NATIONAL STATE OF WATER REPORT 2023

WATER IS LIFE - SANITATION IS DIGNITY

SOUTH AFRICA IS A WATER SCARCE COUNTRY

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

2030 NDP

DOCUMENT CONTROL

Editors:	Version:	Date:	Comments:
SD: Integrated Water Resource Studies	*Ver 3.0*	*27 Mar 2024*	*Final Report*

This report should be cited as:

Department of Water and Sanitation (DWS), 2024. National State of Water Report 2023. Integrated Water Resource Studies Report Number WII/IWRS/NSoW 2023 PRETORIA, South Africa.

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APPROVAL

Report Title:	*NATIONAL STATE OF WATER REPORT 2023*
Report No:	*WII/IWRS/NSoW 2023*
Status of Report:	*Final Report*
First Issue:	*22 December 2023*
Final Issue:	*27 March 2024*

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ACRONYMS

Acronym	Description
AMD	Acid Mine Drainage
BGCMA	Breede-Gouritz Catchment Management Agency
BOCMA	Breede-Olifants Catchment Management Agency
BRVAS	Berg River Voelvlei Augmentation Scheme
CEO	Chief Executive Officer
CMA	Catchment Management Agency
CME	Compliance Monitoring and Enforcement
CoGTA	Department of Cooperative Governance and Traditional Affairs
CoH-WHS	Cradle of Humankind World Heritage Site
CRR	Cumulative Risk Rating
CS	Citizen Science
CSIR	Council for Scientific and Industrial Research
DEFF	Department of Environment, Forestry and Fisheries
DFFE	Department of Forestry, Fisheries and the Environment
DM	District Municipality
DPP	National Director of Public Prosecutions
DSI	Department of Science and Innovation
DUCT	Duzi-uMngeni Conservation Trust
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
ECMS	Enforcement Case Management System
EIS	Ecological Importance and Sensitivity
EMI	Environmental Management Inspector
EMSSA	Eutrophication Management Strategy for South Africa
ENSO	El Niño-Southern Oscillation
EWR	Ecological Water Requirements
FBW	Free Basic Water
FRAI	Fish Response Assessment Index
FSC	Full Supply Capacity
FSM	Faecal Sludge Management
FY	Financial Year
GDARDE	Gauteng Department of Agriculture, Rural Development, and Environment
GDP	Gross Domestic Product
GwLS	Groundwater Level Status
Gw-SWSA	Groundwater Strategic Water Sources Area
GWSs	Government Water Schemes

IEA	International Energy Agency
ILI	Infrastructure Leakage Index
IRIS	Integrated Regulatory Information System
IUA	Integrated Unit of Analysis
IUCMA	Inkomati-Usuthu Catchment Management Agency
IVRS	Integrated Vaal River System
IWA	International Water Association
KOBWA	Komati Basin Water Authority
KPA	Key Performance Area
KZN	KwaZulu-Natal
LHWC	Lesotho Highlands Water Commission
LIMCOM	Limpopo Watercourse Commission
LOCMA	Limpopo-Olifants Catchment Management Agency
l/c/d	Litres Per Capita Per Day
MCM	Million Cubic Meter
MCWAP	Mokolo Crocodile West Water Augmentation Project
MFMA	Municipal Finance Management Act
MIRAI	Macroinvertebrate Response Assessment Index
MTCMA	Mzimvubu-Tsitsikamma Catchment Management Agency
NCIMS	National Compliance Information Management System
NCMP	National Chemical Monitoring Programme
NDP	National Development Plan
NEMA	National Environmental Management Act
NEMP	National Eutrophication Monitoring Programme
NGA	National Groundwater Archives
NIWIS	National Integrated Water Information System
NMMP	National Microbial Monitoring Programme
NPA	National Prosecuting Authority
NRW	Non-Revenue Water
NSF	National Sanitation Framework
NSIP	National Sanitation Integrated Plan
NSoW	National State of Water
NWA	National Water Act
NWRIA	National Water Resource Infrastructure Agency
NWRS-2	National Water Resource Strategy 2
NWRS-3	National Water Resource Strategy 3
NWSMP	National Water and Sanitation Master Plan
ONEMP	Optimised National Eutrophication Monitoring Programme
ORASECOM	Orange-Senqu River Commission
ORWRDP-2	Olifants River Water Resources Development Project Phase 2

PEC	Present Ecological State
PFMA	Public Finance Management Act
PNCMP	Priority National Chemical Monitoring Programme
PUCMA	Pongola-Umzimkulu Catchment Management Agency
PSC	Project Steering Committee
RDMs	Resource Directed Measures
REMP	River EcoStatus Monitoring Programme
RHP	River Health Programme
RQIS	Resource Quality Information Services
RQOs	Resource Quality Objectives
RSA	Republic of South Africa
RU	Resource Unit
SANBI	South African National Biodiversity Institute
SAEON	South African Earth Observation Network
SALGA	South African Local Government Association
SAPS	South African Police Service
SANS	South African National Standards
SAR	Sodium Adsorption Ratio
SAWS	South African Weather Services
SDG	Sustainable Development Goal
SDCs	Source Directed Controls
SFD	Shit Flow Diagram
SFRA	Stream Flow Reduction Activity
SIV	System Input Volume
SPI	Standardised Precipitation Index
SQR	Sub Quaternary Reach
SWSAs	Strategic Water Source Areas
TCTA	Trans-Caledon Tunnel Authority
TDS	Total Dissolved Solids
TP	Total Phosphorous
TPTC	Tripartite Permanent Technical Committee
UNEP GEMS	United Nations Environmental Programme-Global Environmental Monitoring System
VOCMA	Vaal-Orange Catchment Management Agency
VEGRAI	Vegetation Response Assessment Index
V&V	Verification and Validation
WARMS	Water Use Authorisation and Registration Management System
WC/WDM	Water Conservation and Water Demand Management
WEF	Water Energy Food
WHO	World Health Organisation
WMAs	Water Management Areas

WMS	Water Management System
WRC	Water Research Commission
WRCs	Water Resource Classes
WRCS	Water Resource Classification System
WSA	Water Services Authority
WSAs	Water Source Areas
WSDP	Water Services Development Plans
WSI	Water Services Institutions
WSP	Water Service Provider
WSS	Water Supply Systems
WWTWs	Wastewater Treatment Works
ZQM	National Groundwater Quality Monitoring

ACKNOWLEDGEMENTS

The Directorate: Water Information Integration, under the Chief Directorate: National Water Resource Information Management are the editors and coordinators for the provision of the National State of Water Report. The reporting on the state of water is a collaborative effort of several components within the Department of Water and Sanitation and other water sector institutions.

The editors would like to appreciate and acknowledge the following contributors from various DWS components:

Resource Quality Information Services; National Hydrological Services; Spatial Information; Water Resource Classification; Reserve Determination; Sanitation Services Planning Support; Strategic Water Resource Planning; Water Resource Management Planning; Raw Water Regulation, Compliance & Enforcement; National Register of Water Use; Wastewater Services Regulation; Drinking Water Regulation; Infrastructure Implementation Planning; Shared Watercourse; Water Resource Institution Governance; Water Resource Policy, Strategy and Evaluation.

The following collaborators from other water sector institutions are acknowledged:

- Dr Andries Kruger and Nthabiseng Letsatsi from the South African Weather Services for contributions under the Climatic Environment chapter,
- Dr Mokhele Moeletsi, Dr Johan Malherbe, and Ms Teboho Masupha, the authors of the Climatic Environment Chapter,
- Dr Luxon Nhamo from the Water Research Commission (WRC), the author of the Water-Energy-Food (WEF) Nexus chapter.
- Ms Lesego Gaegane from the Water Research Commission (WRC, the author of the case study: *Navigating Climate Challenges: A Case Study on Welbedacht Dam Catchment Climate Adaptation through Siltation Management*,
- Prof Vhahangwele Masindi from Magalies Water, thank you for the valuable input.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

In South Africa, The Department of Water and Sanitation (DWS) is the custodian of the nation's water resources and a public trustee. The DWS is obliged by the National Water Act (Act No. 36 of 1998) to establish monitoring networks and information systems and report on the status of water resources in the country. The annual National State of Water Report communicates available information on water resources to all water sector stakeholders, including water users. The main aims of the report are to assist water managers in decision-making, to evaluate the implementation of legislation, to highlight identified problem areas, and to outline measures taken by the DWS to eradicate highlighted issues and balance the water demand and supply. The report is based on an analysis of identified and monitored water resource indicators for the hydrological year, which will be from October 2022 to September 2023.

The 2022/23 hydrological year in South Africa was characterised by wetter and warmer weather associated with the global El Niño-Southern Oscillation's (ENSO) El Niño phase. The annual mean temperature anomaly for 2023, based on the data of 20 climate stations, was, on average, about 0.4 ºC above the average of the reference period (1991-2020), making it the 8th hottest year on record since 1951. The eastern half of the country, characterised by summer rainfalls, has received significantly above-normal rainfall in the past three hydrological years.

During the 2023 summer season, significant rainfalls, mostly covering the eastern half of the country, were received. Again, during the 2023 winter season, the eastern half of the country anomalously received significant rainfalls (200-500 mm). These more-than-normal rainfalls experienced in the last four hydrological years significantly decreased the number of areas affected by drought conditions. Stream flow data also show a significant increase in the total annual flow volume in the current hydrological year compared to the previous year. Only three strategic stations were below normal, compared to five reported last year, with one being extremely below normal. One of the highlights was a station in the Olifants Water Management Area (WMA), which flows into Mozambique recorded 2601 million cubic meters (MCM) annual volume, the highest since 1980. The national dam storage levels of 221 dams for the 2021/22 and 2022/23 hydrological years were the highest and longest in the past five hydrological years.

Heavy rains not only cause high stream flows and fill most reservoirs but also recharge groundwater aquifers. National Average Groundwater levels reached 64,7% in July 2023, the highest in 22 years. The national average groundwater level status indicates a recovery trend from below normal in 2019 to above normal in 2023. During the groundwater quality assessment for 2022/23, several groundwater monitoring sites in Limpopo and North West were found to have relatively high nitrate concentrations ever recorded. Two borehole sites, ZQMGYA2 and ZQMGMI1, anomalously crossed the

110 mg/L levels for the first time since monitoring started. On the downside, heavy rains often lead to flooding, which is destructive to humans and the environment. In 2023, the National Disaster Management Centre (NDMC) reported to have received alerts about overflowing dams and sewerage facilities. On 13 February 2023, the government in South Africa declared a National State of Disaster to enable an intensive, coordinated response to the impact of multiple flood events affecting seven provinces: Mpumalanga, Eastern Cape, Gauteng, KwaZulu-Natal, Limpopo, Northern Cape and North West. At the time of declaration, Mpumalanga (Nkomazi Local Municipality) and Eastern Cape (Chris Hani District Municipality) were reported to be the most affected by the floods. Post declaration, flooding continued in the Eastern Cape in March 2023 and again in May 2023. In June 2023, flooding occurred in the Western Cape, Northern Cape, and KwaZulu-Natal.

The heavy rains in some parts of the country led to the implementation of dam safety protocols to prevent dam failures and significant disasters. In November 2022, in parts of Gauteng and in the southern highveld of Mpumalanga near Standerton and Secunda, widespread flooding resulted in a large inflow of water into the Vaal Dam, raising dam levels and compelling the decision to open eight sluice gates for flood management. Dam safety protocols were triggered again in February 2023, where twelve sluice gates were opened to manage another Vaal Dam overflow and dam safety.

The report highlights the severe challenges of microbial contamination in the South African water resources (Rivers and Dams). Microbiological data collected from 43 hotspot sites in the country from October 2022 to September 2023 suggests that water at all 43 newly selected sites is unsuitable for drinking without treatment. While treating water at the household level through methods such as boiling, filtration, or chlorination can help mitigate the potential health risks, 35% of the sampled sites still demonstrated a high risk associated with using the water even after undergoing limited treatment. Furthermore, the findings indicated that 41% of the sites were unsuitable for irrigating crops intended for raw consumption, and 67% of the sampled sites were deemed unsuitable for recreational activities, posing a high risk of infection for individuals engaging in such activities. These recreational activities include full-contact activities such as swimming, washing laundry, and events like baptisms. Treating water at the household level through methods such as boiling, filtration, or chlorination can help mitigate the potential health risks.

A total of 144 Water Services Authorities (WSAs) were assessed during the 2022/23 hydrological year. However, 14.6% of the water services authorities did not upload data on the Integrated Regulatory Information System (IRIS). The results of the Water Supply Systems compliance in terms of chemical drinking water quality from October 2022 to September 2023 show that 79% of the systems had excellent compliance in terms of chemical quality compliance, 2.8% had good compliance, while 3.5% demonstrated poor chemical quality compliance.

The National Water Balance indicates a System Input Volume (SIV) of 4,39 billion m^3/a, water losses of 1,79 billion m^3/a (40,8%), and Non-Revenue Water (NRW) of 2,08 billion m^3/a (47,4%). NRW and water losses have increased by a notable 5.9% and 4,3%, respectively, from June 2016. The Infrastructure Leakage Index (ILI) deteriorated drastically from 2016 to date. The ILI of 6,9, and 7,0 for 2022 and 2023, respectively, indicates poorly managed physical losses; this trend is expected to improve once municipalities have returned to normal, eliminated the leak repair backlogs, and improved revenue collection.

South Africa also faces challenges in water and sanitation services delivery, such as insufficient water infrastructure maintenance and/or investment. These challenges are further compounded by an increasing number of municipalities not managing their water infrastructure assets strategically; this includes record keeping of water infrastructure assets and their locations and the age and condition of water infrastructure assets. Water resource development mainly addresses issues such as socio-economic uplifting and development, ensuring the availability of safe water supplies to communities, and meeting the water requirements for industries and other sectors critical for economic growth. The Department has been involved in the development of water resources infrastructure to augment the water supply and safeguard future water security. Estimated funding of at least R126 billion is required to finance key water resource development projects in the next ten years**.** The bulk water projects under construction across the country to improve water supply to millions of residents in villages, towns, and cities include the Lesotho Highlands Water Project, Raising Hazelmere Dam, uMkhomazi Water Project, Raising Clanwilliam Dam, Raising Tzaneen Dam, Giyani pipeline from Nandoni Dam, and many more.

In 2015, South Africa adopted a revolutionary approach under the theme – “It is not all about flushing”, recognising that South Africa is a water-scarce country, with a projected 17% deficit in the availability of water by 2030 if the same rate of water consumption is maintained. The projected water deficit will have a significant impact on the historical way of providing waterborne sanitation and requires the sector to reconsider sanitation provision approaches, with more investment in non-sewered, low water, and waterless sanitation solutions as a means to increase the rate of sanitation service delivery within the seven years left until 2030. The DWS has recognized that due to climate change, water resources constraints, and energy supply challenges, the historic approach of providing waterborne sanitation is no longer sustainable and realistic in achieving universal access to safely managed sanitation. The envisaged 17% deficit in the availability of water and the projected demand by 2030 requires the water sector leader to embrace the use of a range of appropriate sanitation solutions and innovative technologies that require little or no water or recycled water.

1

INTRODUCTION

1 INTRODUCTION

1.1 Background

The Department of Water and Sanitation is the public trustee or custodian of the nation's water resources and has a vital and significant role in managing the country's water resources. The Department runs several monitoring programmes through established monitoring networks to collect data and derive information on surface and groundwater quality and quantity.

River systems (mostly surface water storage) are the common surface water expression of water availability in South Africa, with others being lakes, ponds, and pans. South African river systems and catchments are characterised by a high spatial variation in rainfall, as well as variations in catchment sizes and physical properties. These result in different river patterns and dynamics within catchments and further in water management areas (WMAs), which have implications for water resource availability.

Aquifer (groundwater) storage is another expression of water availability in the country. In the past decades, an increased groundwater utilisation in the country's water mix has been observed due to the significant potential of the groundwater resources in adaptation to climatic-related stresses and augmenting of conventional surface water supply systems.

South Africa is characterised by spatial variability in rainfall, with the east of the country lying in the predominantly summer rainfall zone, receiving high rainfalls. In contrast, the country's west primarily lies in the semi-arid to arid region, receiving relatively less rainfall. South Africa is, however, naturally inclined to drought conditions because it is a semi-arid country. Also, there are persistent challenges that pose a risk to water security, as reported in this National State of Water Report.

South Africa requires additional water resources to support the growing economy as a developing country. With 98% of the country's available water resources already allocated, opportunities to supplement future water requirements with conventional surface water resources are limited. A mix of water resources or sources will be required to reconcile supply and demand, including sustainable ground water use, reuse of wastewater, and desalination where feasible.

South Africa also faces challenges in water and sanitation services delivery, such as insufficient water infrastructure maintenance and/or investment; increasing frequency of extreme weather events such as droughts and floods; and the worsening social inequities. Ruiters and Amadi-Echendu (2022) describes medium to long-term consequences of insufficient investments on water operations and maintenance include: (1) deteriorating reliability and quality of waters services (2) move to more expensive crisis maintenance rather than planned maintenance (3) increasing the future cost of maintenance and refurbishment (4) shortening the useful life of assets leading to earlier replacement (5) cost influence on charge calculations and models. These challenges are further intensified by increasing number of municipalities not managing their water infrastructure assets strategically, this includes record keeping of water infrastructure assets and their locations, and the age and condition of water infrastructure assets.

South Africa's water supply is dependent on Strategic Water Source Areas (SWSAs). SWSAs are defined as areas of land of national importance that either: (a) supply relatively large quantities of mean annual surface water runoff compared to their size or (b) have high groundwater recharge and high dependence or (c) areas that meet both criteria (a) and (b). They include transboundary Water Source Areas that extend into Lesotho and Swaziland. All surface water SWSAs are located in high rainfall areas where baseflow is at least 1125 mm/a, which is evidence of a strong link between groundwater and surface water in the SWSAs. The water produced by these areas supports at least 50% of the population, 64% of the economy, and supplies about 70% of the water used by irrigated agriculture. Gauteng gets about 65% of its water from these areas, and Cape Town and eThekwini about 98%. About 24% of the settlements reliant on groundwater are located within groundwater SWSAs, which is equivalent to 10% of all settlements in South Africa. These SWSAs supply about 46% of the groundwater used by agriculture and 47% of the groundwater used for industrial purposes in South Africa.

A necessary means to address water insecurity challenges is the consideration of integrated, circular, and transformative approaches that include the Water-Energy-Food (WEF) nexus. The challenges of water, energy, and food insecurity are interlinked in such a way that any changes in any of the three sectors would also affect the other two. Providing solutions to any of the three should also consider the impacts on the other two. Otherwise, the interventions would transfer the challenges from one sector to another. Linear approaches have been helpful for a long time but have reached their limits. They are being replaced by circular approaches, which are multi-sectoral and multi-stakeholder in their approach.

The National State of Water (NSoW) Report sets out to communicate the available water resources information through this integrated report to assist water managers in decision-making; evaluating the impact of the implementation of legislation; highlight identified problem areas; inform the public on the status of water resources and sanitation; what is being done to balance the water demand and supply; and ensure availability of water for future generations. The report is based on analysis of identified and monitored water resource indicators for the Hydrological Year – October 2022 to September 2023.

1.2 National Water Resource Strategy

The goals of the National Water Resource Strategy-3 (NWRS-3) are to ensure water is protected, used, developed, managed, and controlled sustainably and equitably and that water and sanitation must support development and eliminate poverty and inequality. The NWRS-3 should contribute to the economy and job creation. The NWRS-3 focuses on increasing water supply, reducing water demand, managing effective water and sanitation, regulating the water and sanitation sector, redistributing water for transformation, promoting international cooperation, managing water and sanitation under a changing climate, improving raw water quality, and protecting aquatic ecosystems and maintaining and restoring ecological infrastructure.

The implementation of the NWRS-3 is possible when enabling aspects such as the creation of effective water sector institutions, data collection, analysis and information management for effective monitoring, evaluation and reporting, building capacity for action, ensuring financial sustainability, enhancing and deploying research, development and innovation, and addressing legislative and policy gaps are adequately addressed.

1.3 Water Management Areas

Based on the outcome of the Departmental Institutional Reform and Realignment study, the National Water Resource Strategy second edition (NWRS-2) established the nine WMAs in South Africa in July 2012 (Figure 1.1). These replaced the 19 WMAs identified before this date.

