have been determined and completed during October 2012 and September 2013 (Tables 4.1 and 4.2).

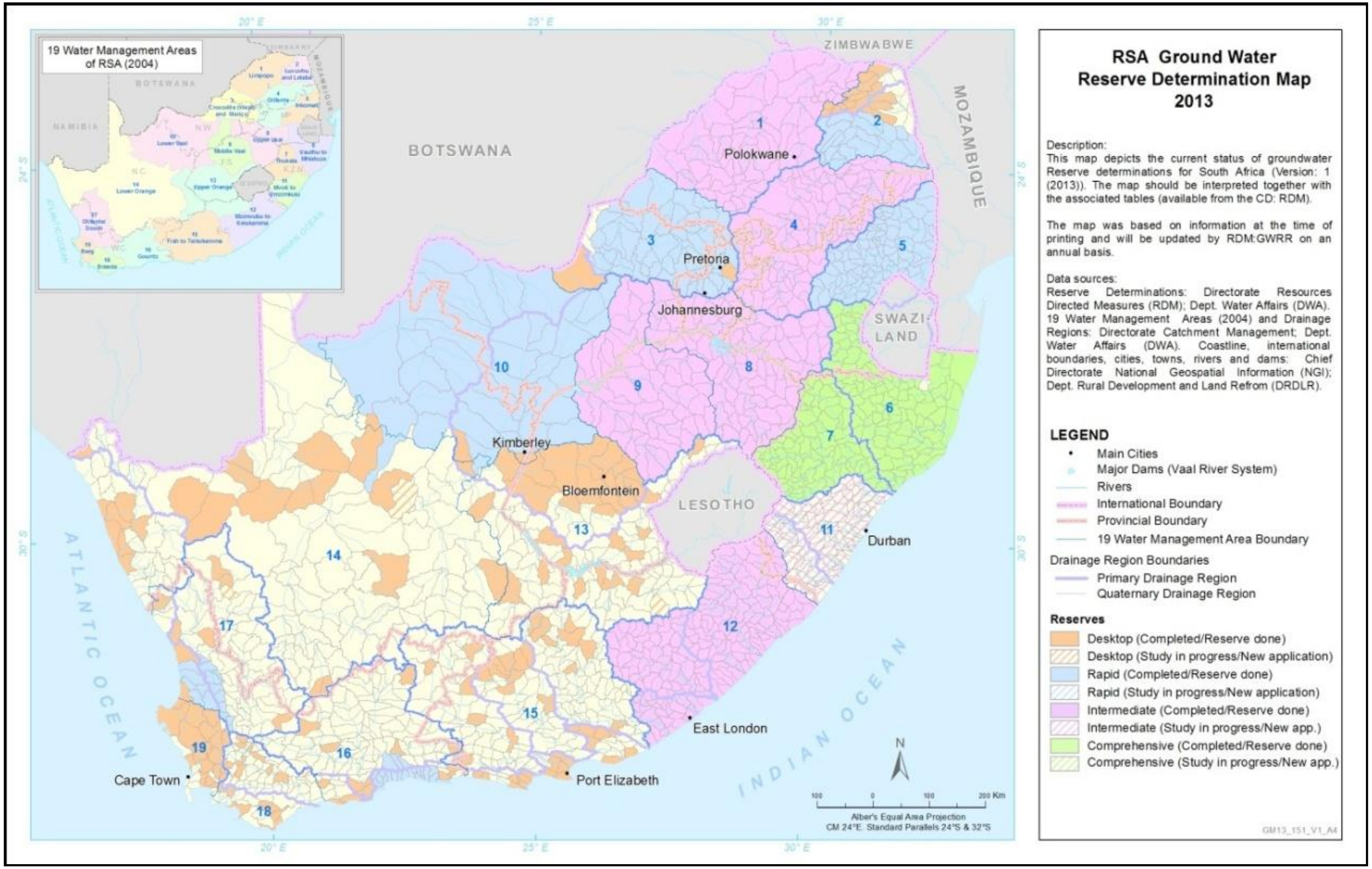


Figure 4.1: Groundwater Reserves determined during October 2012 to September 2013 (DWA, 2013)

Table 4.1: Summary of groundwater reserves completed between October 2012 and September 2013

Drainage Region	Desktop	Rapid	Intermediate	Comprehensive	Total
A	13	53	68	-	134
B	3	23	114	-	140
C	18	20	149	-	187
D	31	14	-	-	45
E	5	10	-	-	15
F	8	-	-	-	8
G	27	6	-	-	33
H	13	-	-	-	13
J	7	3	-	-	10
K	10	19	-	-	29
L	7	-	-	-	7
M	6	-	-	-	6
N	9	-	-	-	9
P	7	-	-	-	7
Q	8	-	-	-	8
R	-	-	30	-	30
S	-	-	58	-	58
T	-	-	106	-	106
U	-	-	-	-	0
V	-	-	-	86	86
W	-	-	-	117	117
X	-	93	-	-	93
TOTAL	**172**	**241**	**525**	**203**	**1141**