It was recognised that these WMA boundaries needed to be reviewed periodically to accommodate new realisations and issues. WMAs are based mainly on catchment boundaries, except for those catchments that cross international borders. Within these WMAs, catchments are further subdivided into tertiary, secondary, and quaternary catchments. The current state and historical trends of various water resource indicators provided in this report have been analysed and presented based primarily on the nine WMAs or, in some instances, Provinces.

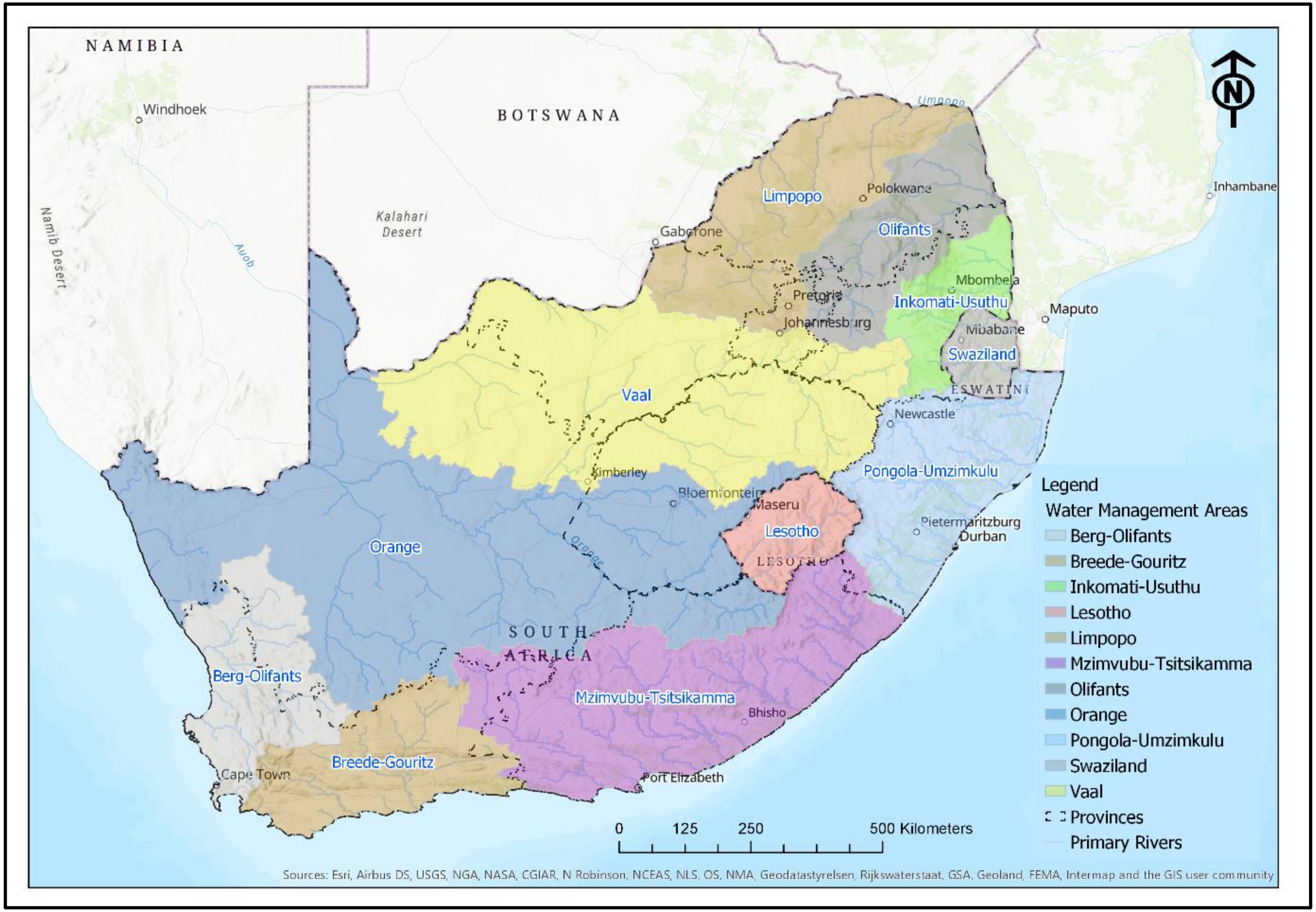

Figure 1.1: South African Nine Water Management Areas as of 2012.

1.4 Water Sector Institutional Reform

The South African Water Sector Institutional Reform has not been completed, and the outlook is illustrated Figure 1.2. The National Department of Water and Sanitation is the custodian of water resources with an obligation to perform water resource management functions. The National Department acting through the Minister is responsible for water sector policy, support, and regulation.

The water resource management functions are to be delegated to the Catchment Management Agencies (CMAs). This supports the principles of good governance, where water is managed locally. In water management areas where a CMA has not been established, DWS National and Provincial Operations remains the responsible authority, and continues to act as a CMA to perform all water resource management functions at a catchment level.

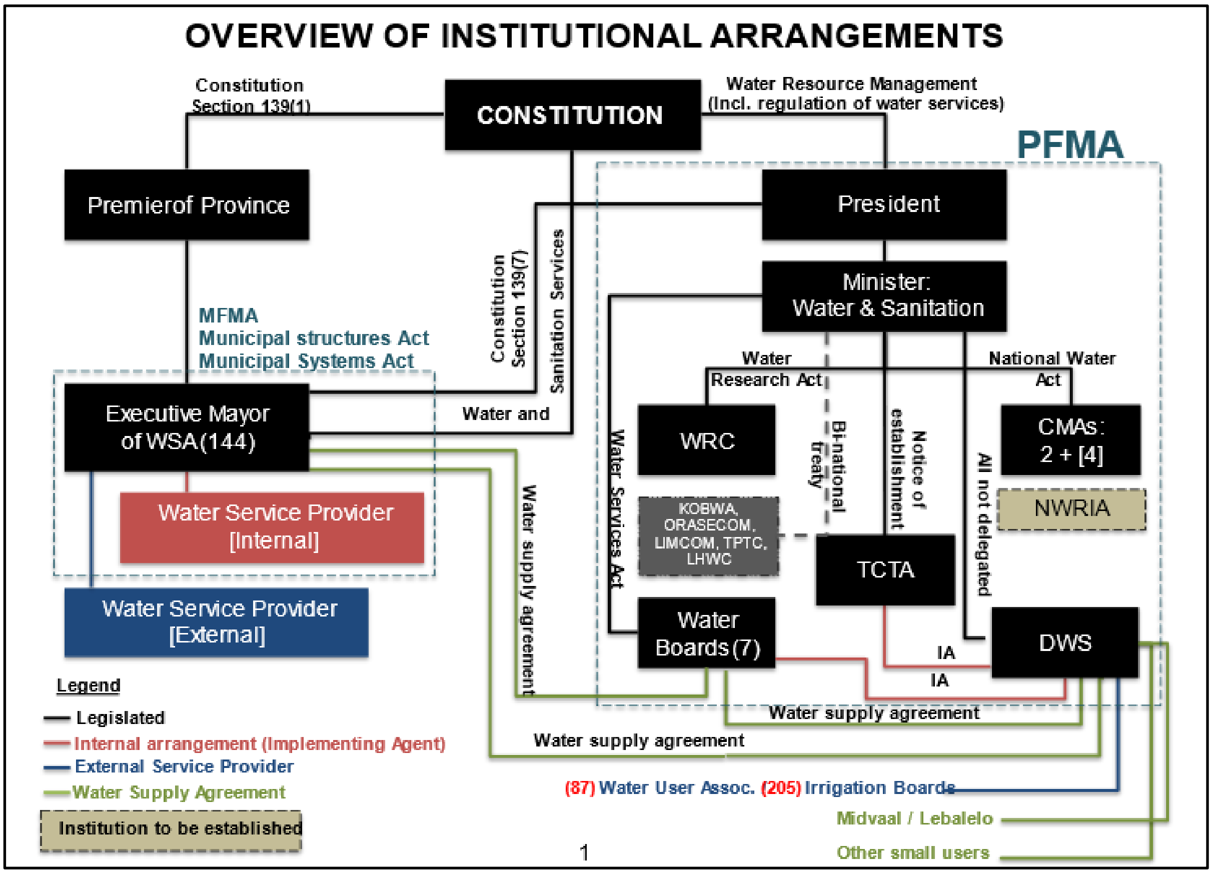

Figure 1.2: Water Sector Institutional Landscape.

At a national level, the reform process involves the consolidation of the DWS's Water Resource Infrastructure Branch and Trans Caledon Tunnel Authority (TCTA) to form a *National Water Resource Infrastructure Agency (NWRIA),* which will be responsible for infrastructure development and management. At a regional level, the process of converting the Water Boards to Regional Water Utilities has been halted. At a local level, the transformation of Irrigation Boards into Water User Associations (WUAs) has been halted due to policy shifts which are currently taking place.

Furthermore, we find Water Services Institutions (WSI) at the local level, and these are Water Services Authorities (WSAs) – municipalities that provide water services or outsource water services provisions to the private Water Services Providers (WSPs) – water boards. These WSAs and WSPs provide water and sanitation services and are regulated by the Department of Cooperative Governance and Traditional Affairs (CoGTA).

A water services authority would mean any municipality, including a district or rural council (as defined in the Local Government Transition Act, 1993), responsible for ensuring access to water services. Water services providers are any person who provides water services to consumers or another institution. Notably, some WSAs are WSPs; in other cases, the WSA has WSPs that provide water services on their behalf.

1.5 Establishment of CMAs

The Department has embarked on several institutional re-alignment processes to transform the water sector, build stable institutions with clearly defined roles and responsibilities, and promote effective institutional performance.

The National Water and Sanitation Master Plan, launched in November 2019, has prioritised the establishment of CMAs, and the progressive delegation or assignment of powers, functions, and duties of CMAs. CMA establishment has demanded attention be given to any opportunities for reducing costs and increasing efficiencies without compromising on the core objectives of decentralising water resource management.

The number of CMAs has as per NWRS-3, revised from nine to six through the consolidation of WMAs (Figure 1.3:.). The CMAs will be for: (1) Limpopo-Olifants (2) Inkomati-Usuthu; (3) Pongola-Umzimkhulu; (4) Vaal-Orange; (5) Mzimvubu-Tsitsikamma; (6) Breede-Olifants.

The main principles in realigning the WMA and CMAs from nine to six are the following:

- ***Operational Integration –*** *connected and integrated water systems, easy coordination, and monitoring of agreements improved capacity-pooled technical skills.*
- ***Integrated water resource planning –*** *the river basins fall within the same system, improved resource planning, and the same conventions manage transboundary systems.*
- ***Economies of scale –*** *enhance revenue and hence sustainability, cost-effectiveness, and consolidated management structures.*

The CMAs initial function will be to promote community participation in water governance. The CMA will manage and control water resources, develop catchment management strategies and ensure coordination and implementation by municipalities as per section 80 of the National Water Act, 36 of 1998. The progress of the establishment of CMAs is provided in Table 1-1.

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Figure 1.3: Revised WMAs as per NWRS-3.

Table 1-1: CMA Establishment Progress – December 2023

NAME OF THE CMA	STATUS OF CMA ESTABLISHMENT	Next Steps
Breede-Olifants (BOCMA)	• The new board-appointed process is underway and should be finalised by March 2024. • Workstreams have been established for a smooth transfer from Proto CMA to BOCMA	Appointment of the Chief Executive Officer (CEO) to commence once the board is appointed – currently there is an acting CEO
Vaal-Orange (VOCMA)	• Cabinet concurred on the appointment of Board Members for the VOCMA in November 2023 and their appointment was on 1 December 2023. • Workstreams have been established for a smooth transfer from Proto CMA to VOCMA.	Interim CEO appointed for the transitional phase until the board appoints a CEO
Pongola-Umzimkulu (PUCMA)	• Cabinet concurred on the appointment of Board Members for the VOCMA in November 2023 and their appointment was on 1 December 2023. • Workstreams have been established for a smooth transfer from Proto CMA to PUCMA.	Interim CEO appointed for the transitional phase until the board appoints a CEO
Limpopo-Olifants (LOCMA)	• Gazette notice for the establishment of the CMA was published on 22 September 2023. • The board appointment process has commenced and should be completed by April 2024. • DWS has requested to list the LOCMA under the Public Finance Management Act (PFMA) schedule.	Processes to continue at a local level. Workstreams to be established for a smooth transfer from Proto CMA to LOCMA. Appointment of CEO once the board is established.
Mzimvubu-Tsitsikamma (MTCMA)	• The recommendations on the board appointment process have been completed and submitted to the minister for consideration.	

	• Workstreams have been established for a smooth transfer from Proto CMA to MTCMA.	
Inkomati-Usuthu	• No configuration to be done	

1.6 Transboundary Water Resources

South Africa shares four international river basins, namely the Limpopo, Orange/Senqu, Inkomati, and Maputo, with six neighbouring countries, Botswana, Lesotho, Mozambique, Namibia, eSwatini, and Zimbabwe.

The shared watercourse institutions are responsible for international cooperation on water resource management of the basin, including equitable water sharing between countries, basin management, operation of basin infrastructure for droughts and floods, and future water resource development options, water resource protection, etc. South Africa has three international rivers which it shares with its neighbours (Figure 1.4), i.e.:

- Orange – Senqu River: shared with the Kingdom of Lesotho, Botswana & Namibia
- Limpopo River: shared with Botswana, Zimbabwe, and Mozambique
- Inkomati River: shared with the Kingdom of Eswatini and Mozambique
- Maputo River: shared with the Kingdom of Eswatini and Mozambique

The summary of international agreements and their status is given in Table 1-2. These agreements have been established with the neighbouring states to promote international transboundary cooperation.

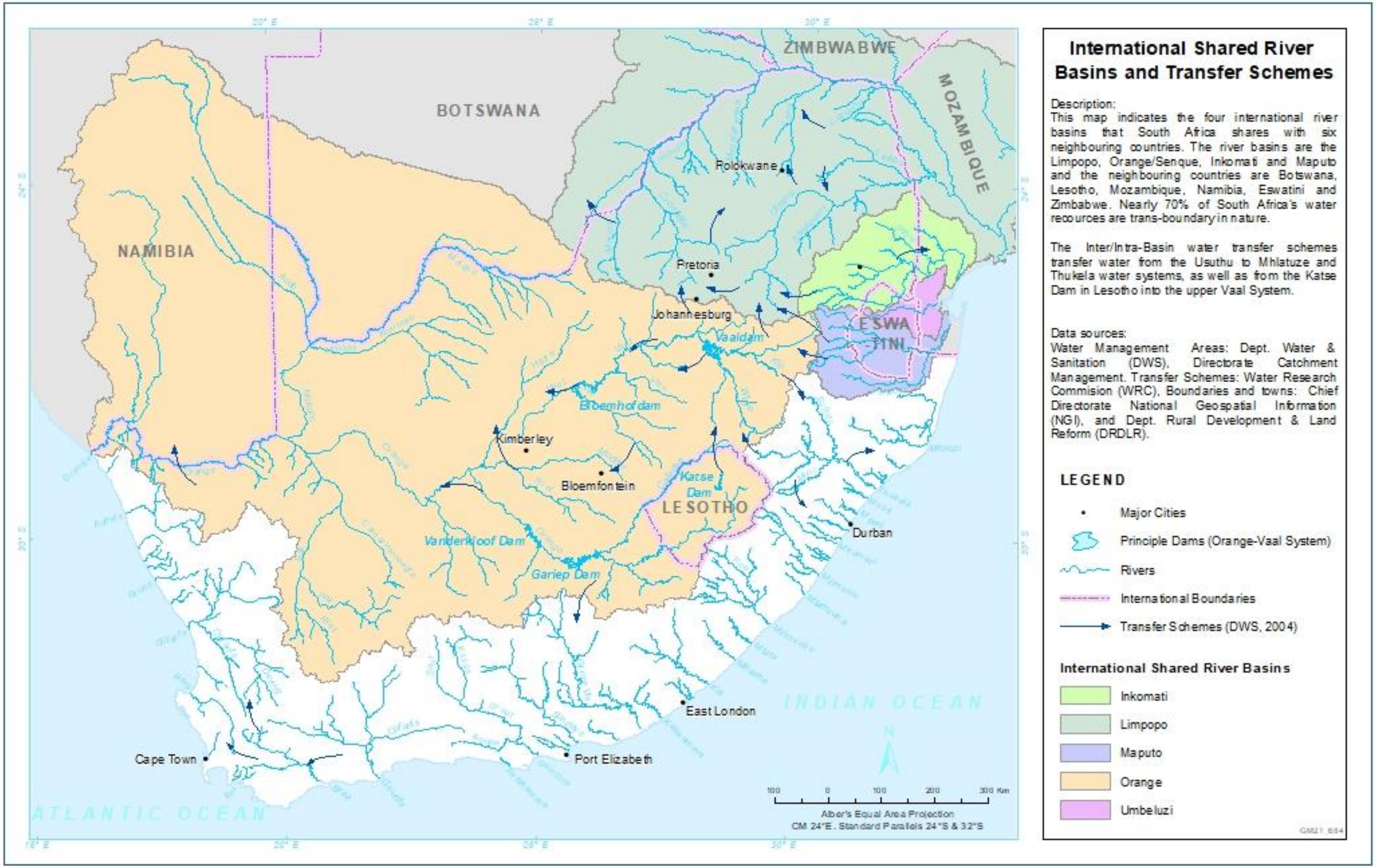


Figure 1.4: International shared basin and transfer schemes

Table 1-2 List of Shared Watercourses Agreements

Country	Title of the Agreement	Date signed	Date entered into force	Status of Agreement	Areas of Cooperation
Republic of Botswana, Republic of Mozambique, Republic of South Africa, and Republic of Zimbabwe	Agreement between Republic of Botswana, Republic of Mozambique, Republic of South Africa (RSA), and Republic of Zimbabwe on the establishment of the Limpopo watercourse Commission (LIMCOM**)**	2003/11/27	2003/11/27	Active	Joint Integrated Water Resource Management of the Limpopo River Shared Water between RSA, Botswana, Mozambique, and Zimbabwe
Republic of Botswana, Kingdom of Lesotho, Republic of Namibia, and Republic of South Africa	Agreement between Republic of Botswana, Kingdom of Lesotho Republic of Namibia, and Republic of South Africa on the establishment of the Orange Senqu River Commission (ORASECOM)	2000/11/03	2000/11/03	Active	Joint Integrated Water Resource Management of the Limpopo River Shared Water between RSA, Botswana, Namibia, and Lesotho
Republic of Botswana, Kingdom of Lesotho, and Republic of South Africa.	Memorandum of Agreement between the Government of Republic of Botswana, Kingdom of Lesotho and Republic of South Africa on the Lesotho-Botswana Water Transfer Feasibility Study	2017/11/16	2017/11/16	Active	RSA, Botswana, and Lesotho experts (engineers) jointly study the possibility of Botswana extracting water from the Lesotho Highlands Water Project. Implementation of Phase II Procurement process implementation

Country	Title of the Agreement	Date signed	Date entered into force	Status of Agreement	Areas of Cooperation
					Establishment of Project management
Republic of Mozambique, Kingdom of Swaziland/Eswatini, and Republic of South Africa	**Agreement between the Kingdom of Swaziland, The Republic of Mozambique and Republic of South Africa on the establishment of Inco and Maputo Watercourse Commission.** This is an envisaged Agreement which countries are still consulting with their respective Legal entities in their countries.			Not active	

2

WATER RESOURCES DATA

2 WATER RESOURCES DATA

2.1 Surface Water Quantity Monitoring

The Department has established and operates a national surface water monitoring network along rivers, dams, estuaries, eyes, canals, and pipelines. The purpose of the national network is to monitor hydrological and hydro-meteorological conditions to enable water resource assessment, planning, water supply management, system operations, and flood forecasting. The summary structure of the surface water monitoring programme in the Department is shown in Figure 2.1. The programmes are divided into two, the first is hydro-meteorological programme which monitors evaporation and rainfall, and the second programme is hydrological monitoring which entails streamflow and dam levels monitoring.

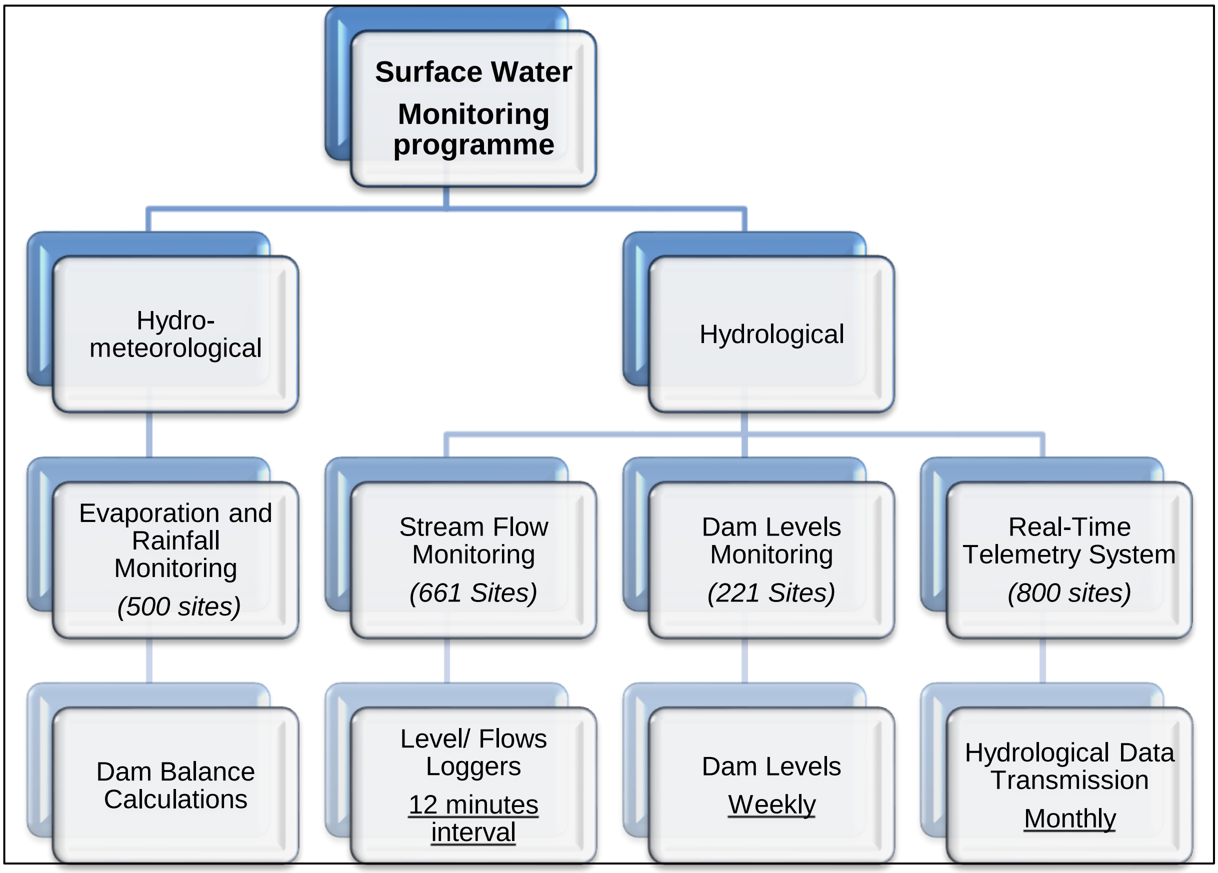


Figure 2.1: Summary structure of the surface water monitoring programmes

The DWS regional offices have selected several monitoring primary stations equipped with real-time telemetry data transmission systems. These include monitoring stations for dams, evaporation, rainfall, and streamflow. Data is transmitted from the monitoring stations directly to the national office and DWS website in near real-time. It is made available for use by all stakeholders as unverified data.

- *Dam Levels Monitoring*

The national dam monitoring is conducted at a regional level, and the DWS regional officials collect dam gauge plate readings every Monday. Upon capturing the collected data, the national office is responsible for processing, verifying, and disseminating data to various stakeholders through a weekly dam levels bulletin and summary synopsis. The locality map of the dam levels stations nationally is presented in Figure 2.2.

- *Evaporation and Rainfall Monitoring*

Evaporation and rainfall monitoring stations are situated at dam sites. The evaporation and rainfall readings are taken daily, except for rain gauges equipped with automatic tipping buckets. Data collected from these monitoring stations are audited monthly and processed in three months at the national office.

- *Streamflow Monitoring*

Streamflow monitoring stations are managed by the regional offices and are responsible for monthly downloading data from the dataloggers. Several streamflow monitoring stations are equipped with real-time telemetry data transmission systems; data transmitted from these systems can be accessed at www.dws.gov.za/hydrology. The national surface water monitoring network for streamflow gauging stations is presented in Figure 2.3.

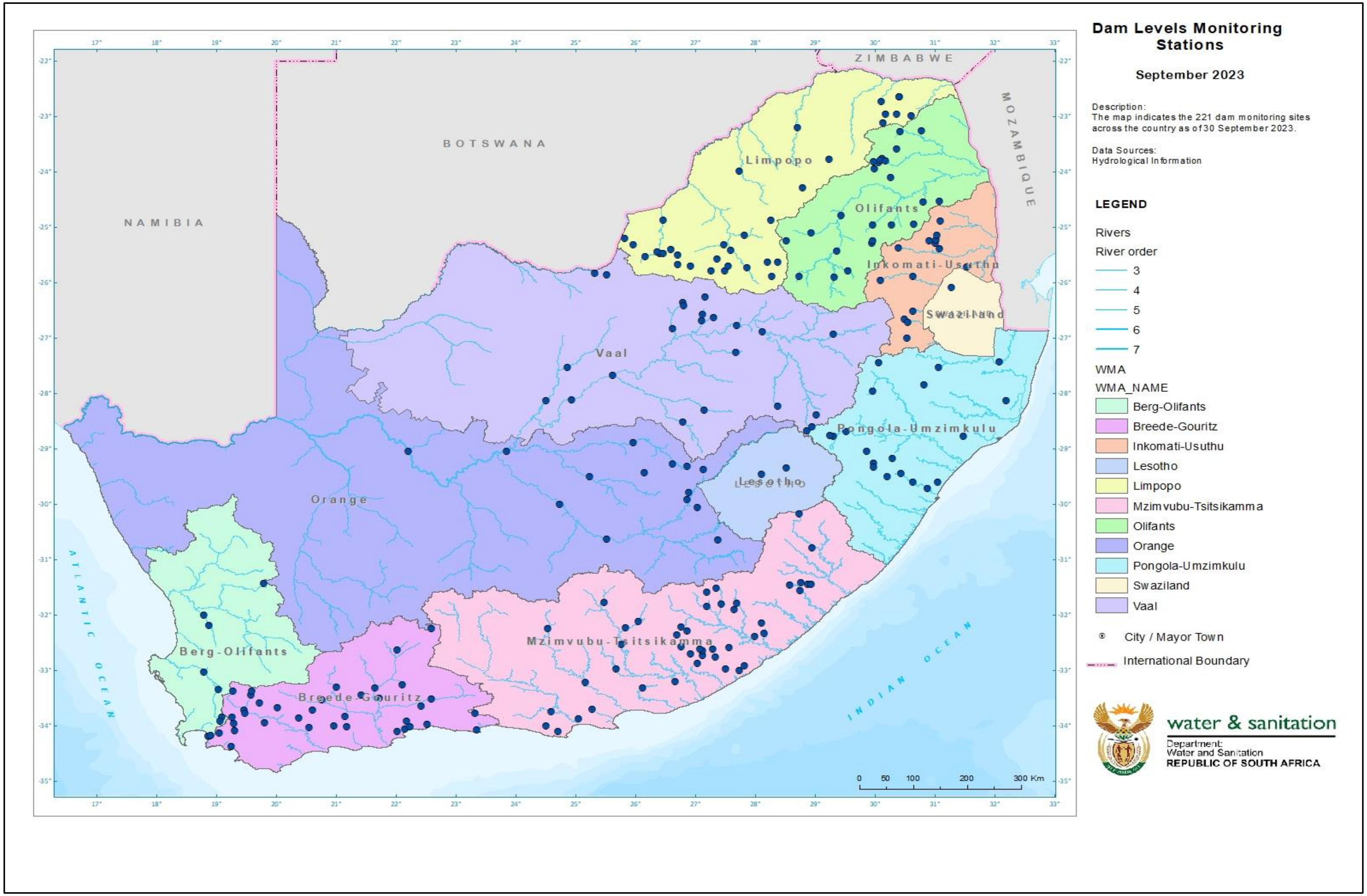


Figure 2.2: Dam levels monitoring stations network- September 2023.

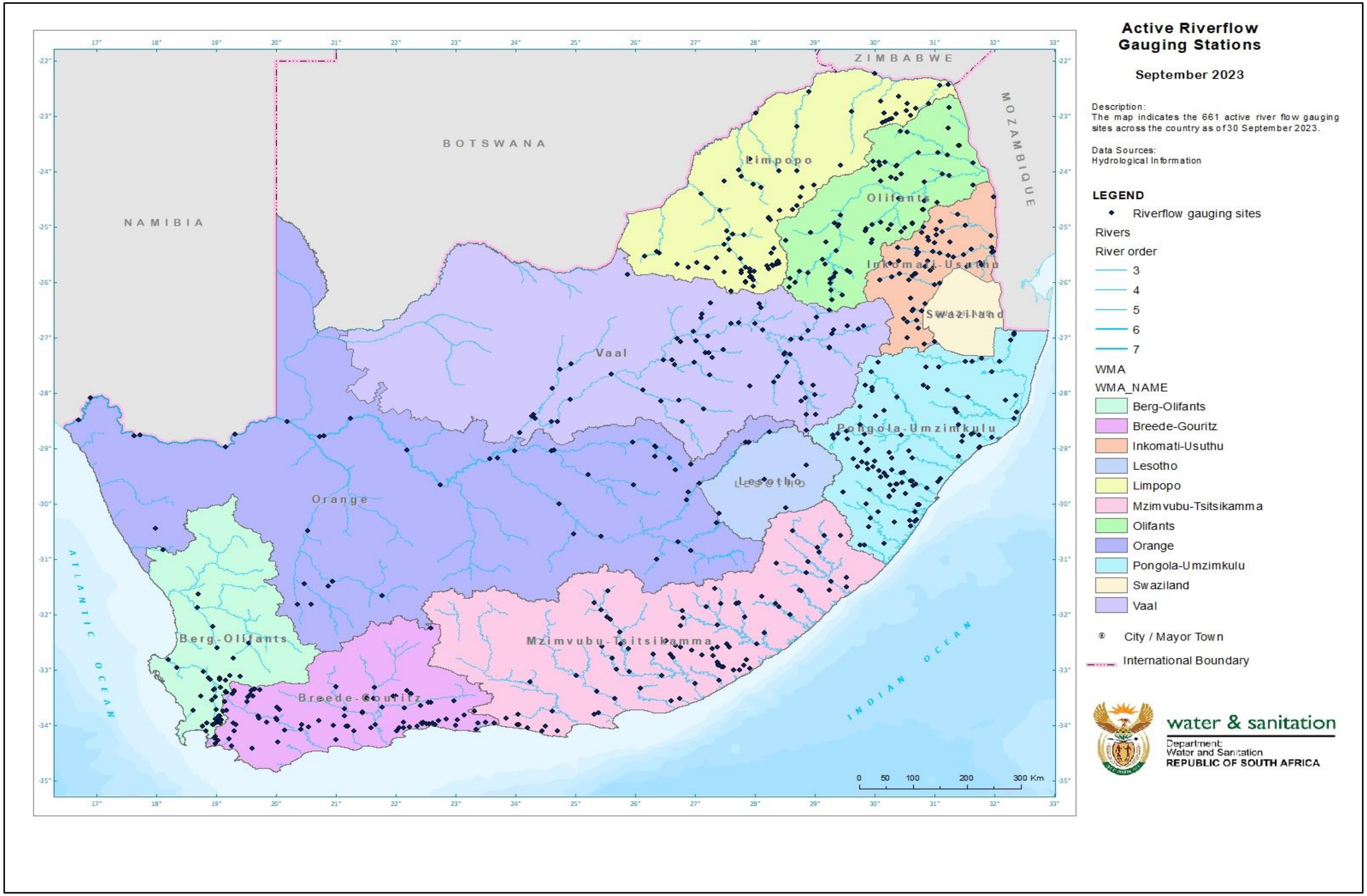


Figure 2.3: National Streamflow monitoring network - September 2023.

2.1.1 Surface Water Quantity Data Availability

The surface water monitoring network has 1450 stations across all the provinces, as shown in Figure 2.4. At the end of the current reporting period, 1123 stations were active and had data, a slight decline from the reported 1238 active stations with data at the end of the 2021/22 hydrological year. All station types across provinces had impressive data availability, with Limpopo, Western Cape, Eastern Cape, and Gauteng all having above 90% data availability at the end of the reporting period, the average national data availability across all provinces is currently at 89%.

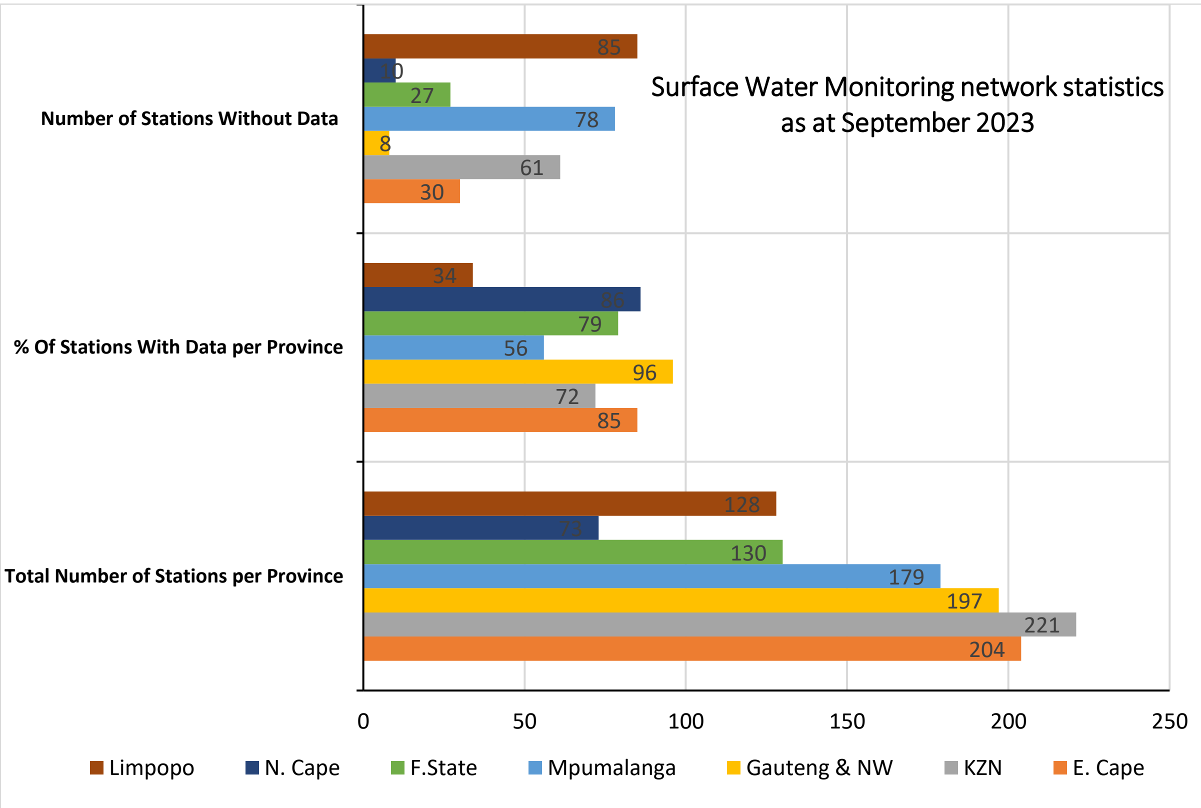
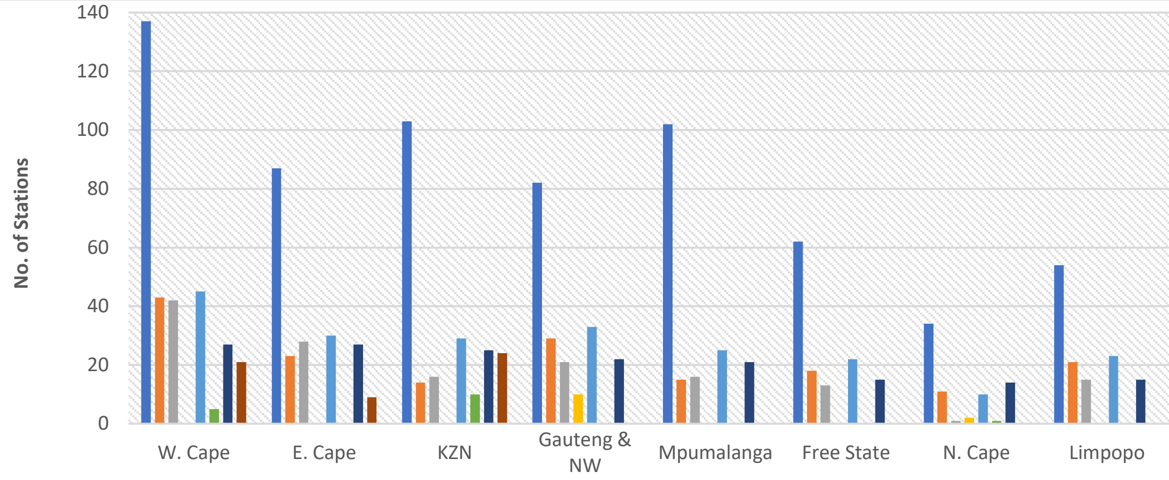


Figure 2.4: Summary of monitoring networks across South Africa as of September 2023 (extracted December 2023)

The station types per province in Figure 2.5, show a predominance of stations for river flow monitoring, most provinces reported a significant improvement in data availability compared to the previous year for river flow gauging. KZN reported 103 active stations, an increase of 23 from the previous year; and Mpumalanga increased from 63 stations with data in 2022 to 102 stations in the current reporting period. Estuaries are monitored in coastal areas, and the number of estuaries active stations in the Western Cape has increased from 10 in the 2020/21 hydrological year to 20 in the current reporting period. All provinces demonstrated a reasonable number of active stations in the reservoir monitoring, with the Western Cape and Gauteng leading, respectively.



	W. Cape	E. Cape	KZN	Gauteng & NW	Mpumalanga	Free State	N. Cape	Limpopo
RIVER	137	87	103	82	102	62	34	54
CANAL	43	23	14	29	15	18	11	21
PIPELINE	42	28	16	21	16	13	1	15
EYE	0	0	0	10	0	0	2	0
RESERVOIR	45	30	29	33	25	22	10	23
LAKE	5	0	10	0	0	0	1	0
MET	27	27	25	22	21	15	14	15
ESTUARY	21	9	24	0	0	0	0	0

Figure 2.5: Station types with available data per province as of September 2023 (extracted December 2023).

2.2 Surface Water Quality Monitoring Programmes

The Department of Water and Sanitation, as custodian of South Africa's water resources, seeks to ensure that water resources remain fit for recognised water uses while also maintaining and protecting the viability of aquatic ecosystems. As a result, several water quality monitoring programmes are currently in operation across the country. This section will outline DWS water quality monitoring programmes, their objectives, distribution, and performance during the current reporting period.

2.2.1 National Chemical Monitoring Programme (NCMP)

The NCMP provides information on the status and trends of inorganic chemical water quality in South Africa, primarily in rivers, on a national scale. It was established in the 1970s based on the information requirements and national priorities at the time and has been amended over the years to remain relevant to evolving needs. It is the longest-running South African water quality monitoring programme which has provided data and information for over 50 years for the inorganic chemical quality of surface water resources at various sites across the length and breadth of the country.

Figure 2.6 shows the location of the 341 sites that currently constitute the Priority National Chemical Monitoring Programme (PNCMP). The main objectives of this national scale programme include:

- Having sufficient inorganic water quality data available to determine the status and trends in South African rivers at a national scale;
- Supporting the National River Eco-status Monitoring Programme (REMP); the United Nations Environmental Programme – Global Environmental Monitoring System (UNEP GEMS), and Sustainable Development Goals (especially SDG 6.3) initiatives;
- Contributing to the integrated overarching historical database; and
- The dissemination of data and information.

The NCMP monitoring sites are primarily located at the downstream end of each tertiary drainage region as a descriptor of that drainage region's impact on water quality. Sites are also chosen based on strategic significance, such as interactions with neighbouring countries or participation in the UNEP GEMS, and Sustainable Development Goals (SDG) initiatives, specifically SDG 6.3.2 on Ambient Water Quality. Where possible, site selection aims to preserve long and consistent data records.