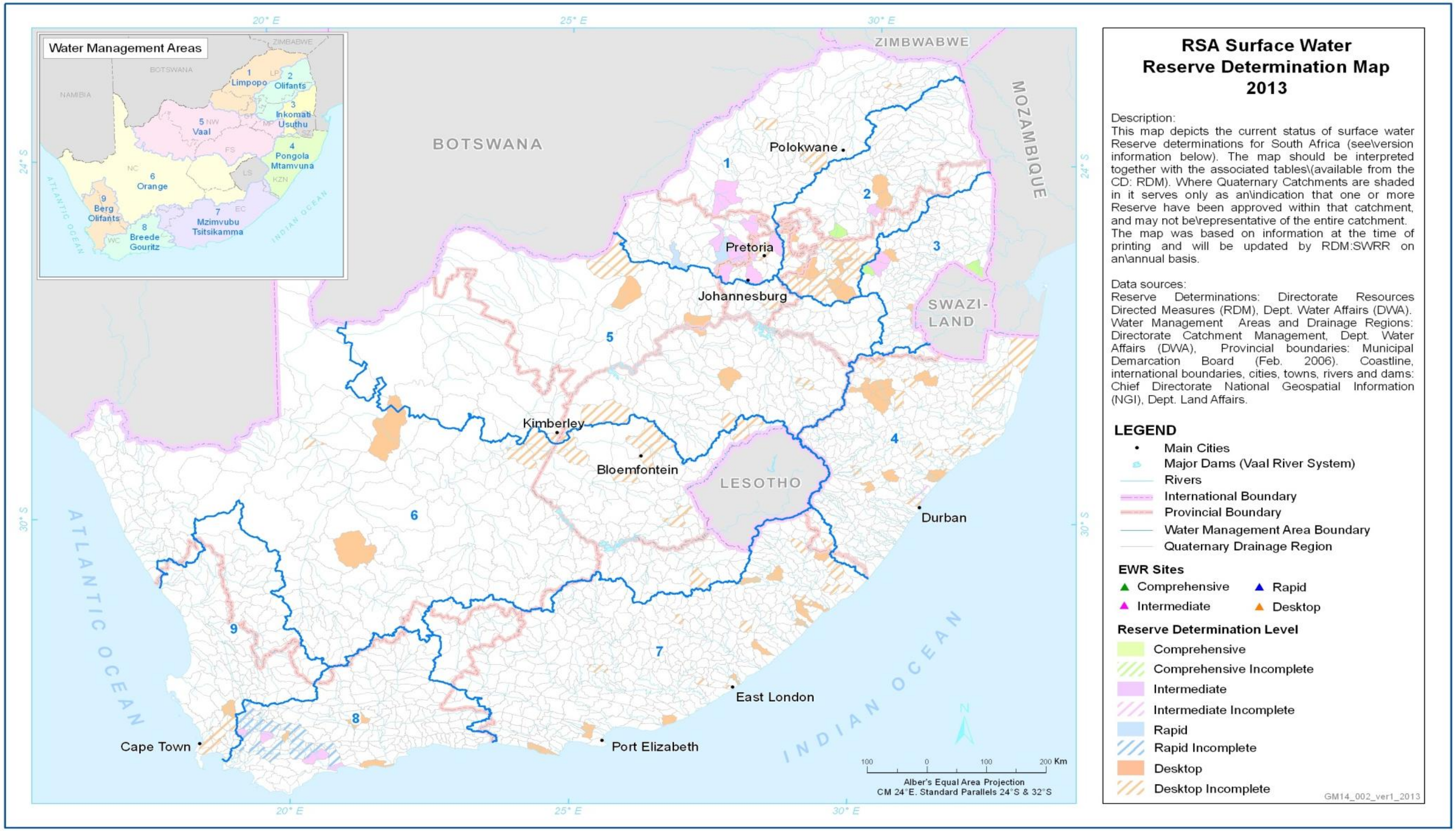


Figure 4.2: Surface water Reserves determined as at end September 2013 (DWA, 2013)

Table 4.2: Summary of surface water reserves completed between October 2012 and September 2013

DRAINAGE REGION	DESKTOP	RAPID	INTERMEDIATE	COMPREHENSIVE	TOTAL
A	6	2	9	0	**17**
B	34	0	2	1	**37**
C	15	0	0	0	**15**
D	11	0	0	0	**11**
G	5	0	0	0	**5**
H	1	0	0	0	**1**
J	1	0	0	0	**1**
K	2	0	0	0	**2**
M	1	0	0	0	**1**
P	1	0	0	0	**1**
Q	1	0	0	0	**1**
R	4	0	0	0	**4**
S	1	0	0	0	**1**
T	22	0	0	0	**22**
U	5	1	2	0	**8**
V	13	0	0	0	**13**
W	18	0	0	0	**18**
X	3	0	0	0	**3**
TOTAL	**144**	**3**	**13**	**1**	**161**

4.2 Estuaries

South Africa's estuaries range from cool or 'temperate' on the west coast, to moderately warm on the south coast, and to hotter climes of the sub-tropical east coast. Some estuaries are sparsely vegetated, particularly along the cooler stretches of coastline while others have salt marshes and mangroves forests especially along the KwaZulu-Natal north coast (DEA, 2012). The condition of estuaries in the south and south east are healthier than those in the warm east coast and cool west coast. South African has six estuaries that are RAMSAR-declared. The Wilderness and Kosi are the only two RAMSAR estuaries that are in a healthy condition. The St Lucia, Heuningnes, Orange, and Verlorenvlei estuaries are not in good condition. Estuaries may be impacted by discharges into the river from land based activities in a catchment. Any development or land use near the estuary may change habitat, sand and silt deposit.

The DWA has established a National Estuarine Monitoring Programme (NESMP) and is currently conducting pilot testing using 20 estuaries of the country (see Table 4.3). The programme is engaging various government departments and other role-players outside government. The Department of Environmental Affairs (DEA), SANPARKS, Ezemvelo / KZN Wildlife, South African Environmental Observation Network (SAEON), Cape Nature, Over-strand and West Coast District Municipalities are some of the role-players involved and are assisting with the collection of data.

The main parameters monitored on monthly bases are temperature, pH, oxygen concentration, salinity and chlorophyll a. The data collected thus far is limited making it impossible to deduce the status of estuarine water quality.

Table 4.3 List of estuaries monitored through NESMP

	SYSTEM	PERMANENT PROBE (Salinity, temperature & depth)	Number of sites monitored
1	Mfolozi / St Lucia system	2	25
2	MlalazI	0	11
3	Zinkwazi;	0	5
4	Nonoti	0	4
5	Mhlanga	0	6
6	Mgeni	0	10
7	Mpenjati	0	6
8	Mtamvuna	0	10
9	Mdlotane	0	4
10	Swartkops	2	0
11	Gamtoos	2	0
12	Kromme	4	6
13	Knysna	0	6
14	Swartvlei	0	8
15	Breede	2	18
16	Klein River	1	-
17	Bot	1	-
18	Berg	2	6
19	Verlorenvlei	1	5
20	Olifants	1	8

This monitoring programme is firmly based and driven through collaborative efforts between afore mentioned role players. It has thus far been an effective co-operative governance initiative within the water sector, with specific reference to estuarine water resources. However the data collected is yet of limited nature and need to be expanded for at least another year before an indication of changes in basic estuarine water quality can be determined.

4.3 Wetlands

The majority of South Africa's wetlands are degraded or modified due mainly to unsustainable developments including mining. More wetlands are threatened because they are not protected exposing them to types of pollution and activities. Only wetland systems located in the Kruger National Park and iSimangaliso Wetland Park are well protected (SANBI, 2013).