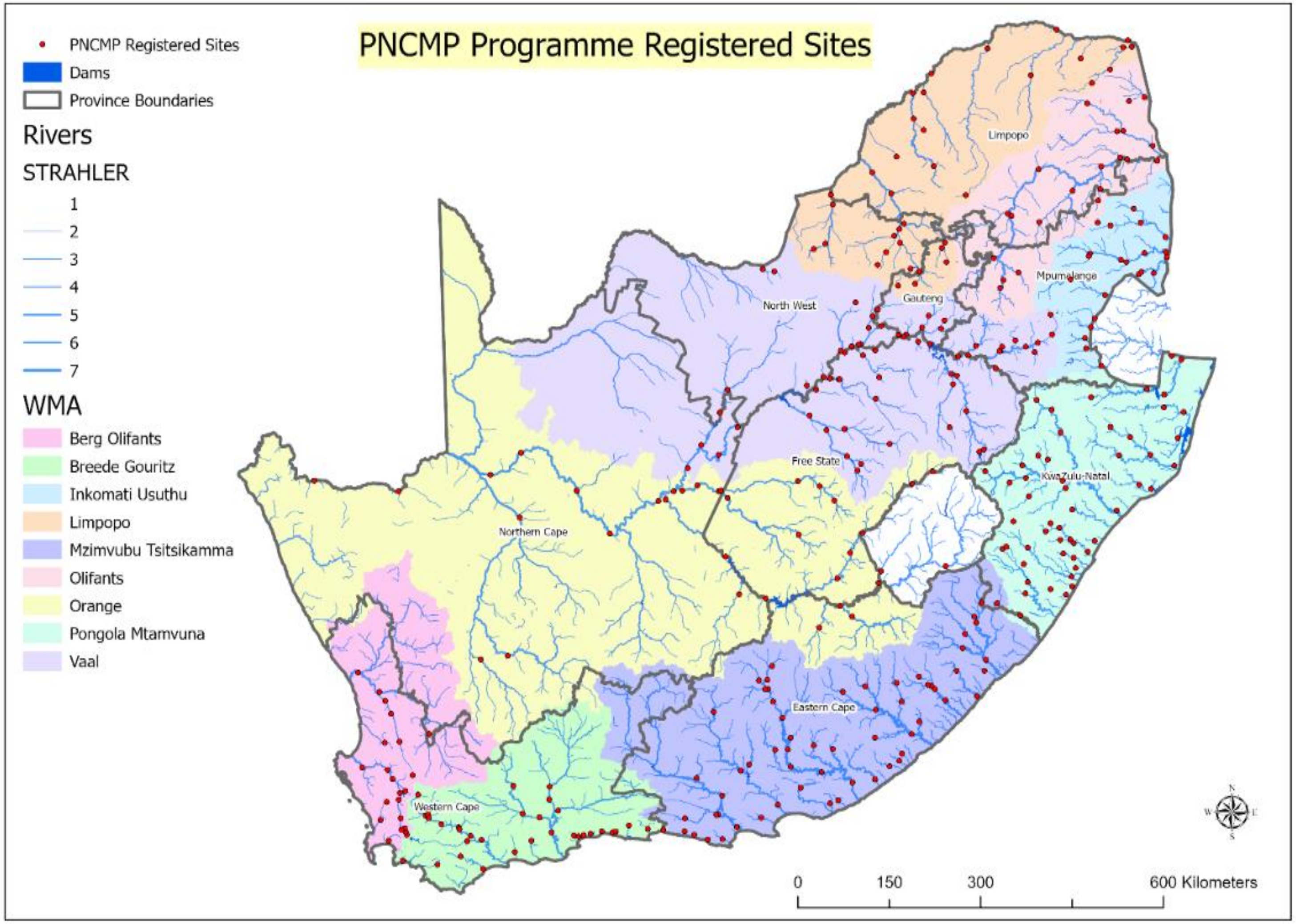


Figure 2.6 : Location of the PNCMP sites across South Africa.

The parameters monitored for the programme include the salinity, which is measured as Total Dissolved Solids (TDS) or Electrical Conductivity (EC), the concentrations of Iron (Fe), Sodium (Na), Chloride (Cl), Magnesium (Mg), Potassium(K), Sulphates (SO_4), Ammonium (NH_4) and Nitrates-nitrites (NO_3 + NO_2). The ammonium and nitrate-nitrite levels indicate nutrient loading from discharges and return flows into water resources. The programme has recently commenced with sampling for trace metal constituents. However, sufficient data is not yet available at this stage.

The sampling compliance at NCMP sites was 15.9% in the 2020/21 hydrological year, but it improved to 42.2% in 2021/22. Compliance dropped slightly to 40.5% for the 2022/23 hydrological year (Figure 2.7). However, it should be emphasised that the fourth quarter of the 2022/23 hydrological year had a dramatically improved 73% sample site visit compliance, owing largely to all parties' more focused sampling efforts (Figure 2.8).

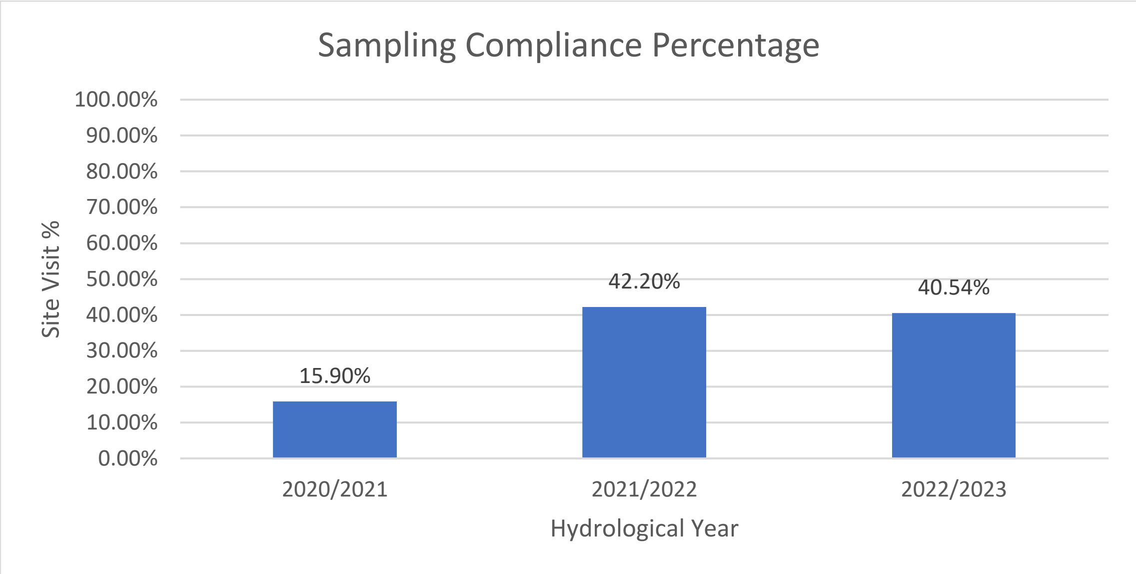


Figure 2.7: Percentage of Priority NCMP sites visited for sampling purposes over the past three hydrological years.

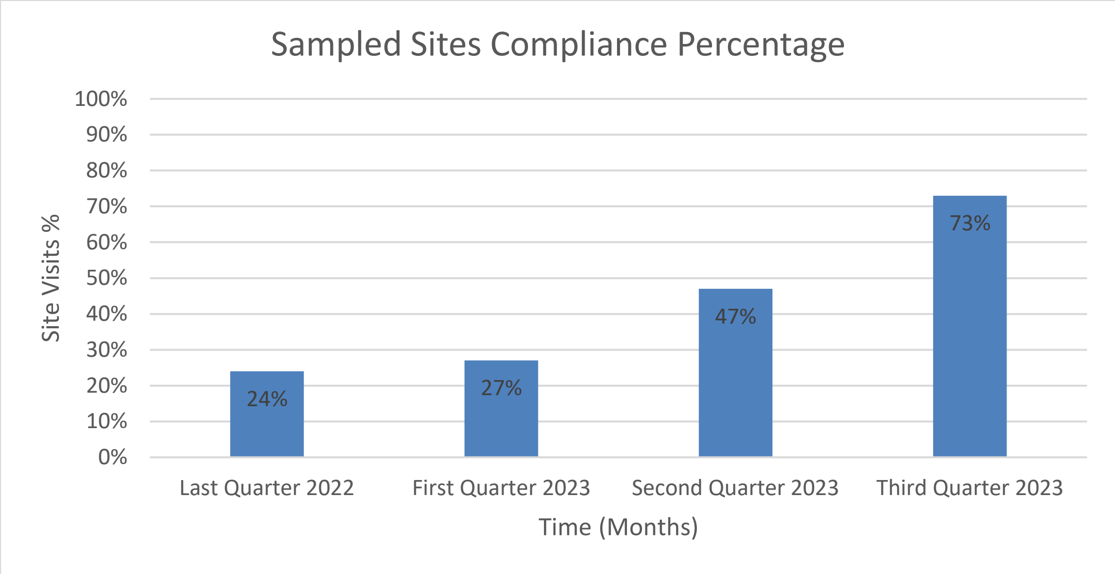


Figure 2.8: Quarterly NCMP sampling performance for the 2022/23 hydrological year.

The NCMP remains highly dependent on Regional Office officials, as well as staff at Water User Associations and Catchment Management Agencies, for sample collection. The laboratories at the Department of Water and Sanitation's Resource Quality Information Services (RQIS) directorate are essential for sample analysis, quality assurance and data capturing into the Water Management System (WMS) database. Sample Reception, a sub-directorate of RQIS is essential for sending out the required supplies to samplers, as well as receiving and logging samples sent to RQIS. These data and other resources are available to the public through the link: https://www.dws.gov.za/iwqs/wms/default.aspx.

2.2.2 National Eutrophication Monitoring Programme (NEMP)

The National Eutrophication Monitoring Programme (NEMP) monitors status and trends in relation to nutrient enrichment of water bodies in South Africa, it was established and officially implemented in 2002. The objective of the NEMP is to measure, assess and report regularly on the current trophic status and the nature of the current eutrophication problems for South African water resources. It also reports on the potential for future changes in the trophic status of dams/lakes and rivers in a manner to support strategic decisions in respect of their national management, being mindful of financial and capacity constraints yet being soundly scientific. The NEMP provides frameworks for addressing the following six (6) objectives for impoundments (dams/lakes) and rivers:

- Establishing trophic status in dams/lakes
- Early warning system – water treatment
- Early warning system – blooms
- Early warning system – invasive macrophytes

- Early warning system – long-term impacts
- Nutrient balance

The programme has over 289 registered sites, including dams, lakes, and rivers. The dam sites are selected based on their strategic importance for the region, country, and international commitments. Sampling is conducted at the dam wall or near the abstraction or discharge point. River sites are mostly selected at points that represent the inflow to the dams monitored.

A total of 119 sites were sampled for NEMP during the 2022/23 hydrological year, similar to the previous hydrological year (Figure 2.9). The provinces which contributed to sampling compliance included Mpumalanga, Free State, Gauteng, Limpopo, Western Cape and North-West. Significant improvements in sampling contribution were noted for Northern Cape and KwaZulu-Natal provinces. Eastern Cape is still lagging behind, and intervention methods are being developed. There were samples collected by DWS partners and stakeholders such as Water boards, Water User Associations, National Parks and Irrigation Boards in the various provinces.

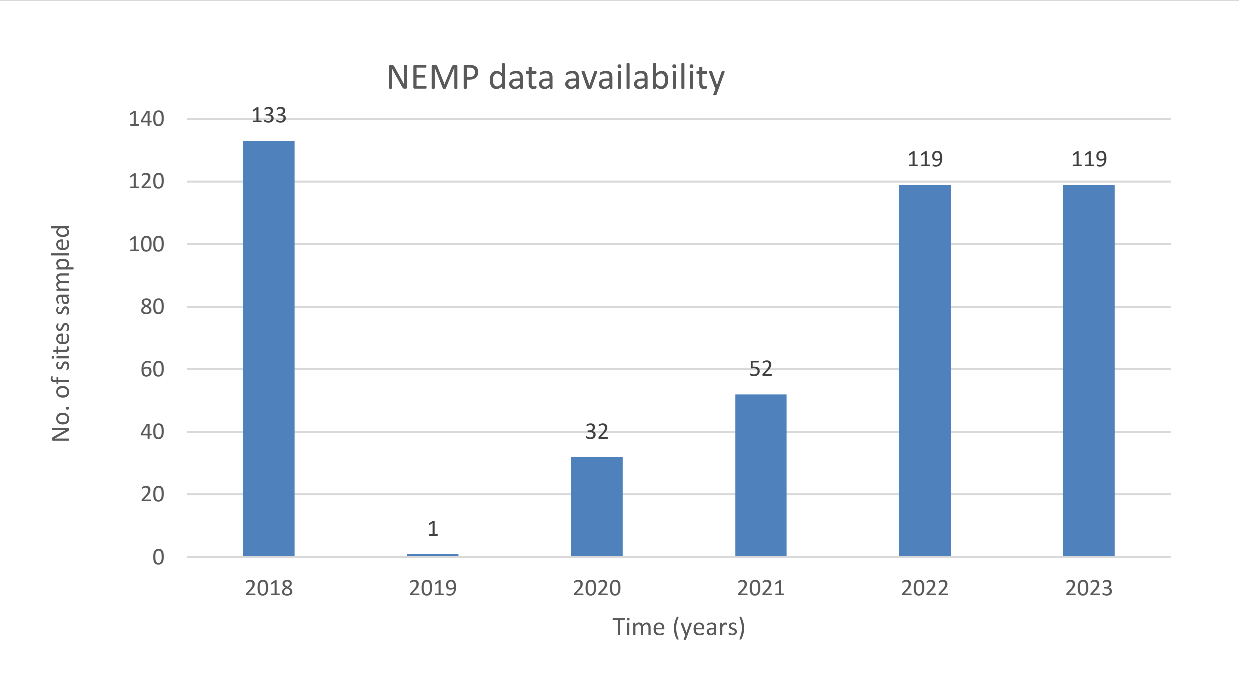


Figure 2.9: NEMP data availability from the year 2018 to 2023.

- *Optimised NEMP sites*

Forty five of the sixty-one dams were monitored during the current reporting period, giving a 74% compliance to the monitoring programme. This is a good baseline for future monitoring of optimised NEMP sites and plans are already underway to further improve this sampling compliance. The distribution of optimised sampling dam sites is depicted in Figure 2.10.

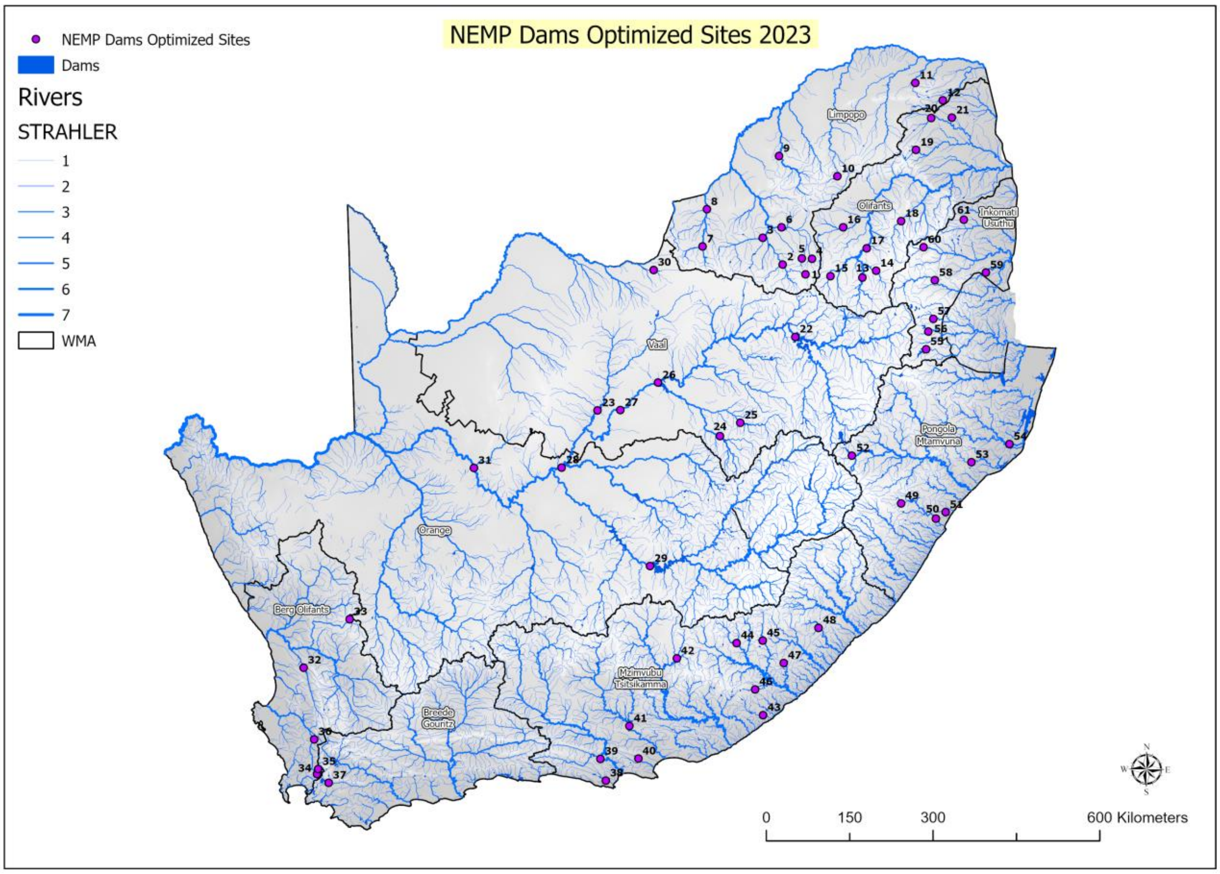


Figure 2.10: Distribution of optimised NEMP sites across the country.

2.2.3 National Microbial Monitoring Programme

The National Microbial Monitoring Programme (NMMP) aims to provide information on the status and trends of the extent of faecal pollution, in terms of the microbial quality of surface water resources in priority areas in South Africa, and to assess the potential health risks to humans associated with the possible use of faecal polluted water resources. The programme was implemented nationwide in the year 2000 to report on the potential health risks associated with faecal pollution of surface water resources at nationally identified hotspots. An indicator bacteria (*E. coli* and or Faecal Coliform) is used to indicate the presence of other pathogens in water or as an indicator of faecal contaminated water. The main objectives of the programme are to:

- Provide information on the status and trends of the extent of faecal pollution, in terms of the microbial quality of surface water resources in high-priority areas, and
- Provide information to help assess the potential health risk to humans associated with the possible use of faecal polluted water resources at those sites.

The programme's primary emphasis is on national hotspots and currently monitors 64 hotspot sites. However, the process of finding new hotspots is already underway. Figure 2.11 illustrates that, beginning in October 2022, the number of active NMMP locations increased from 35 to 52 by September 2023. This development was made possible through collaboration with partners such as eThekwini Municipality, the City of Joburg Municipality, Olifants-Doorn Proto CMA, and the DWS Regional offices. More sites have been identified and will be restored in the Limpopo and Northern Cape regions.

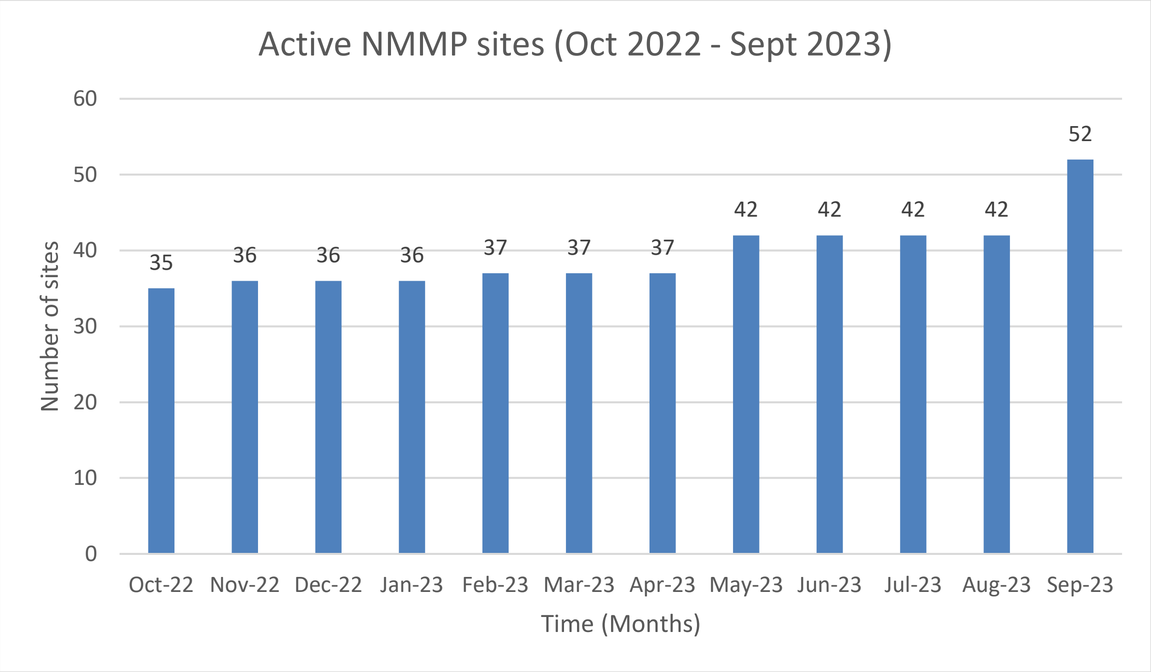


Figure 2.11: Active NMMP sites October 2022 – September 2023

2.2.4 River Eco-Status Monitoring Programme (REMP)

The South African River Health Programme (RHP) was initiated in 1994 in response to the need for more detailed information on the condition of South Africa's River ecosystems. The RHP was initiated prior to the promulgation of the Water Act and as such did not align completely with the Act, so it was later replaced by the River Eco-status Monitoring Programme (REMP). The REMP enables the monitoring of the ecological condition of river ecosystems in South Africa. It provides information regarding the ecological condition of river ecosystems to support the management of rivers and was designed to meet the following objectives:

- Measure, assess, and report the ecological status of river ecosystems;
- Detect and report spatial and temporal trends in the ecological status of river ecosystems;
- Identify and report emerging problems regarding river ecosystems;
- Ensure that all river ecosystem status reports provide scientifically relevant information for the management of these river ecosystems; and

- Create public capacity and environmental awareness.

The REMP is based on existing approved Eco-Status models such as the Index of Habitat Integrity (IHI), Fish Response Assessment Index (FRAI), Macroinvertebrate Response Assessment Index (MIRAI), Vegetation Response Assessment Index (VEGRAI), and Integrated Ecological Condition (Eco-Status), which are used in the ecological conditions assessment at the sub-quaternary reach or site levels. Monitoring is conducted quarterly, and technical reports are issued annually.

Figure 2.12 presents the trends in the REMP sites sampled over the past six years, while Figure 2.13 presents the spatial distribution of the REMP sites across the country. The number of sites per reporting year increased from 207 in 2016/17 to 506 in 2021/22. The COVID-19 restrictions caused a decrease in the number of sites monitored from 2019 to 2020.

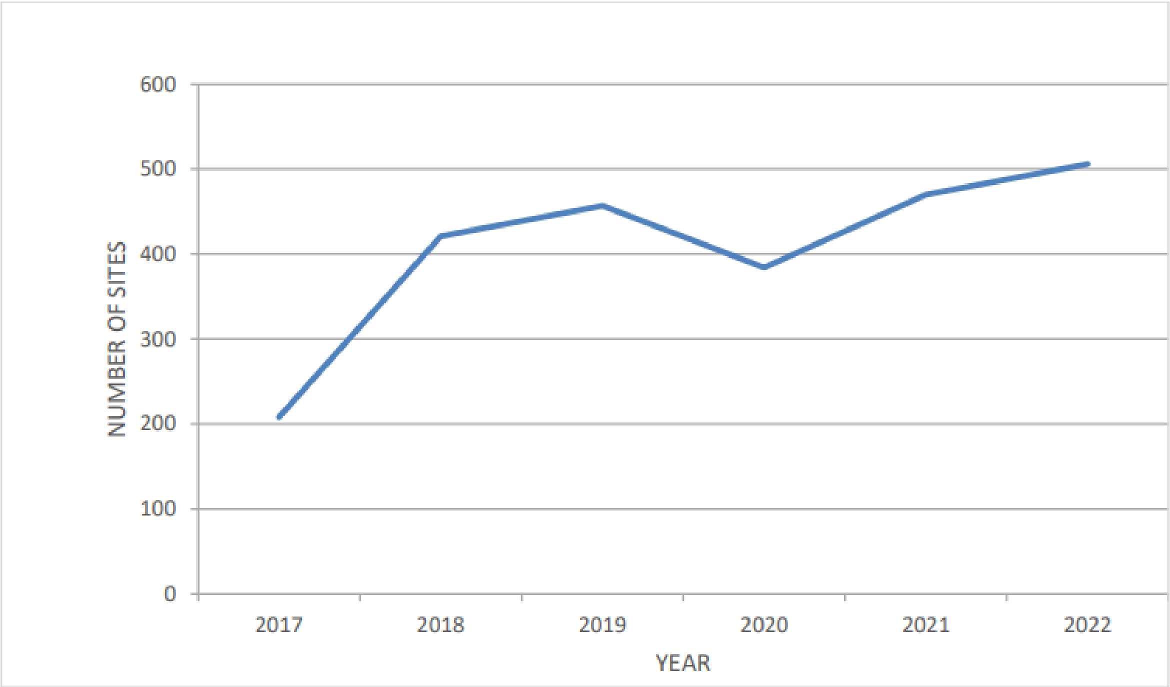


Figure 2.12: Trends of REMP sites monitored over the years.

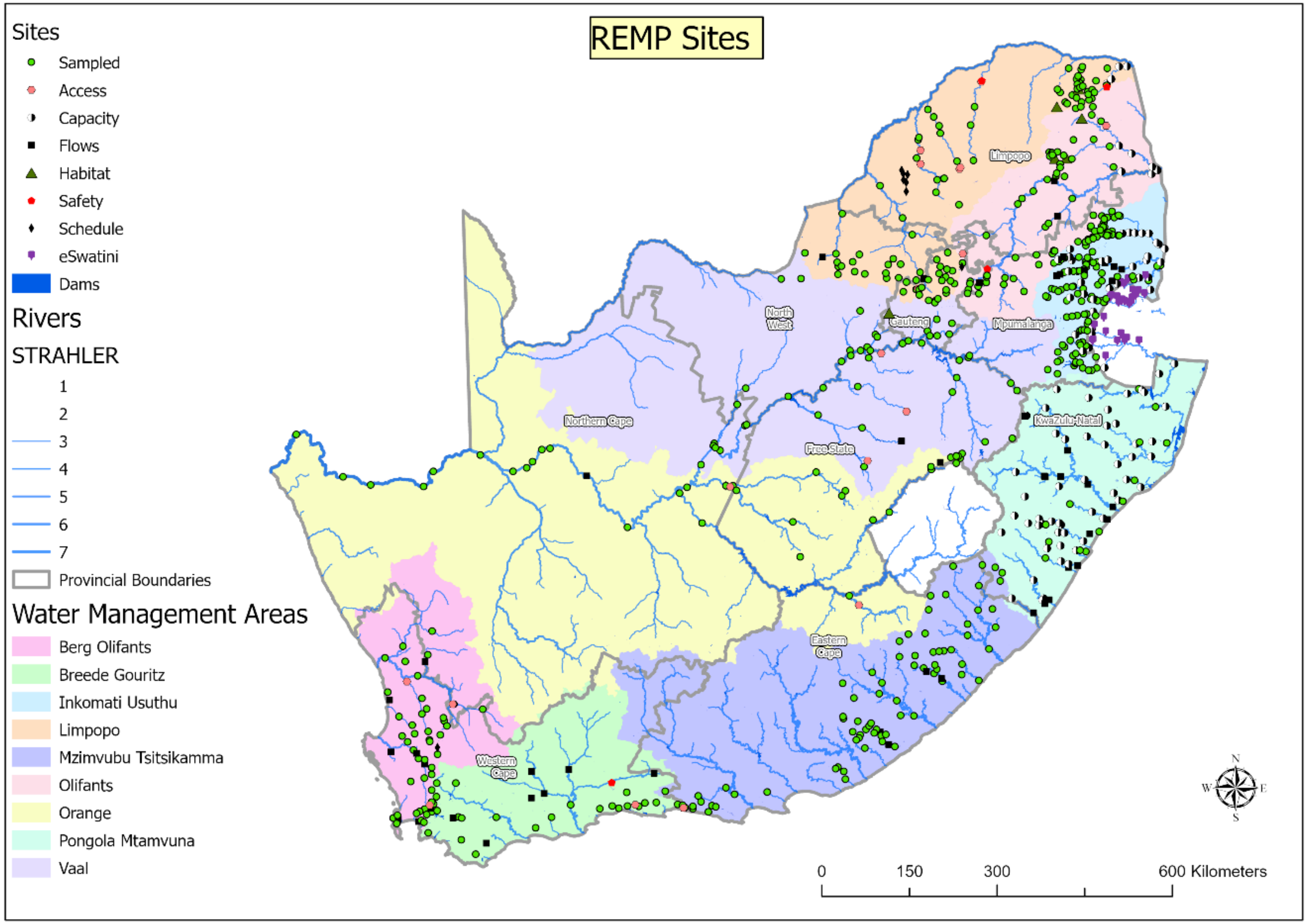


Figure 2.13: Distribution of REMP sites- 2021/22 hydrological year.

2.3 Groundwater Monitoring

The DWS Groundwater Monitoring programme is divided into two programmes which are groundwater quality monitoring and groundwater level monitoring (Figure 2.14). The Groundwater Quality Monitoring Programme comprises two sub-programmes, the National Groundwater Quality Monitoring also known as ZQM Programme and the Acid Mine Drainage (AMD) Special monitoring programme covering managed by the National Office at the Cradle of Humankind World Heritage Site (CoH-WHS) and Dundee. The Groundwater Level Monitoring programme also comprises two sub-programmes, the combined groundwater level networks managed by the Regional Offices and Catchment Management Agencies (CMA), and the AMD Special Monitoring programme which is managed by the National Office.

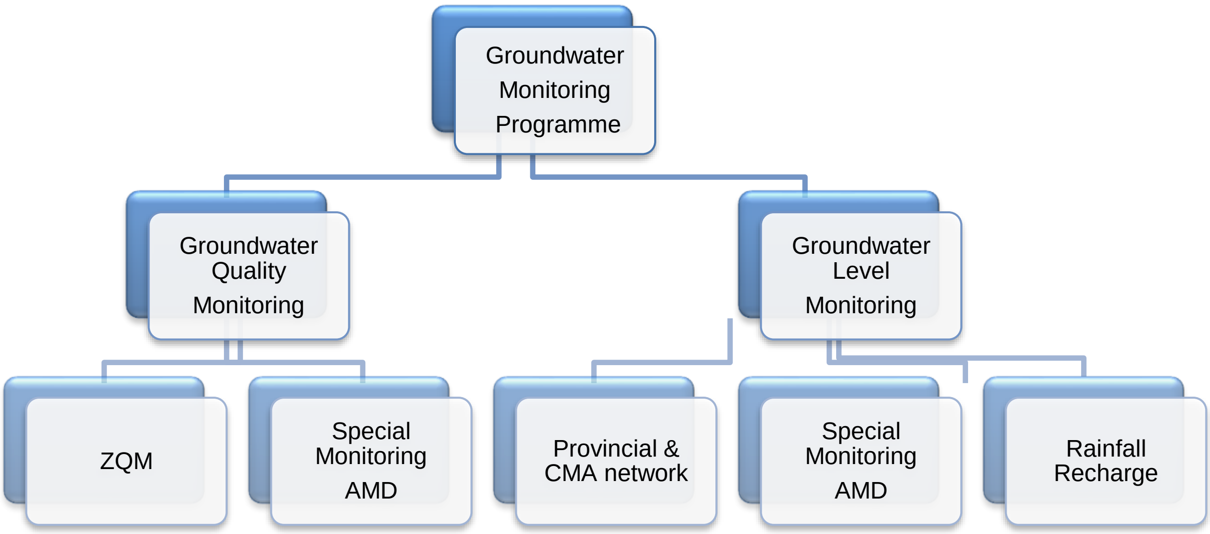


Figure 2.14 Groundwater Monitoring Programmes

2.3.1 Groundwater Quality Monitoring Programmes

The Groundwater Quality Monitoring (ZQM) Programme was established in 1994. The objectives of the ZQM programme are to investigate the influence of rainfall on groundwater quality; to determine the state of groundwater quality nationally; and observe groundwater quality trends. The ZQM programme has 420 groundwater quality stations, monitoring chemical and physical parameters across the country. The monitoring stations are distributed in strategic locations such as Schools, Clinics, Farms, Hospitals, Community Supply etc. The spatial distribution of the ZQM sites based on April/May monitoring run is presented in Figure 2.15.

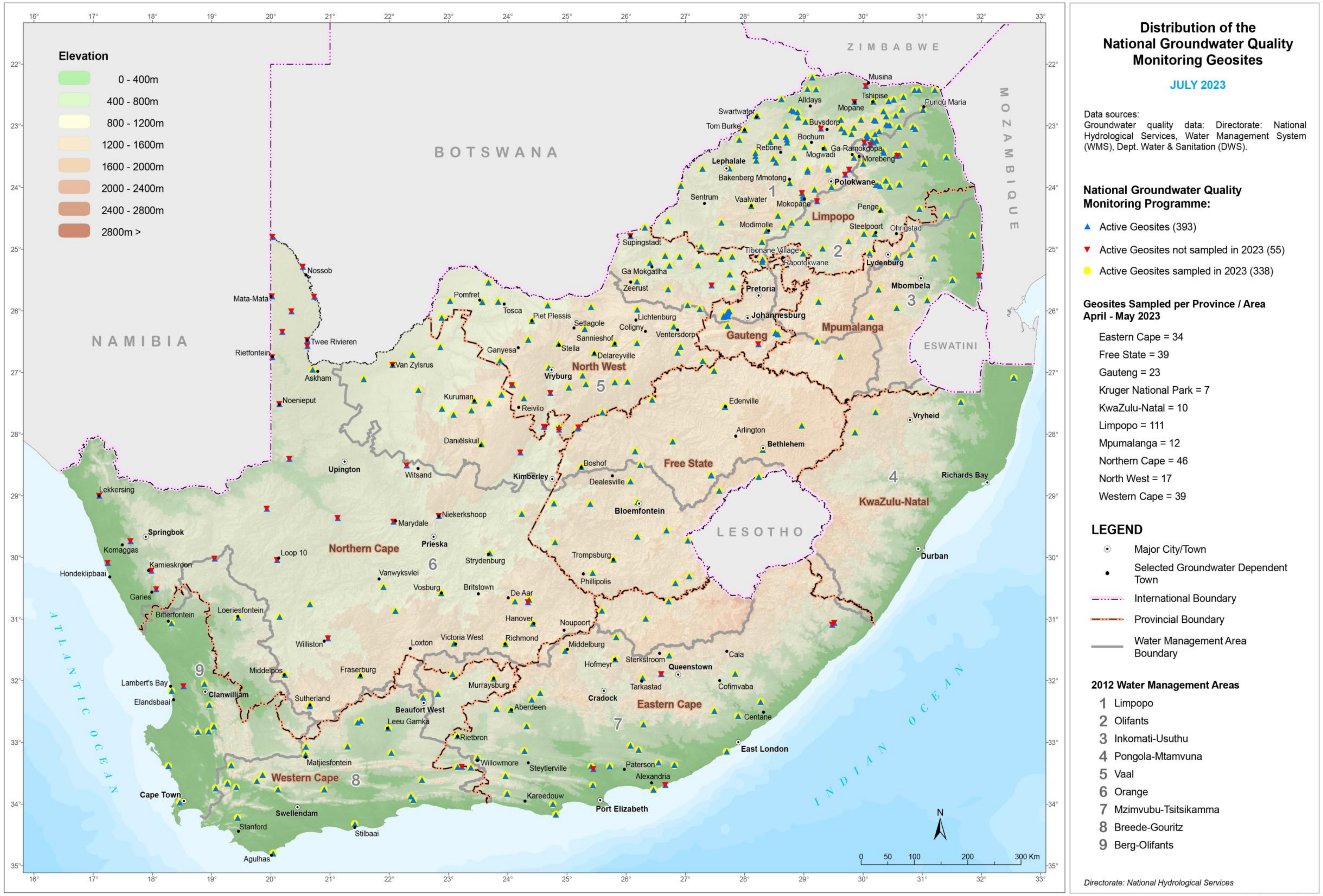


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Figure 2.15: The National Groundwater Quality Monitoring network – July 2023.

The AMD special programme at CoH-WHS was established in 2012. It has 24 monitoring stations, and the frequency is four times a year. The objective of the AMD special programme at CoH-WHS is to evaluate the hydrochemical impact of historical mining activities around CoH-WHS property. Monitoring is a collaboration between the Council for Scientific and Industrial Research (CSIR) and the Gauteng provincial office.

The AMD special programme at Dundee was established in 2011. The objective of the AMD special programme at Dundee is to evaluate the impact of defunct coal mines on the local water resource, within the Sandspruit catchment.

2.3.2 Groundwater Quality Data Availability

Groundwater quality and groundwater levels are usually conducted for at least the end of the wet season (Apr / May) and end of the dry season (sept/Oct) for most parts across the country. During the Sep/Oct 2022 and Apr/May 2023 sampling runs, 240 (57%), and 243 (58%) monitoring sites were sampled and analysed, respectively (Figure 2.16). This data including data from the AMD special programmes is available on WMS on request. Groundwater quality data is publicly available through a data request, which can be sent to: georequests@dws.gov.za.

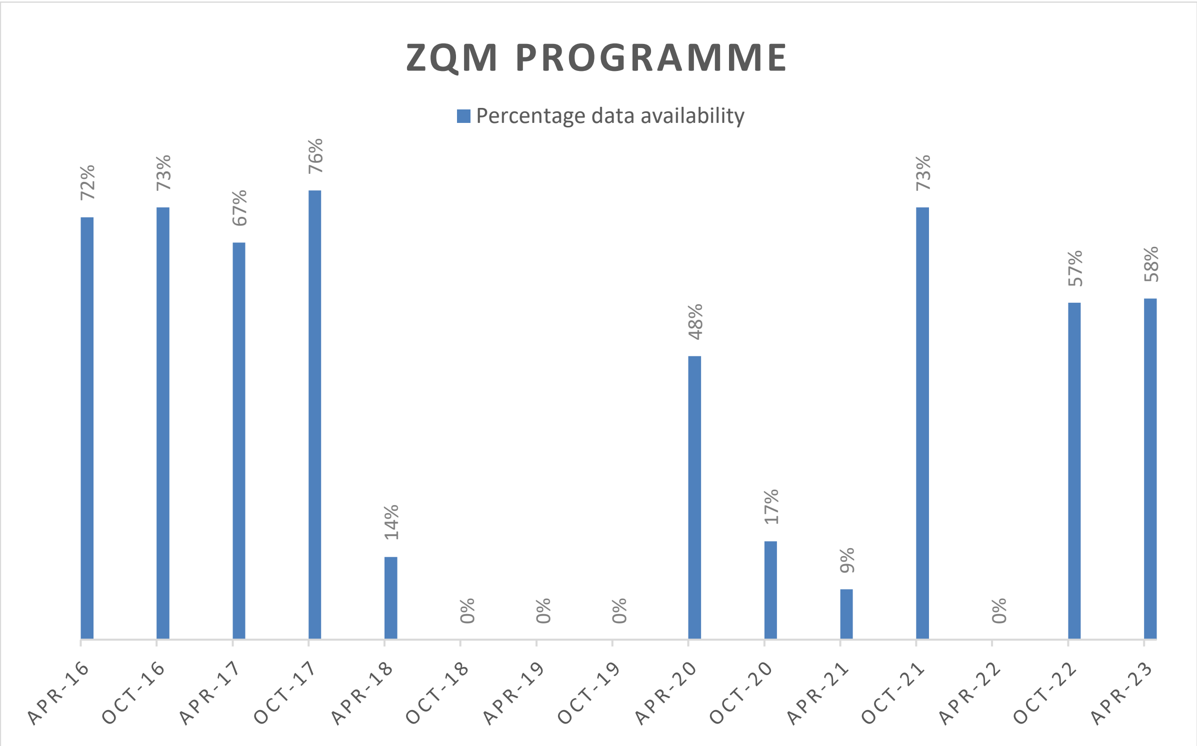


Figure 2.16: ZQM programme data availability on WMS from 2016 to 2023 as of January 2024.