Wetlands are sustained by a combination of surface and groundwater inflows including springs. Changes to catchment water balance including groundwater recharge might pose a threat to wetlands (Holland & Benyon, 2010). Wetlands offer benefits such as improving water quality, trickling water during dry season, support local livelihood, and is a habitat for a diverse range of species. Some of the species are used for food, reeds used for craft, medicines etc. Because of the both social and economic value wetlands bring, it is critical that they are rehabilitated and those under threat protected.

According to the 2012 State of Biodiversity report (SANBI, 2013), wetlands mapped in South Africa to date cover a total area of 2.9 million hectares, which is about 2.4% of the country's surface area. Studies conducted in various major catchments reveal that between 35% and 60% of the wetland in South Africa have been lost or severely degraded. The DWA is initiating a wetland project called Working for Wetland (WfW) in an effort to protect South Africa's wetland systems.

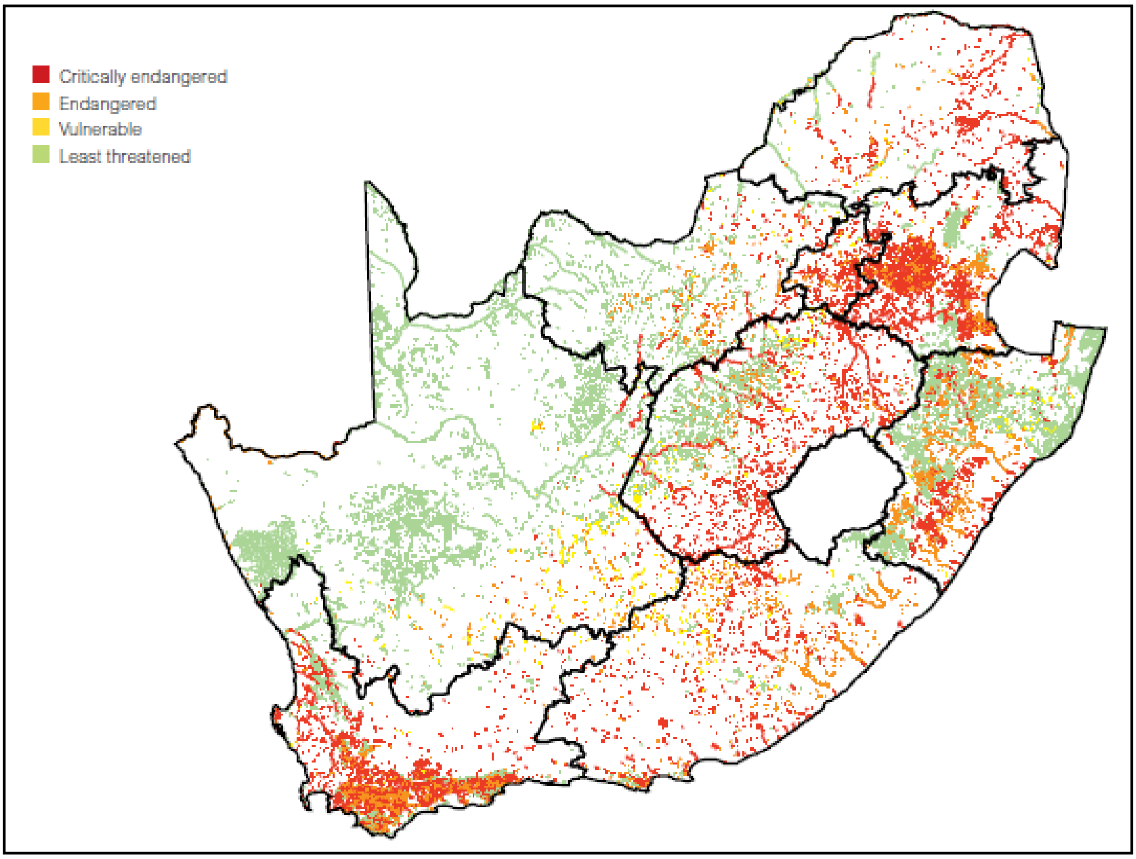


Figure 4.3: The status of threat to wetland ecosystems (SANBI, 2013)

4.4 Water Use

The DWA is responsible for regulating the use of water in the country. Water is used mainly by agricultural, municipal, mining, energy, afforestation and industrial sectors. Water use must be licensed unless it falls under Schedule 1, is an existing lawful use or is permissible under a general authorization. The Department is mandated by Section 21 of the National Water Act (Act 36 of 1998) to authorise and license all water uses. The objective of licensing process is to ensure that water is used sustainably and equitably by all. The number of registered licences and water volumes authorised is managed by the Water Use Authorization and Registration Management System (WARMS).

Water abstractions are registered as water use. A large proportion of water is abstracted for irrigation and some of the water from spray irrigation is lost through evaporation. Afforestation, especially alien vegetations such as eucalyptus and wattles, are known to use lots of water thus reducing stream-flows. This is due to deeper roots which could result in evapotranspiration. Table 4.4 shows the status of stream flow reduction activities licences issued during the past three years.

Table 4.4: SFRA Licences issued in the past three years

Financial year	KZN	EC	Limp	Mp	Total
2010/11	1026 (2 438.58ha)	85 (8684ha)	0	0	1 111 (11 122.58ha)
2011/12	61 (1 435.33ha)	12 (365.33ha)	25 (163ha)	5 (3 193.85ha)	103 (5 156.66ha)
2012/13	50 (85.30ha)	2 (84.7ha)	1 (3ha)	0	53 (173ha)

4.4.1 Water allocation

Equitable access to water contributes to eradicating poverty and promoting equitable sustainable economic growth. There is therefore a need to regulate water use to ensure equitable and efficient utilization. Regulation is done through licensing and general authorisation (GA). Compulsory licensing is a process where there is validation and verification of all the water users. The intension is to identify water that can be re-allocated according to specific imperatives and needs thus achieving fair allocation and promote beneficial use of water. Where all water resources have already been allocated, the DWA would apply compulsory licensing. Compulsory Licensing has been completed for Jan Diesel in Western Cape, Tosca in the Northern Cape and Mhlathuze in KwaZulu-Natal. The whole process involves intensive stakeholder engagement and requires cooperation from existing users for it to be quick and successful. The legal part of the process is long and tedious resulting in the delay in completing the process.