2.3.3 Groundwater Level Monitoring

As of 30 September 2023, there are 6 273 (57 AMD) registered groundwater level monitoring sites, however, only 1 744 sites are active. The frequency of groundwater level data collection for sites per Provincial Office is summarised in Table 2-1. The monitoring frequencies vary from monthly, every two months, and quarterly. The most common frequency is quarterly at 74%, followed by monthly at 14% dominated by KZN, MP and FS. Gauteng province monitoring frequency is mainly 2-monthly at 98%.

Out of the 1 744 active monitoring sites, 1 361 sites are monitored manually with a dip meter, while 375 sites are equipped with electronic data loggers. Groundwater level data is collected and uploaded onto the HYDSTRA database system where it can be extracted for analysis.

Table 2-1: Groundwater level monitoring frequency per region.

Region	Frequency			
	Monthly	**2-Monthly**	**Quarterly**	**Other**
WC	6%	7%	87%	
EC	4%		96%	1%
KZN	96%			4%
GP	2%	98%		
MP	67%		26%	7%
FS	100%			
NC			100%	
LP			93%	7%
NW	6%		94%	
AMD	89%		9%	2%
Total	**14%**	**10%**	**74%**	**1%**

*Special programme

2.3.4 Groundwater Level Data Availability

The total groundwater level data available on HYDSTRA is 1 481 (85%) for HY2022/23 (Figure 2.17 and Table 2-2). The spatial distribution of active monitoring sites is presented in Figure 2.18. Groundwater level monitoring data is publicly available through a data request, which can be sent to: georequests@dws.gov.za.

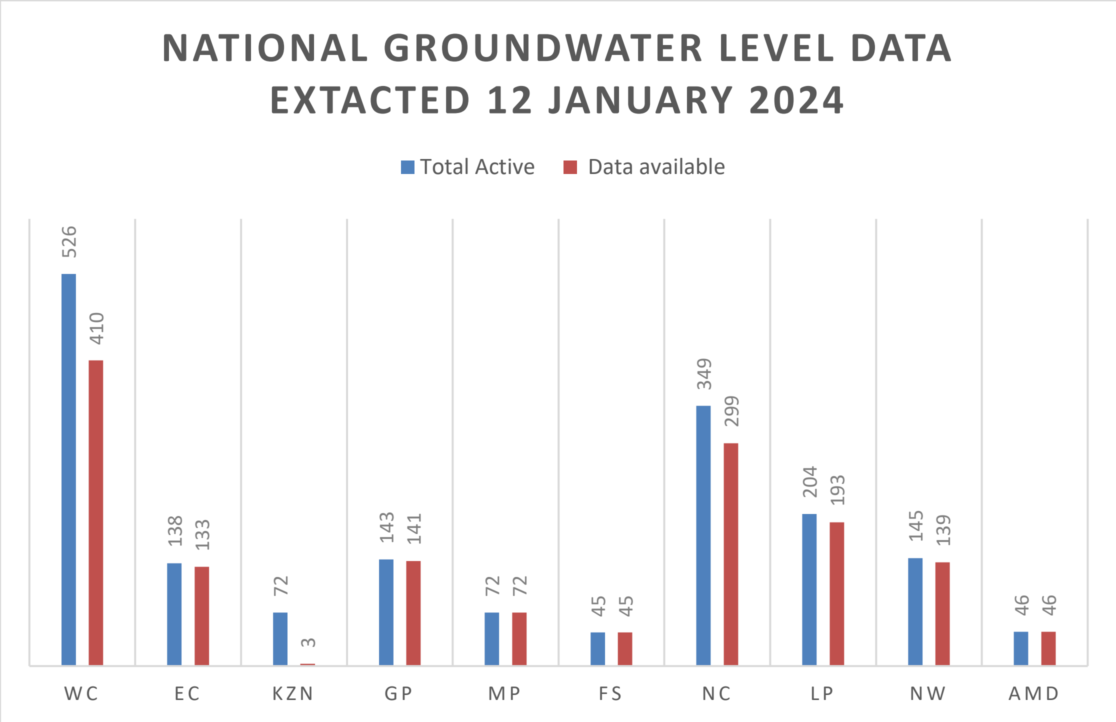
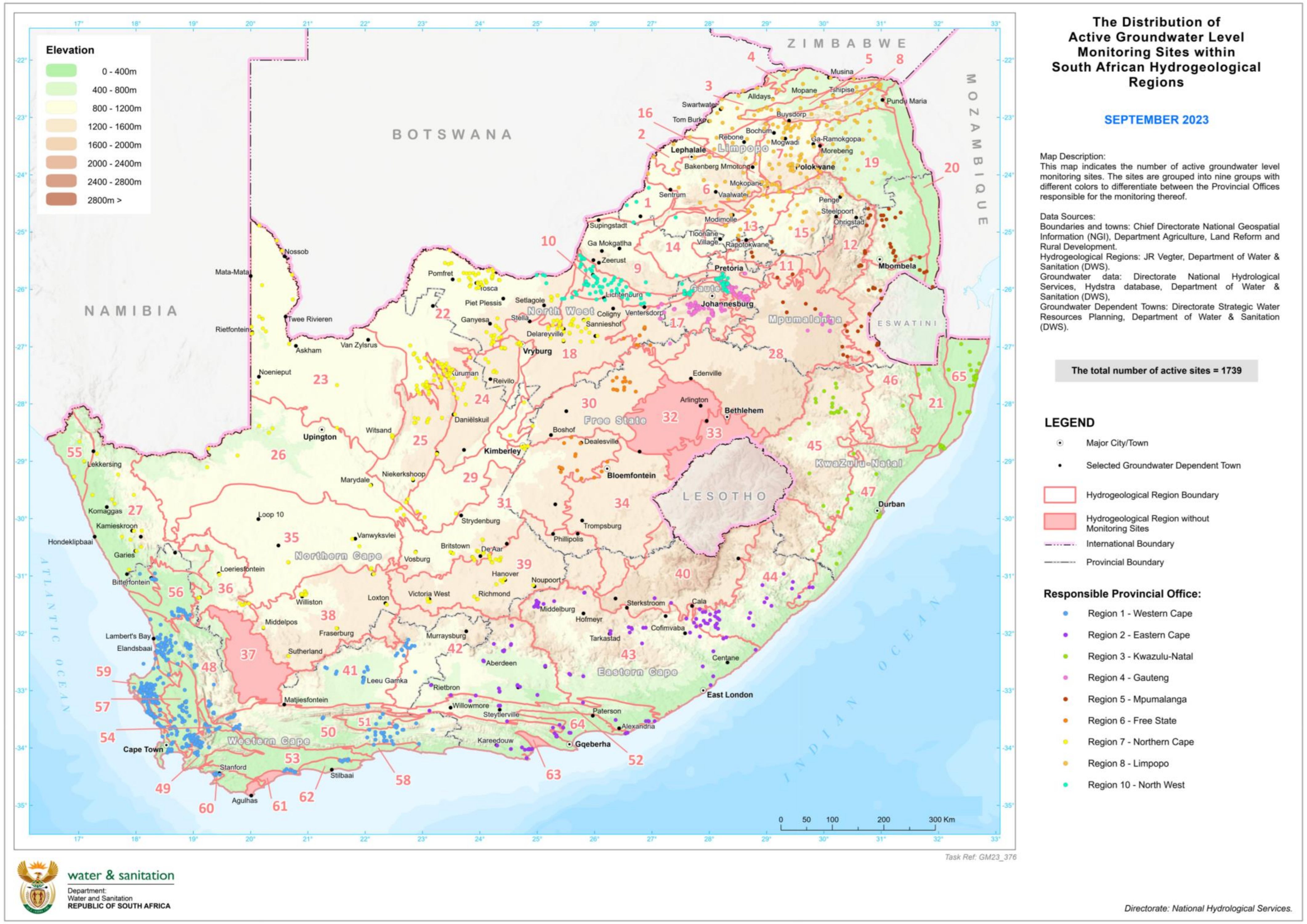


Figure 2.17: Groundwater data availability on HYDSTRA per region for 2023 (as of 12 January 2024)



REGION ID	REGION NAME
4	Limpopo Karoo Basin
3	Limpopo Granulite Gneiss Belt
5	Soutpansberg Hinterland
20	Northern Lebombo
8	Soutpansberg
19	Lowveld
7	Pietersburg Plateau
6	Waterberg Plateau
2	Waterberg Coal Basin
16	Northern Bushveld Complex
12	Eastern Bankeveld
1	Makoppa Dome
15	Eastern Bushveld Complex
13	Springbok Flats
9	Western Bankeveld and Marico Bushveld
14	Western Bushveld Complex
23	Western Kalahari
22	Eastern Kalahari
10	Karst Belt
46	Northeastern Middleveld
11	Middelburg Basin
17	Central Highveld
24	Ghaap Plateau
21	Southern Lebombo
65	Northern Zululand Coastal Plain
29	Dry Harts-Lower Vaal-Orange Lowland
25	West Griqua Land
45	Northwestern Middleveld
26	Bushmanland
27	Namaqualand
55	Richtersveld
47	Kwazulu-Natal Coastal Foreland
35	Bushmanland Pan Belt
44	Transkeian Coastal Foreland and Middleveld
39	Eastern Upper Karoo
40	Southeastern Highland
36	Hantam
56	Knersvlakte
38	Western Upper Karoo
43	Ciskeian Coastal Foreland and Middleveld
42	Eastern Great Karoo
37	Tanqua Karoo
48	Northwestern Cape Ranges
41	Western Great Karoo
59	Southwestern Coastal Sandveld
57	Swartland
52	Grootrivier-Klein Winterhoek-Suur-Kaprivier Ranges
50	Southern Cape Ranges
54	Intermontane Tulbagh-Ashton Valley
49	Southwestern Cape Ranges
64	Algoa Basin
51	Oudtshoorn Basin
63	Lower Gamtoos Valley
53	Ruensveld
58	Outeniqwa Coastal Foreland
62	Stilbaai Coastal Belt
61	Bredasdorp Coastal Belt
60	Die Kelders Embayment
18	Western Highveld
28	Eastern Highveld
30	Northeastern Pan Belt
32	Southern Highveld
33	Northern Highland
31	Central Pan Belt
34	Northeastern Upper Karoo

Figure 2.18: Active groundwater level monitoring sites - September 2023.

Table 2-2:Groundwater Level Monitoring Data availability

STATUS OF THE AVAILABILITY OF GROUNDWATER LEVEL MONITORING DATA ON HYDSTRA AS ON 12 JANUARY 2024						
		Total Registered Sites	**Total NOT Active Sites**	**Total Active Sites**	**Total Active Sites with data as on 12 January 2024**	**Total Active Sites with available data as on 12 January 2024 (%)**
		6 273	**4 529**	**1 744**	**1 481**	**85%**
Monitoring Groundwater Level: Variable 110.00, 110.40				**(Extracted on 12 January 2024 from HYDSTRA)**		
Responsible Regional Office		**Total Registered Sites**	**Total NOT Active Sites**	**Total Active Sites per Region**	**Active Sites with available data as on 12 January 2024**	**Active Sites with available data as on 12 January 2024 (%)**
1	Western Cape	1 678	1 152	526	410	78%
2	Eastern Cape	333	196	137	133	97%
3	KZN	134	62	72	3	4%
4	Gauteng	800	653	147	141	96%
5	Mpumalanga	119	47	72	72	100%
6	Free State	167	122	45	45	100%
7	Northern Cape	1 861	1 512	349	299	86%
8	Limpopo	598	393	205	193	94%
10	North-West	526	381	145	139	96%
AMD	National Office	57	11	46	46	100%

2.4 National Integrated Water Information System

The National Integrated Water Information System (NIWIS) was conceptualised to meet the objective of serving as a single extensive, integrated, accessible national water information system to fulfil the mandate of both the National Water Act (No. 36 of 1998; Chapter 14, Sections 137 to 145), as well as the National Water Services Act (No 108 of 1997; Chapter 10, Sections 67, 68 & 69). Effective 01 September 2015, NIWIS went live with 43 dashboards that were developed and implemented (Figure 2.19). Ever since NIWIS has been experiencing enormous growth through enhancements responding to ever-growing business information requirements, NIWIS is an information system intended to provide information to researchers, water managers, and the public at large, and this system can be accessed at https://www.dws.gov.za/niwis2.

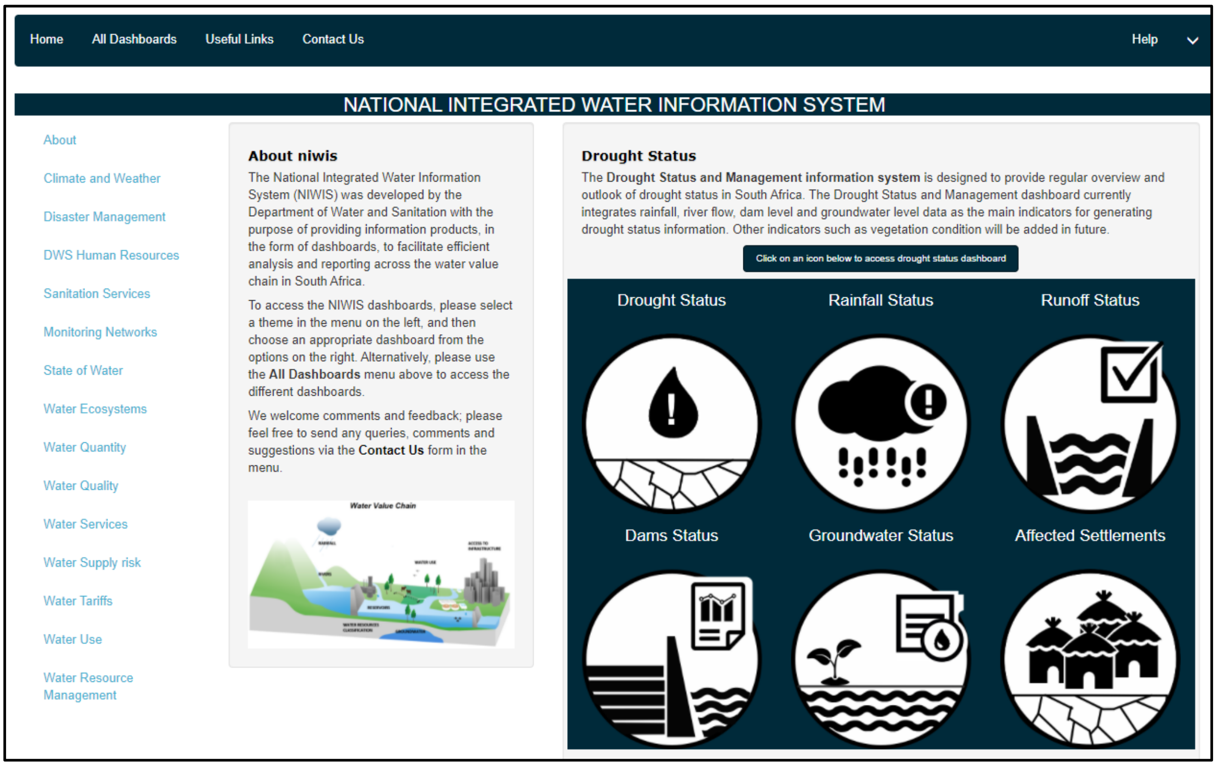


Figure 2.19 NIWIS landing page (https://www.dws.gov.za/niwis2/)

NIWIS allows for user customisation and is convenient. It has since become one of the Department's strategic investment tools, which ensures that information on the sector is readily available and conveniently disseminated. However, the system is currently experiencing challenges, where the automation has been taking place at a business level, not at a Departmental level, which has resulted in many parallel systems that are not complementing one another, albeit sharing the same client or water information in some cases. However, there are further developments of NIWIS in progress despite these challenges.

3

CLIMATIC ENVIRONMENT

3 CLIMATIC ENVIRONMENT

3.1 Climate

3.1.1 South African Climate

Climate, characterised by the long-term patterns and averages of elements such as rainfall, temperature, solar radiation, relative humidity, wind speed, and evaporation, is evident on both temporal and spatial scales. In South Africa, the diverse climatic conditions affecting critical sectors including agriculture, forestry, and biodiversity, similarly influence the availability and distribution of water throughout the country. Ranging from arid conditions in the western regions to humid subtropical climates in the east, the country's varied rainfall patterns create a dynamic and complex water management landscape.

The classification of climate in South Africa is often based on seasonal rainfall patterns such as winter and summer rainfall region. The winter rainfall, typically occurring between May and August and concentrated primarily in the southwestern region, contrasts with the summer rainfall region, covering extensive areas of the country. The latter experiences higher rainfall amounts crucial for replenishing rivers, dams, and reservoirs essential for sustaining numerous sectors. Moreover, the northern and western areas record the highest temperatures, while the elevated regions experience cooler climates. Coastal regions, influenced by the warm Indian Ocean, often maintain higher average temperatures, particularly at night.

The seasonal variability in the country's climate influences water availability and storage dynamics. While summer rainfall regions experience peak flows during wet seasons, winter rainfall areas heavily rely on stored water from dams and reservoirs to meet demands during dry months. Furthermore, climate change exacerbates existing challenges, introducing uncertainties such as changes in rainfall patterns, increased temperatures, and heightened frequency of extreme weather events, which pose challenges for infrastructure development, demand management strategies, and ecosystem sustainability efforts.

The Agricultural Research Council (ARC), with a vast network of weather stations distributed across the country and an extensive agroclimatic archive, provides this Climatic Environment chapter. Furthermore, some analysis and data presented are in this chapter is based on data and information provided by the South African Weather Services (SAWS).

3.1.2 Temperature

Average observed temperatures for the 2022/23 hydrological year are in Figure 3.1. Average temperatures for the hydrological year followed a predictable spatial pattern, with temperatures in the lower tens dominating over the cooler southern to eastern escarpment and eastern Highveld. Highest average temperatures occurred over the traditionally warmer parts including the Limpopo River Valley, Lowveld and north-eastern KZN with values in the lower to mid-twenties dominating. Temperatures were on average near the long-term average over most of the country (Figure 3.1) for the period as a whole, but the north-eastern to eastern lower-lying areas were between 0.5 and 2° C warmer than average.

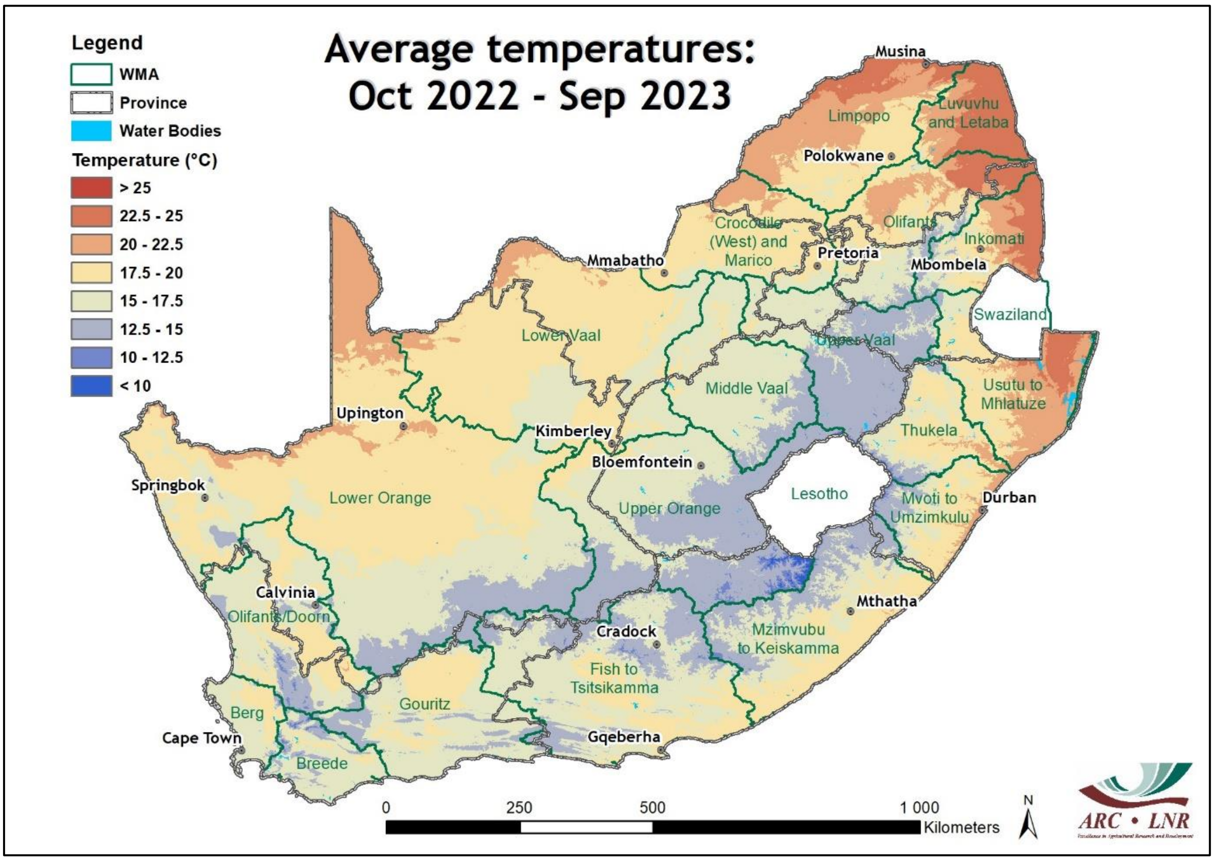


Figure 3.1 Average temperature calculated during the 2022/23 hydrological year.