4.4.1.1 Water licensing

There is also a process of water use licensing and/or authorization. The total number of licences issued during the reporting period is 91 including 19 licences issued to HDIs. There is still a challenge of existing backlog but the backlog has been reduced drastically. One of the reasons for backlogs is applications with unverified information. As the DWA deals with the backlogs, new applications are received all the time causing the target to keep moving.

Table 4.5: Summary of licenses issued from October 2012 to September 2013

Region	HDI	B: BBBEE Compliant	HAI	W: BBBEE Compliant	LG	Total
EC	13	0	1	0	1	**15**
FS	0	1	0	1	1	**3**
GP	0	1	3	0	3	**7**
KZN	0	0	3	3	0	**6**
LP	3	0	0	2	2	**7**
MP	1	3	13	6	2	**25**
NC	1	0	2	1	5	**9**
NW	0	0	4	4	1	**9**
WC	0	0	1	6	3	**10**
Total	**18**	**5**	**27**	**23**	**18**	**91**

4.5 Registered surface water use

During the reporting period, agricultural sector was the largest water user, accounting for 59%. It was followed by domestic/industrial at 34%, forestry at 5% and lastly non-billable use at 2% (Figure 4.4). In terms of registered volumes per WMA, agricultural sector remained the largest user in most WMAs with the exception of the Upper Vaal, Middle Vaal, Mvoti-Umzimkhulu and Berg where the domestic/industry was the largest user (Table 4.6).The Usutu-Mhlatuze WMA accounted for the highest forestry use, followed by Inkomati and Mvoti-Umzimkhulu WMAs.

These WMAs are dominated by commercial plantations as main land-use activity. At the end of September 2013, a total volume of 4 614 million m^3 of water was registered in WARMS. The Upper Vaal WMA registered the highest volumes with a total of 629 million m^3 and Thukela WMA registered the lowest volumes at 105 million m^3 (Table 4.6). Figure 4.5 shows registered water use over a period of five years.

It is also important to note that not all water use is registered. In some cases the registered amount is not all used while in other cases a user abstract more than registered use. This creates a challenge in determining exactly how much is used in each WMA.

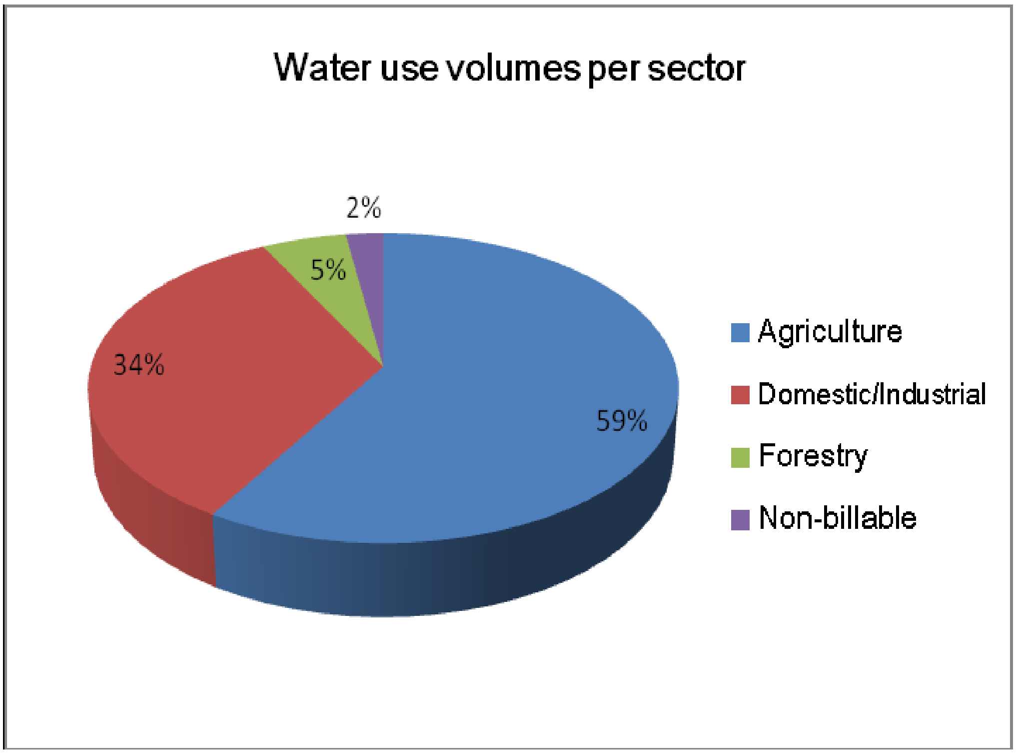


Figure 4.4: Percentage registered water use per sector

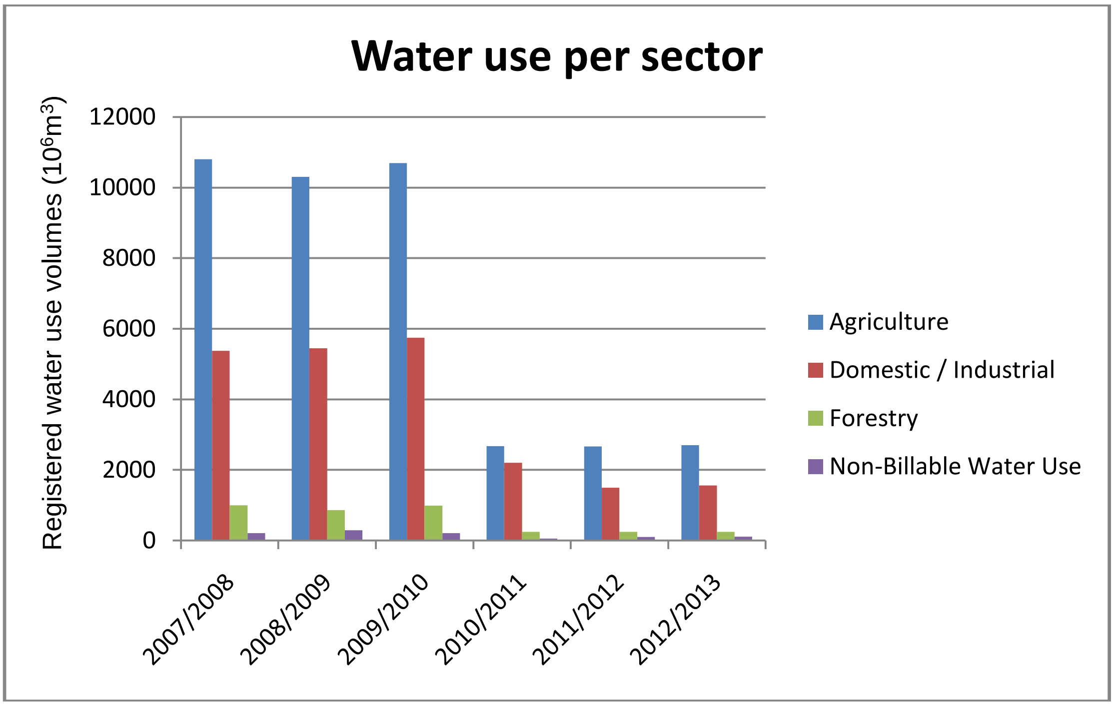


Figure 4.5: Percentage registered water use trends per sector over 5 years

Table 4.6: Registered water use volumes (in 10^6 m^3) per WMA area as at end September 2013.