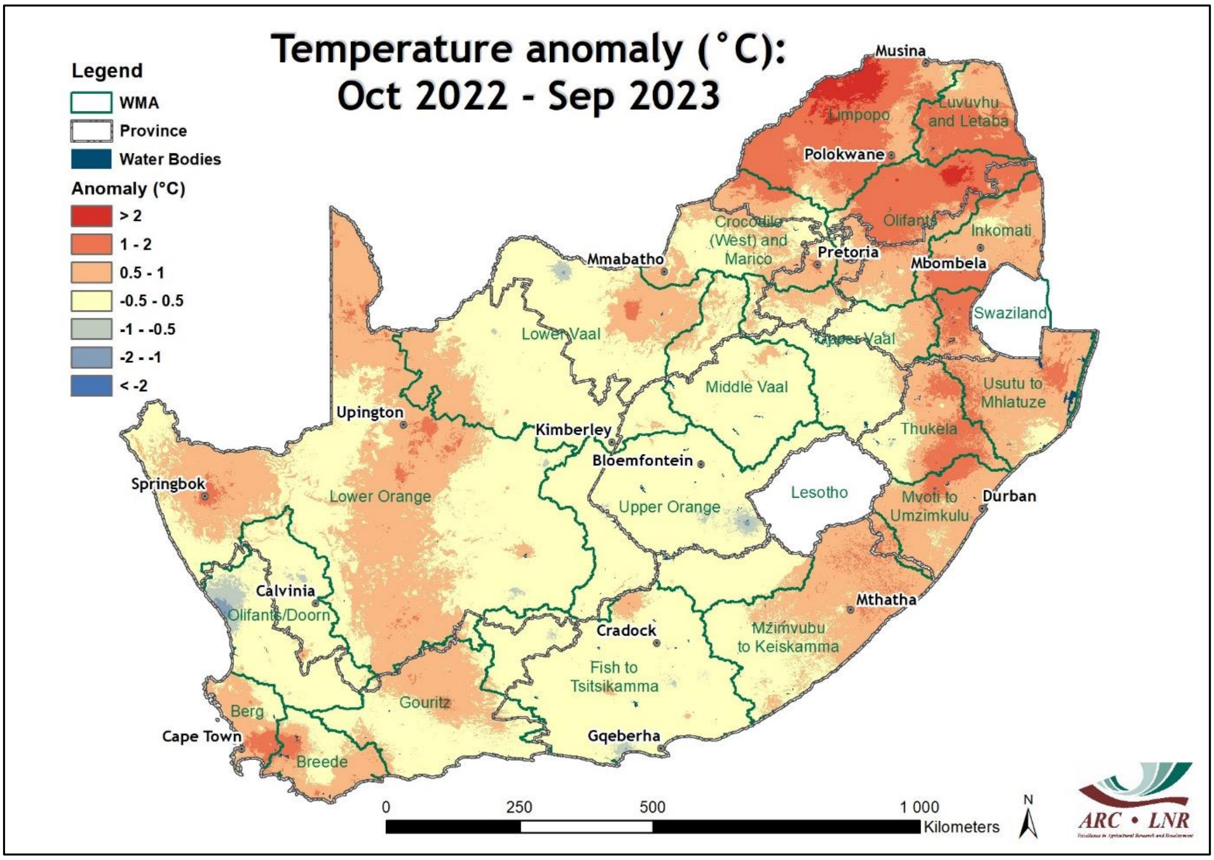


Figure 3.2 Deviation in temperature from the long-term average during the 2022/23 hydrological year.

The monthly break-down of the average temperature anomalies are shown for the summer and winter seasons of the 2022/23 hydrological year in Figure 3.3a and 3.3b, respectively. The only month that was warm across the country was October 2022. Hot and dry conditions dominated during a large part of the month and rain only started over the interior towards the end of the month. Throughout the summer season of the hydrological year, the wetter months (November, December and February – see monthly rainfall maps in Figure 3.7), were also relatively cool' likely linked to increased cloud cover, over the central parts of the country, with temperatures below the long-term average.

The western interior was 2°C or more warmer than the long-term average during October and December 2022. The largest positive contributions to temperature deviation over the northeastern to eastern low-lying areas occurred during October 2022 when the entire country was relatively warm and then more specifically over these areas during autumn and early winter (April – June) as well as September 2023 when the central to western and southern parts of the country were cooler than average.

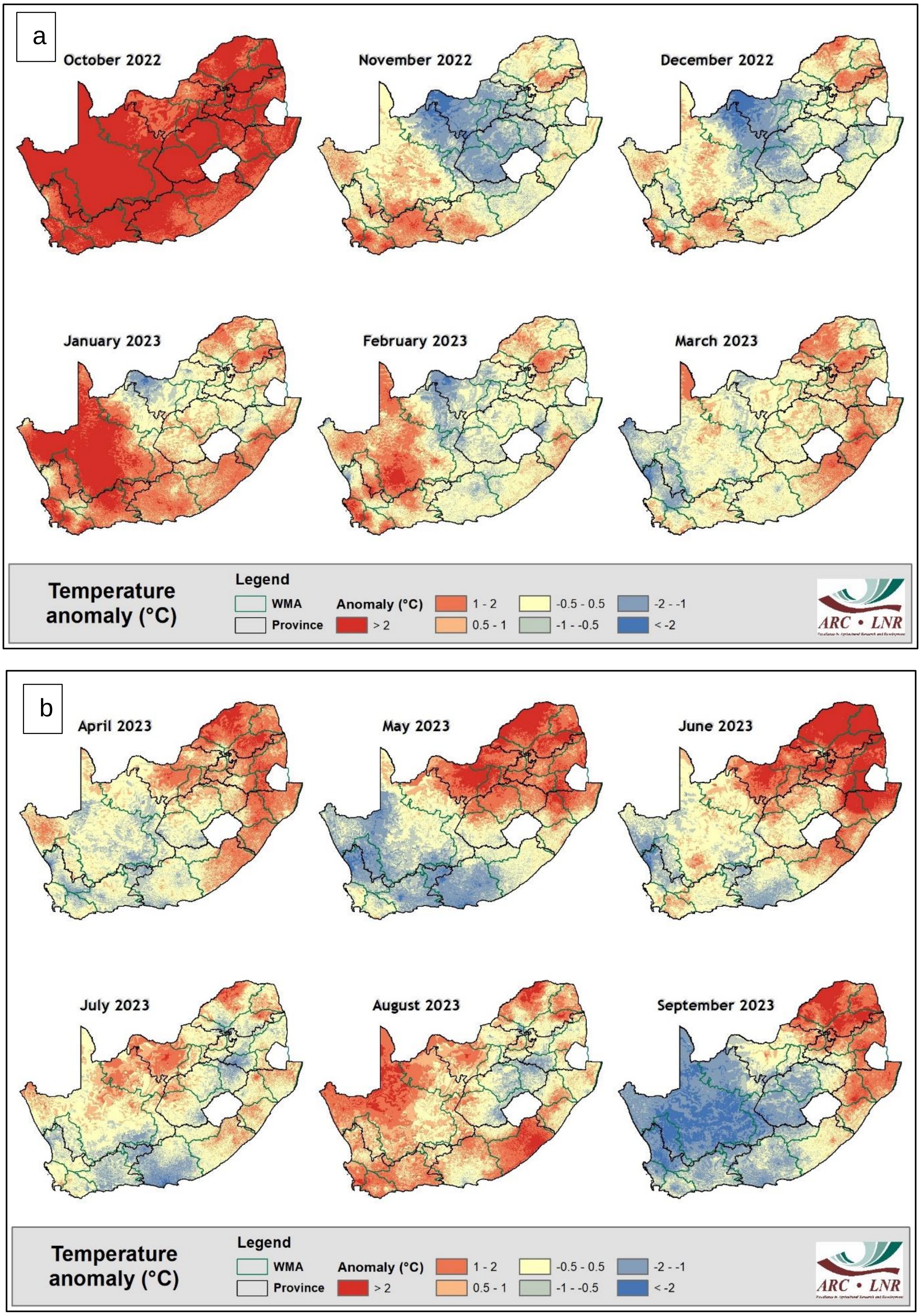


Figure 3.3 (a) Monthly deviation in temperature from the long-term average during the summer season of the 2022/23 hydrological year (b) Monthly deviation in temperature from the long-term average during the winter season of the 2022/23 hydrological year.

South Africa experienced a relatively warm calendar year, especially in the central and northern interior. In the south, however, temperatures were near-normal. The annual mean temperature anomaly for 2023, based on the data of 26 climate stations of the SAWS, was on average about 0.4 ºC above the average of the reference period (1991-2020), making it approximately the 8th hottest year on record since 1951 (Figure 3.4). A warming trend of approximately 0.17 ºC per decade is indicated for the country, over the period 1951-2023, statistically significant at the 5% level (SAWS, 2024).

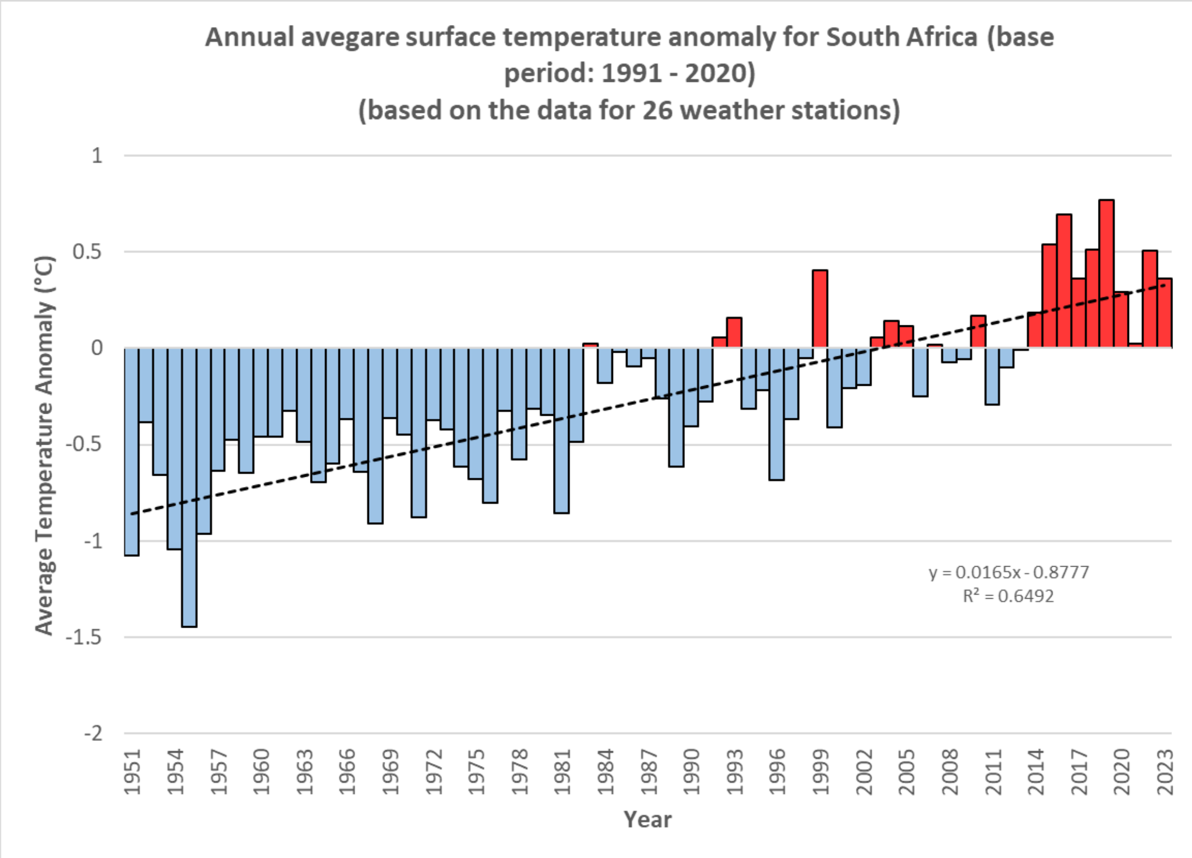


Figure 3.4 Average surface temperature deviation over South Africa based on 26 climate stations: 1951 - 2021 (base period: 1991 - 2020). The linear trend is indicated (Source: South African Weather Service).

3.1.3 Rainfall

The period of reporting included the 2022/23 summer which was the third consecutive summer falling within the protracted 2020-2023 La Niña event. Similar to the previous two summers, wetter and cooler conditions occurred for extended periods of the summer, as is typical during La Niña events. The period also included the 2023 winter which was characterised by above-normal rainfall over large parts of the winter rainfall region. The winter rainfall region has now experienced several winters with near normal to above-normal rainfall since the multi-year drought of the 2015 – 2018 period.

Considering the large-scale change that occurred, in general, the very wet anomaly over most of the interior, diminished somewhat during the 2022/23 hydrological year while a drier signal over the southern to south-western parts was replaced by enhanced wetness. Total rainfall for the 2022/23 hydrological year (October 2022 – September 2023) is presented in Figure 3.5.

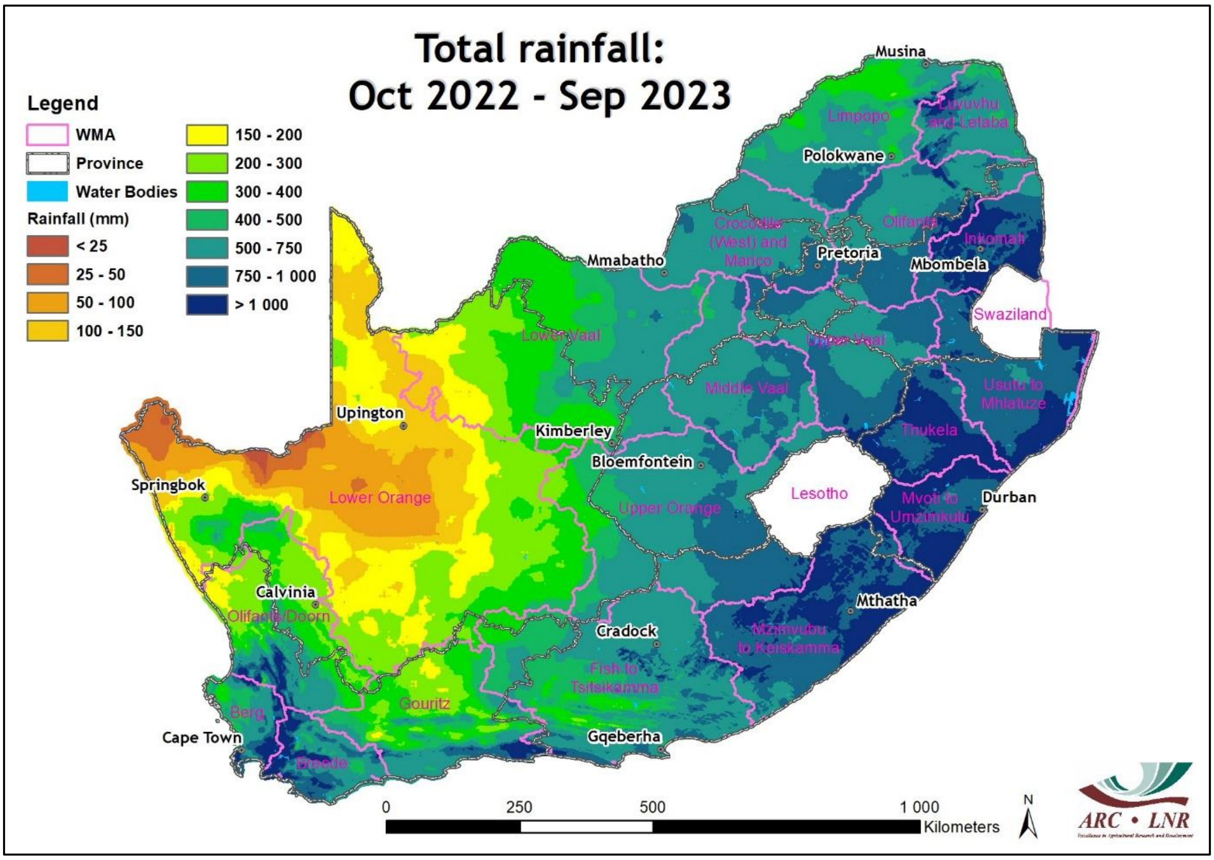


Figure 3.5 Rainfall (mm) for the Hydrological year October 2022 to September 2023.

The patterns of generally wetter and drier parts of the country followed a typical pattern with the lowest totals of less than 50mm along parts of the Lower Orange River Valley and highest totals over the mountainous area in the winter rainfall region in the southwest, along parts of the Garden Route in the south and along the south-eastern to eastern escarpment and towards the eastern seaboard. Most of the eastern half of the country received in excess of 500mm during the hydrological year. On the escarpment and further east over Mpumalanga, KZN and the Eastern Cape, totals exceeded 1000mm.

Relative to the long-term average, rainfall over most of the country was high during the period in total (Figure 3.6). Most of the country received above-average rainfall over the period as a whole, with the most notable exception being the central to northern parts of the Northern Cape where most of the region received below-average rainfall.

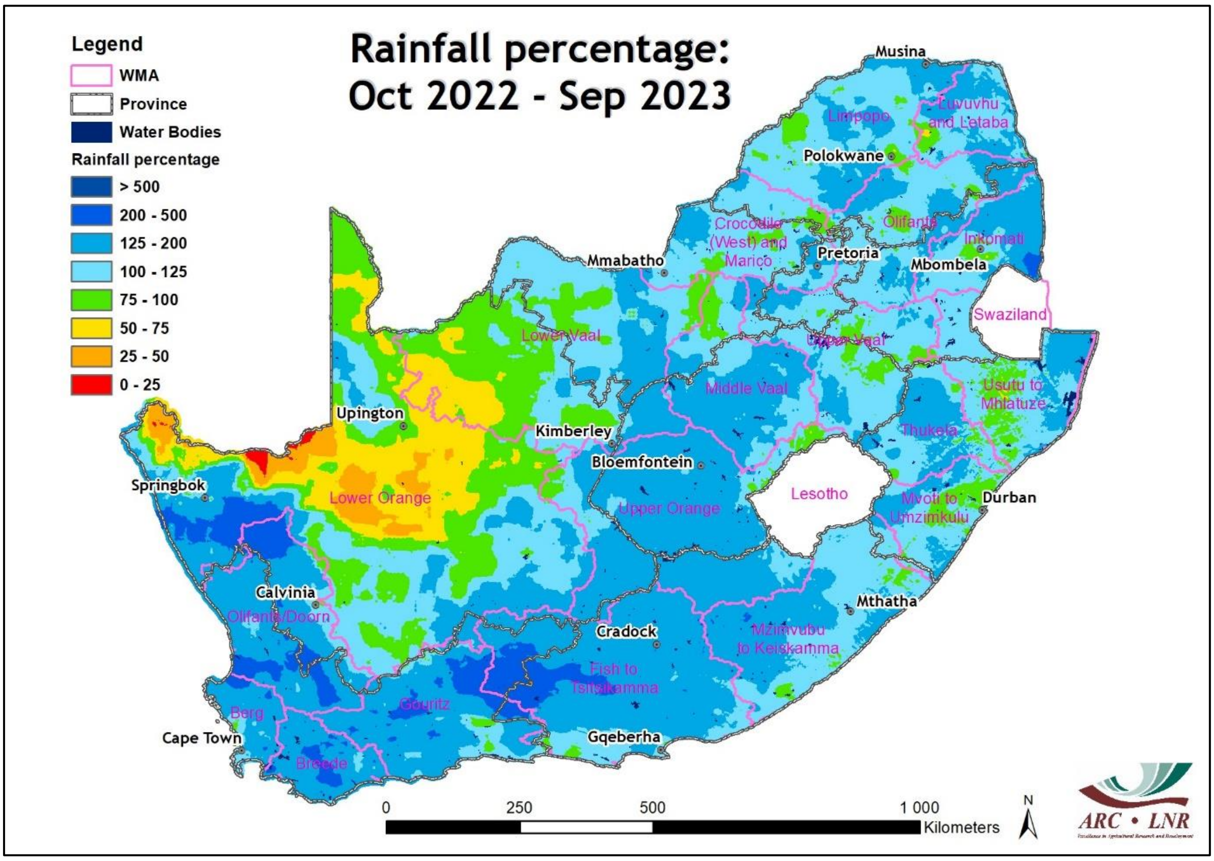


Figure 3.6 Rainfall (percentage of long-term average) for the water year October 2022 to September 2023

The monthly maps, providing the temporal detail during the period, is presented in Figure 3.7a and 3.7b, representing the summer and winter season of the hydrological year, respectively. Considering the monthly distribution of rainfall during the 2022/23 hydrological year, the summer-rainfall region generally received above-average rainfall during the October to December period and again during February and May. Above-average rainfall during these months over much of the summer rainfall region played an important role in the eventual above-average total rainfall observed for the hydrological year in total. Largest contributions leading to above-average rainfall over the winter rainfall region occurred in March, May, June and September.