WMA Name	Agriculture	Domestic / Industrial	Forestry	Non-Billable Water Use	Grand Total (per WMA)
Limpopo	135	18	0.3	0.100	153
Luvuvhu Letaba	104	28	8	3	143
Crocodile (West) Marico	168	76	0.004	12	256
Olifants	174	150	6	15	345
Inkomati	261	87	63	70	481
Usutu-Mhlatuze	157	85	88	0.800	330
Thukela	68	30	7	0.200	105
Upper Vaal	97	532	0.029	0.170	629
Middle Vaal	68	80	-	0.004	148
Lower Vaal	155	39	-	0.060	194
Mvoti-Umzimkulu	60	155	52	0.200	267
Mzimvubu-Keiskamma	41	61	13	2	117
Upper Orange	204	25	-	-	229
Lower Orange	233	20	-	-	253
Fish-Tsitsikamma	272	45	3	3	323
Gouritz	99	18	2	0.020	119
Olifants/Doorn	107	3	0.003	0.200	110
Breede	217	12	1	0.700	230
Berg	84	94	1	0.700	179

4.6 Groundwater Use

Groundwater's role in South Africa is often underestimated, whereas more than two thirds of our population depend on groundwater for their domestic needs and 80% of rural villages rely entirely on this resource. Although a large volume of water users rely on surface water, the majority of small water supplies, which are critical to livelihoods, health and dignity, depend on groundwater. Groundwater is essential to the water supply of towns more than 420 including Beaufort West, Prince Albert, Graaf Reinet, Atlantis and Musina. Even large cities like Pretoria and Johannesburg are partly dependent on groundwater supplies. There is therefore a need to raise the status of groundwater to equal that of surface water in meeting the country's growing water demand (Shafick Adams, Press Release, 2011).

Even though groundwater use has not been quantified precisely, it is estimated that groundwater accounts for between 12 and 16 % of freshwater needs in South Africa. With dwindling surface water resources that the country is mainly dependent on, projections indicate an increase in groundwater demand. Irrigation is still the main groundwater consumer, followed by mining and then rural supply as shown on Figure 4.6.

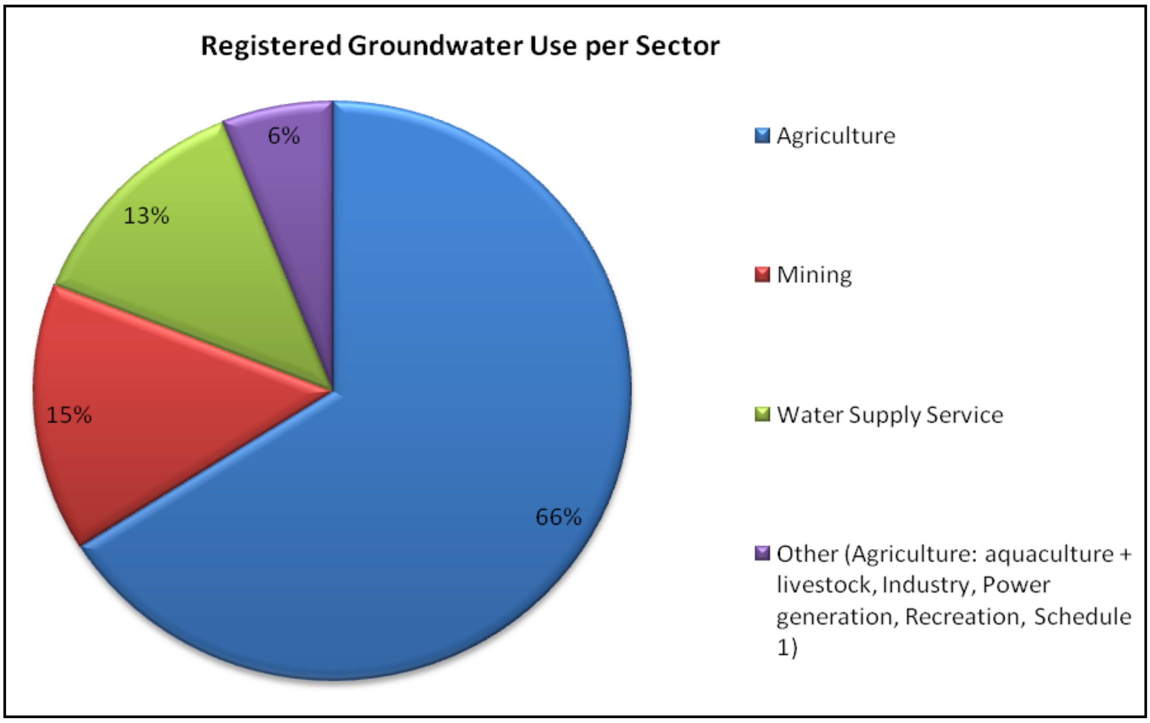


Figure 4.6: Registered groundwater use per sector in South Africa

The groundwater use per catchment map on Figure 4.7 shows that most catchments in the country are still utilising less groundwater with respect to recharge. However, groundwater use in some catchments of the Northern Cape, Limpopo, and the interior of both the Western Cape and the Eastern Cape Provinces surpasses recharge. Moreover, these are areas with naturally low recharge rates. Therefore, monitoring and adequate resource management is crucial for these catchments.

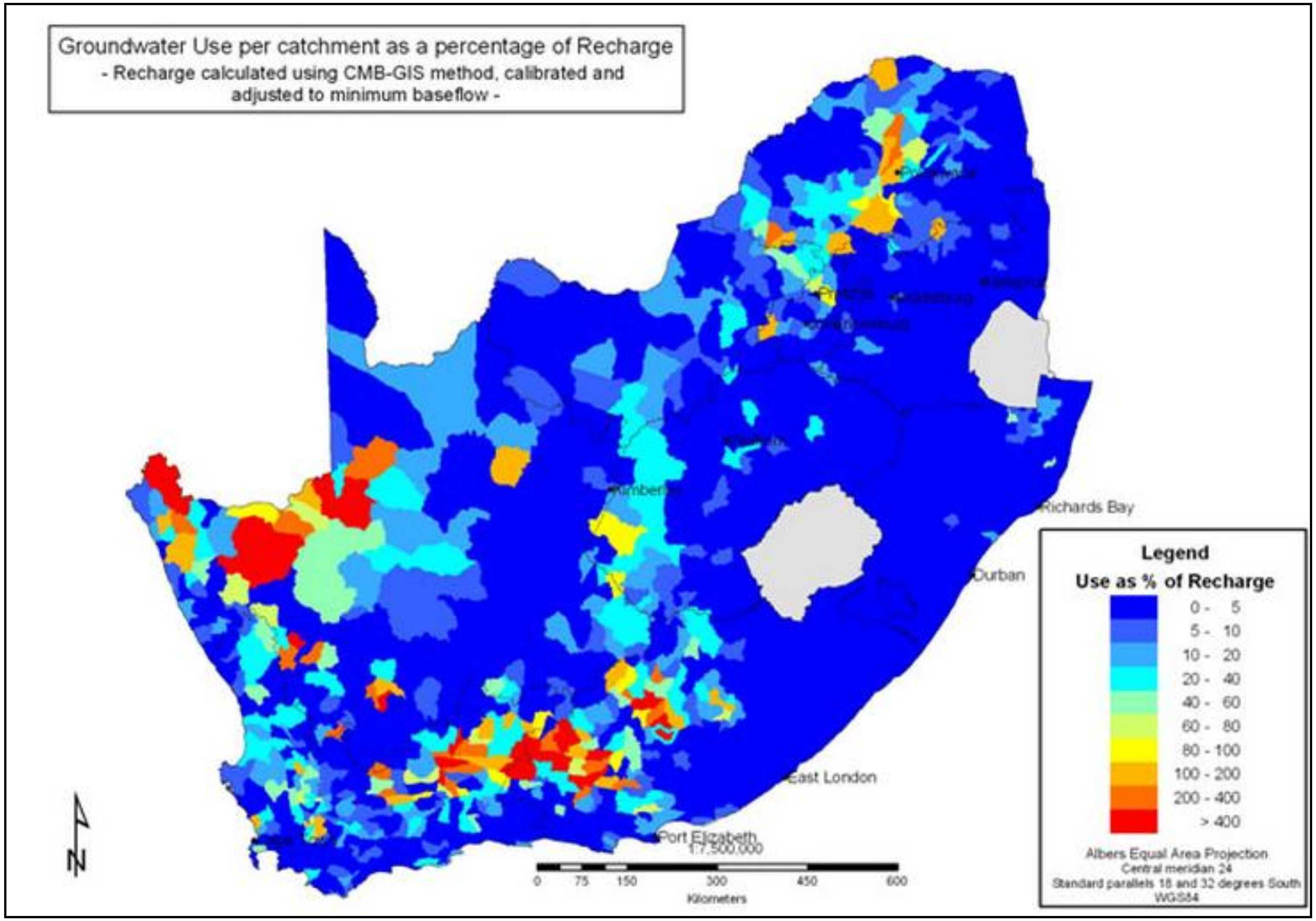


Figure 4.7: Groundwater Use per catchment as a percentage of recharge (Colvin et. al, 2009)

4.7 Groundwater-surface water interaction

A study to understand the lake- groundwater interaction was conducted Lake Sibayi by Weitz and Demlie (2013). Lake Sibayi (a topographically closed freshwater lake) and the coastal aquifers around the Lake in eastern South Africa are important water resources and are used extensively for domestic water supplies. Both the Lake and groundwater support an important and ecologically sensitive wetland system in the area. Surface and subsurface geological information, groundwater head, hydrochemical and environmental isotope data were analyzed to develop a conceptual model of aquifer-lake interaction. The study concluded that where groundwater head is above lake stage, groundwater flows to the lake, at the same time, the presence of mixing between lake and groundwater isotopic compositions indicated that the lake recharges the aquifer.

Isotope analyses as shown in Figure 4.8, confirm a direct hydraulic link between groundwater and the Lake. Based on this plot, it can be seen that groundwater is directly recharged by precipitation without undergoing evaporation; the Mseleni River is fed by groundwater; and the Lake and the ocean water bodies have undergone evaporation. Furthermore, the majority of surface and groundwater samples plot close to or on the LMWL indicating that their origin is from local precipitation (meteoric).

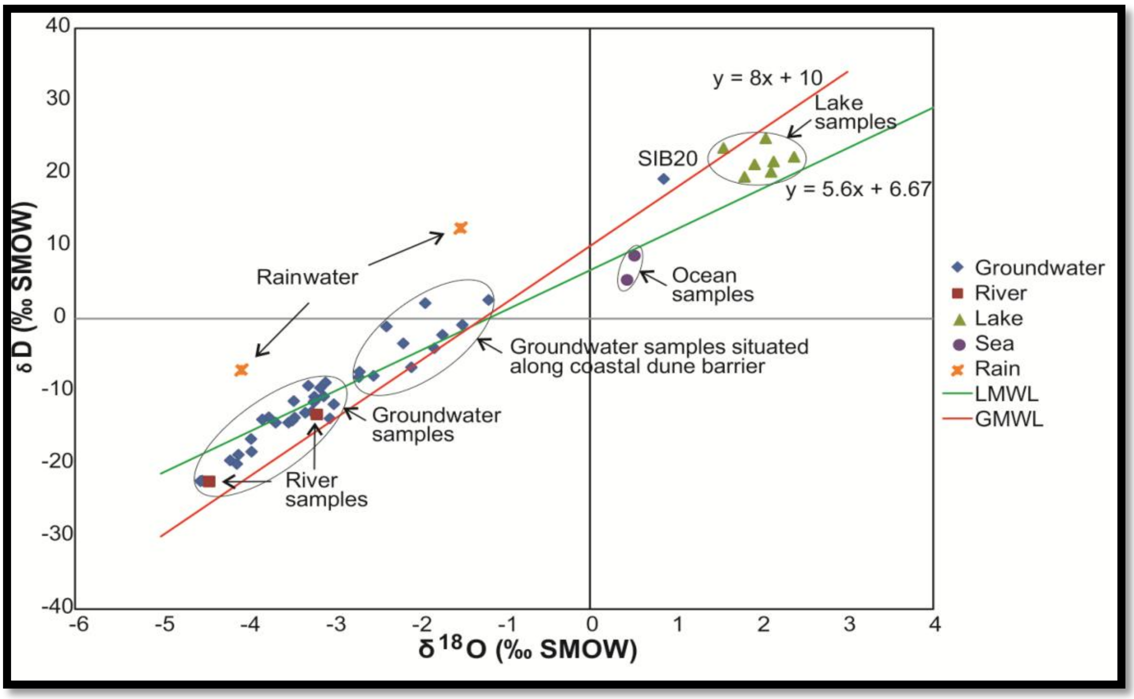
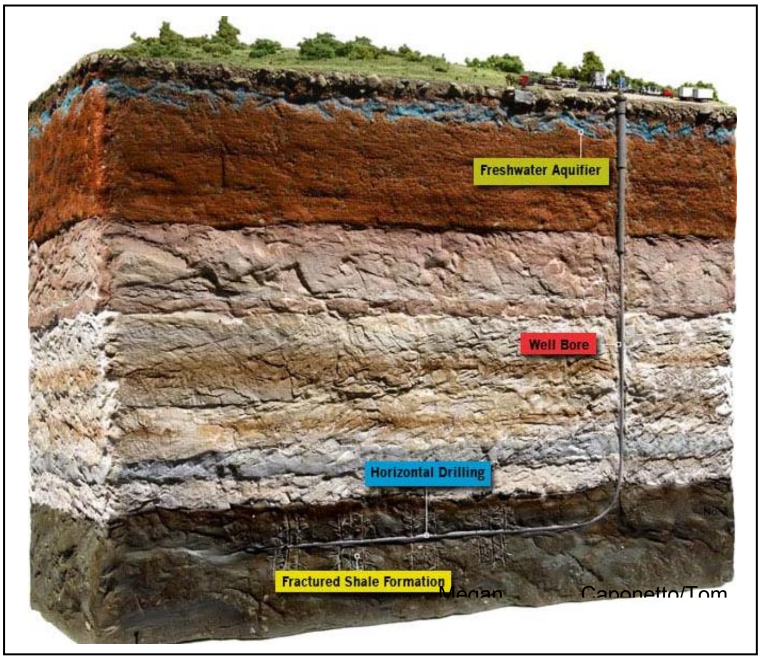


Figure 4.8: ^{18}O – Deuterium plot of samples from various water resources in the catchment

BOX 1: Hydraulic Fracturing – “Fracking”

Hydraulic fracturing is the process of extracting natural gas from shale rock layers deep within the earth. Horizontal drilling (along with traditional vertical drilling) allows for the injection of highly pressurized water and other fracking fluids into the shale area. This creates new channels within the rock from which natural gas is extracted at higher than traditional rates.



In 2012, the government of South Africa lifted the moratorium on shale gas exploration. Under the Cabinet decision, the actual fracking cannot be done now, even though exploration will involve some drilling. As a water scarce country, it was highlighted that if the process is such that there is a threat to water in South Africa, it will have to stop.

Furthermore, if there is going to be an extremely negative impact on the SKA project and it cannot be mitigated, the process will have to stop. A monitoring committee would be formed to ensure that regulations were followed and that appropriate regulations, controls and co-ordination systems were established. It was further emphasized that ongoing research should be carried out in the environmental impact of shale gas in order to develop new and better methods for hydraulic fracturing.

The Minister of the Department of Water Affairs issued a notice in August 2013 of her intention to declare the exploration for and/or production of onshore unconventional oil or gas resources and any activities incidental thereto, including but not limited to, hydraulic fracturing a "controlled activity" under the National Water Act 36 of 1998, Section 38. This implies that the Department of Water Affairs may proclaim fracking as an activity which specifically requires a water use licence before it can lawfully commence. The intention of the declaration is to allow for greater control and oversight of fracking operations by the department.

4.8 Water Conservation and Water Demand Management

The Water Conservation and Water Demand Management programme is aimed at assisting municipalities with non-revenue water. A number of initiatives are being undertaken by the Department to promote and instil a culture in all water users to use water efficiently and to conserve South Africa’s scares water resources.

The DWA, in collaboration with the Water Research Commission, has developed a Water Accounting System (WAS) to improve the management, the efficiency of water distribution and supply and to minimise water losses within irrigation schemes. The system has been successfully implemented in a number of irrigation schemes.

The DWA has also developed a “No Drop” system; an incentive based monitoring and reporting system, to incentivise municipalities to increase their efforts on the implementation of WC/WDM intervention leading to the reduction of water losses or Non-Revenue Water (NRW) and to ultimately safeguard South Africa’s scarce water resources. There is also a “War on Leaks Programme”, which focuses on the fixing of water leakages within indigent households. The programme involves communities and has created awareness for water saving. An education, awareness and capacity building programme in schools on various environmental issues is in place.

Considerable volumes of water have been saved in households and this initiative provides potential for municipalities to reduce water losses. The programme is being implemented in nine municipalities across the country and has provided job opportunities for the youth. The municipalities taking part in the WC/WDM programme have reported success in saving water. However, the availability of both human and financial resources is limiting advanced gains in winning the fight against water losses through distribution systems. Implementation of water pressure management and network management systems could assist in the reducing unaccounted for water through leaks.

4.8.1 Water desalination

Water desalination is a process that removes salt and other minerals from seawater or wastewater, making it safe for drinking or re-use. The process requires high energy levels. The brine produced is very high in salt content creating environmental problem.

The Cederberg Municipality is in the process of building a seawater desalination plant in Lamberts Bay to increase water availability. The desalinised water will be fed into the town existing freshwater network. Mossel Bay has the largest desalination plant but is not used to the fullest. Eskom operates desalination plants to treat the significant wastewater volumes it produces during the cooling process. The eMalahleni Local Municipality in collaboration with Anglo American desalinates rising water from mines in Witbank preventing polluted mine water from decanting into the environment. The treated water is pumped directly into the municipality’s drinking water reservoirs.

The Durban eThekwini Municipality is considering building seawater reverse osmosis desalination plant (s) near Tongaat in the north and/or Illovo in the south Durban coastline, in order to augment the available supply. A feasibility study is being undertaken.

5 Surface and groundwater development

5.1 Surface water development

Water resource development mainly addresses issues such as socio-economic upliftment and development, ensuring the availability of safe water supplies to communities and planned mining expansion. Water resource development is undertaken to increase the capacity for water security and water availability. To assess the level of water resource development, required, key data such as volume of water in storage and sustainable yields for both surface and ground water; surface water run-off; groundwater recharge; surface water diversions; groundwater extraction and entitlement volumes are taken into account. The Department has been engaged in a number of projects to address some of the identified issues.

5.1.1 Olifants River Water Resources Development Project 2

The Olifants River Water Resources Development Project is an extensive water resource development project which will supply water for domestic and industrial (mining) use in the Limpopo Province. Phase 1 of the project encompass the raising of the Boshielo Dam. Phase 2 is the installation of a 70km pipe for pumping water from the Flag Boshielo Dam to the town of Mokopane. The second phase is the extraction and distribution of water from the De Hoop Dam to various end points via pipelines.

Figure 5.1 The view of the De Hoop Dam (DWA, 2013)

5.1.2 Mokolo and Crocodile Water Augmentation Project

The Mokolo and Crocodile Water Augmentation Project (MCWAP) entails the phased construction of two main bulk raw water transfer systems, as well as associated infrastructure to meet the new power station, mines, and domestic demands. The main components of the scheme are abstraction weirs, pump stations, pipelines and balancing storage. When completed in 2015, this project will ensure security of supply for both the surrounding communities and the power station and mines.

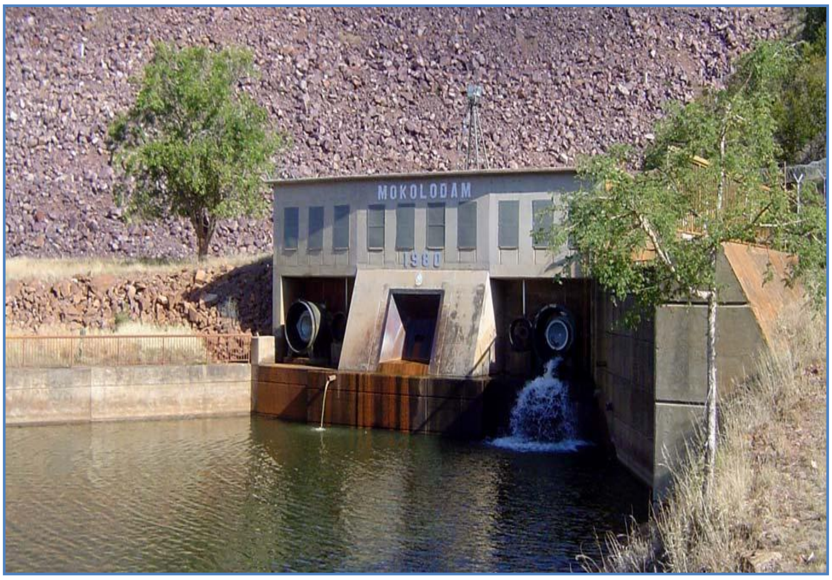


Figure 5.2: The Mokolo Dam (DWA, 2013)

5.1.3 Komati Water Supply Augmentation Project

The Komati Water Scheme Augmentation Project (KWSAP) is essentially an extension of the VRESS system. The project entails an additional pump station and pipeline for water supply from Rietfontein Weir to Eskom's Duvha and Matla power stations and in Mpumalanga. It will augment the Komati Water Scheme from the Vaal Eastern subsystem (VRESAP) for the sole benefit of Eskom. The additional yield is expected to be 57 million m^3 per annum.

5.1.4 Mooi-Mgeni Transfer Scheme Phase 2

The economic growth in the Mgeni System supply area resulted in rapid water demand. The system urgently needed to be augmented. Following investigation of various augmentation schemes, the Mooi-Mgeni Transfer Scheme Phase 2 (MMTS2) in the KwaZulu-Natal Midlands was identified as the preferred option. The scheme will augment the yield of the Mgeni System by 60 million m^3 per annum bringing it to a total of 394 million m^3 per annum. The MMTS2 entails constructing a new Spring Grove Dam on the Mooi River, Water Transfer System from the dam to the Mpofana River and a fish barrier upstream of the dam. The main beneficiaries of this project include eThekwini Metropolitan, uMgungundlovu District, and Msunduzi local municipalities. The Ugu, Sisonke and Illembe municipalities fall under Umgeni Water area of supply, hence benefit indirectly from the project.

Figure 5.3: Construction of Spring Grove Dam (DWA, 2013)

5.1.5 Groot Letaba Water Augmentation Projects (GLeWAP)

The project entails the construction of a large dam on the Groot Letaba River at the Nwamitwa site, downstream of the confluence of the Nwanezi River and raising of the Tzaneen Dam wall. The project is still in design stage.

5.2 Groundwater development

Groundwater is a strategic water resource in South Africa. It also contributes a significant amount to river flow but its contribution to bulk water supply is relatively small.

5.2.1 Groundwater development in 17 Karoo towns

The DWA started the project in 2011 and is expected to be completed in 10 years. The project includes identification of groundwater sources for current and future water requirements for the towns and villages of the Baviaans Local Municipality. The areas covered are Willowmore, Steytlerville, Miller, Vondeling, Mount Stewart and Rietbron. The hydrocensus and test pumping of existing production boreholes have been completed. There is a possibility of artificial recharge from Beervlei dam.

5.2.2 Groundwater Options based on the Reconciliation Strategy for the Olifants River Water Supply System

The Olifants River Water Supply System provides water for domestic and industrial water use purposes, irrigation, mining and power generation. The system serves more than 3 million people , providing domestic water to towns and rural areas within the Olifants Catchment as well as to the towns of Polokwane and Mokopane and their surrounding rural areas northbound and outside of the catchment area. One of the four interventions highlighted in order to increase water supply is; groundwater development from 2012 over the next 23 years. A groundwater development project on the Malmani Dolomite Escarpment in line with this intervention is currently in its infant stages.

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