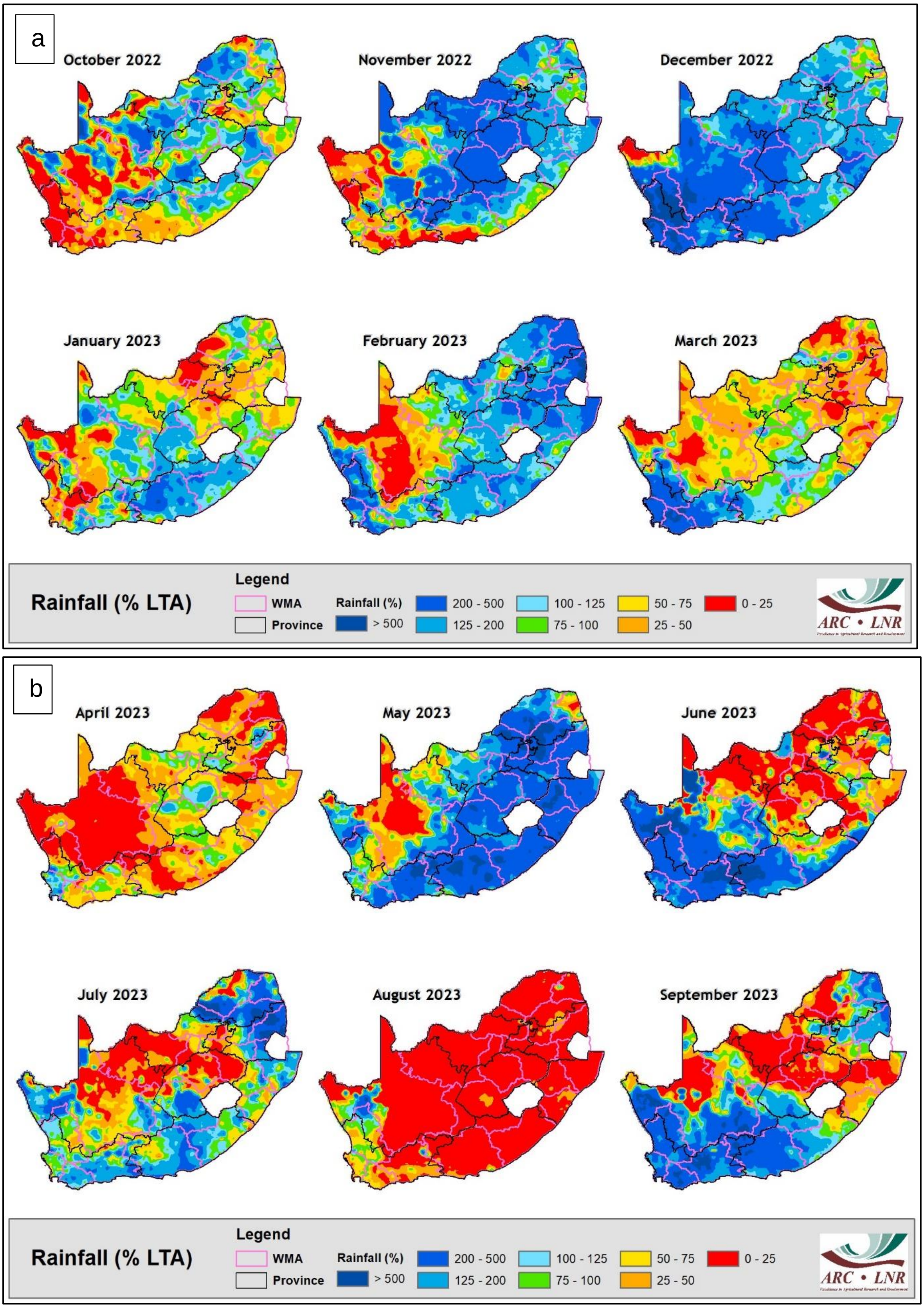


Figure 3.7 (a) Rainfall (percentage of long-term average) per month as indicated for the summer season of the 2022/23 hydrological year (b) Rainfall (percentage of long-term average) per month as indicated for April to September 2023.

During the summer season (October – March) of the hydrological year, the north-eastern parts of the country (large parts of the summer rainfall region) was relatively dry during certain periods while the central to southern parts received above-average rainfall. These periods occurred during January and also March 2023. During most months within the summer season of the hydrological year, large parts of the Northern Cape received below-average rainfall. December 2022 was the only summer month during which almost the entire western interior (including the Northern Cape) received above-average rainfall.

Rainfall was above average over the winter rainfall region during a number of the summer-season months: December, February and March. This was associated with several cut-off lows developing over the region during the period, resulting in unseasonal widespread and sometimes significant rainfall over the winter rainfall region. The summer rainfall region was relatively dry during April, but widespread above-average rainfall occurred during May over most of the country. Several rain-bearing systems developed and caused rain over the summer rainfall region during the first half of the month (May 2023). During the winter season of the hydrological year (April to September), widespread above-average rain occurred over the winter rainfall region and also the south-western third of the country (most of the Cape Provinces) during May, June, July and September. April and August 2023 were relatively dry over almost the entire country, including the winter rainfall region, with large areas receiving less than 50% or even less than 25% of the long-term average rainfall during these months.

The long-term total rainfall anomalies from the hydrological year 1922 – 2023 is presented in Figure 3.8 per water management area. The following classes were used: less than 75% is a dry year, 76-125% is a normal year, while greater than 125 % is a wet year. The Berg-Olifants, Breede-Gouritz, Mzimbvubu-Tsitsikamma and Olifants WMA has experienced a wet hydrological year. Other water management areas experienced a normal year, with no WMA which experienced a dry year across the Country.

Figure 3.8 Hydrological year long-term trends of Rainfall Anomalies: > 125% (wet) & < 75% (dry) (Data Source: SAWS)

3.2 Potential Evapotranspiration

Figure 3.9 shows the total Potential Evapotranspiration (PET) calculated from observed weather data for 2022/23 hydrological year. The PET for the hydrological year follows the typical distribution with highest totals over the warmer, drier northwestern parts of the country, exceeding 1 500 mm and lowest values over the coastal areas in the south and south-east, including the Garden Route, where the total PET for the 12-month period is lower than 900 mm in some places.

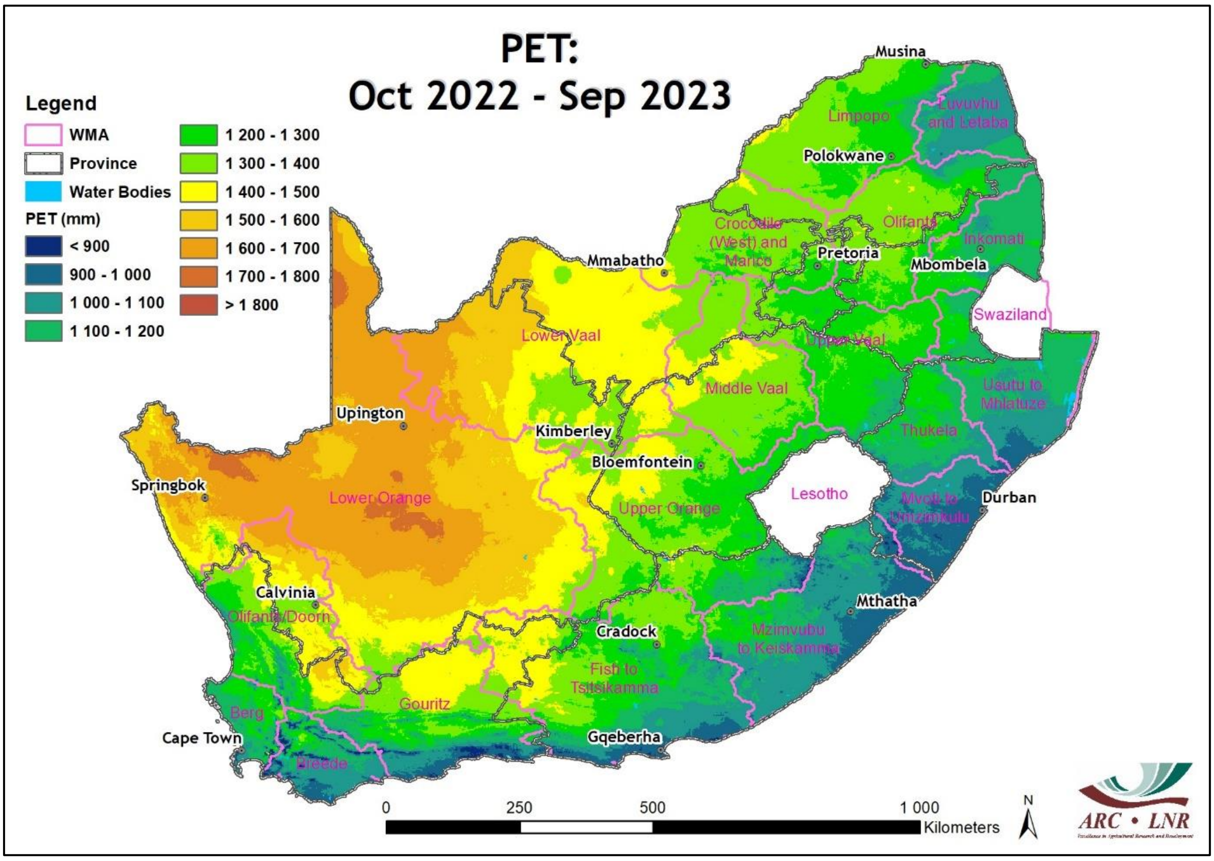


Figure 3.9 Potential Evapotranspiration (PET - mm) for the 2022/23 hydrological year.

Due to cooler conditions especially during the summer months over the interior, together with cloudy and cool conditions and above-normal rainfall during winter over much of the winter rainfall region, most of the country experienced low PET than the long-term average (Figure 3.10). This is especially pronounced over the central parts of the country where negative anomalies exceeded 100 mm.

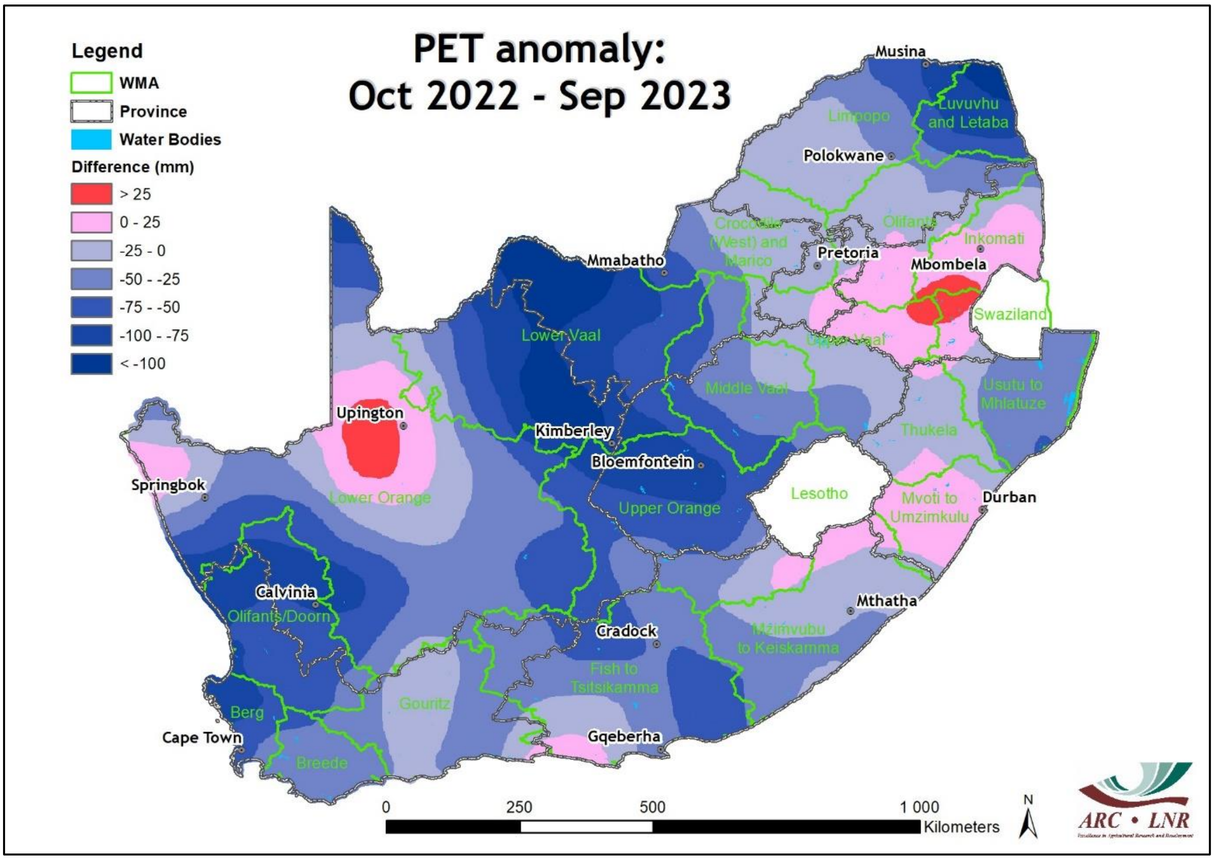


Figure 3.10 Difference (mm) in total Potential Evapotranspiration (PET) for the 2022/23 hydrological year with the long-term average (2022/23 total minus the long-term average value).

3.3 Indicators of Drought

3.3.1 Standardised Precipitation Index

The classification of meteorological drought is based on precipitation's departure from normal (long-term average) over time. Hydrological drought refers to deficiencies in surface and subsurface water supplies due to prolonged meteorological drought. It is measured using indicators derived from streamflow, dam storage levels, and groundwater levels. When precipitation (mostly rainfall in the context of South Africa) is low for a long time, it is reflected in a decline in surface flow and storage and subsurface water levels (soil moisture and groundwater).

The Standardised Precipitation Index (SPI) is an index based on the probability of rainfall for any time scale and can assist in assessing the severity of any drought. The 12- and 24-month SPI maps give an indication of areas where prolonged droughts exist, in other words, where below-normal rainfall occurred over a period of one year or longer.

Relating rainfall to an indicator of drought, the Standardised Precipitation Index (SPI) for the 2-year period ending in September 2023 (Figure 3.11) shows that drought over this longer time scale was virtually absent. Over the interior, this can be linked to the protracted La Niña period of which the 2022 – 2023 years were part of. Much of the central to south-eastern and eastern interior can be characterised as extremely wet over this period as a whole while only an extremely small part of the country near the Richtersveld experienced moderate to severe drought.

Considering only the 2022-2023 hydrological year, the 12-month SPI by September 2023 is presented in Figure 3.12. While drought extent was still very limited during the 2022/2023 hydrological year, near-normal rainfall occurred for the hydrological year as a whole over most of the interior, with severely to extremely wet conditions limited to the winter rainfall region and southern interior. Moderate to severe drought was limited to the north-western parts of the Northern Cape, especially along the Lower Orange River Valley.

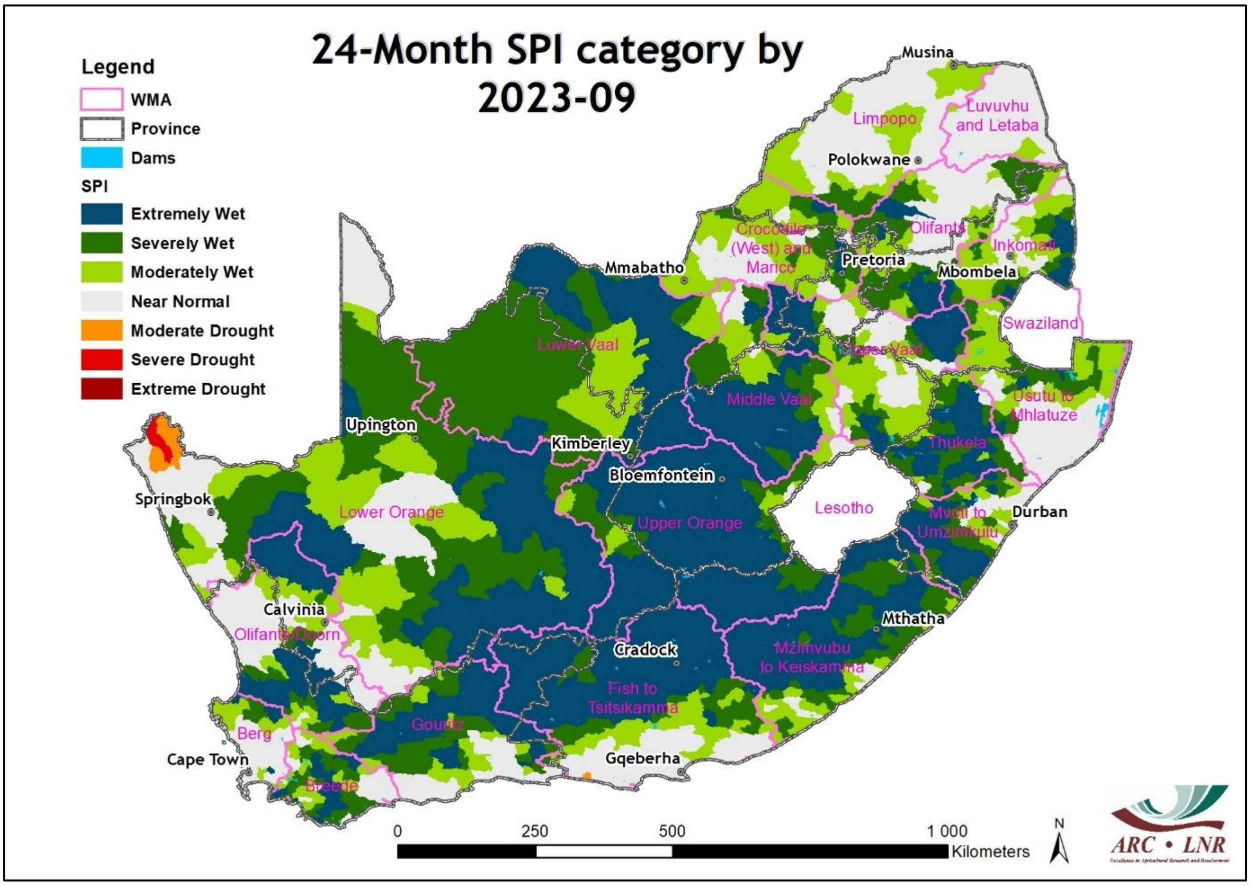


Figure 3.11 24-Month Standardised Precipitation Index (SPI) by September 2023

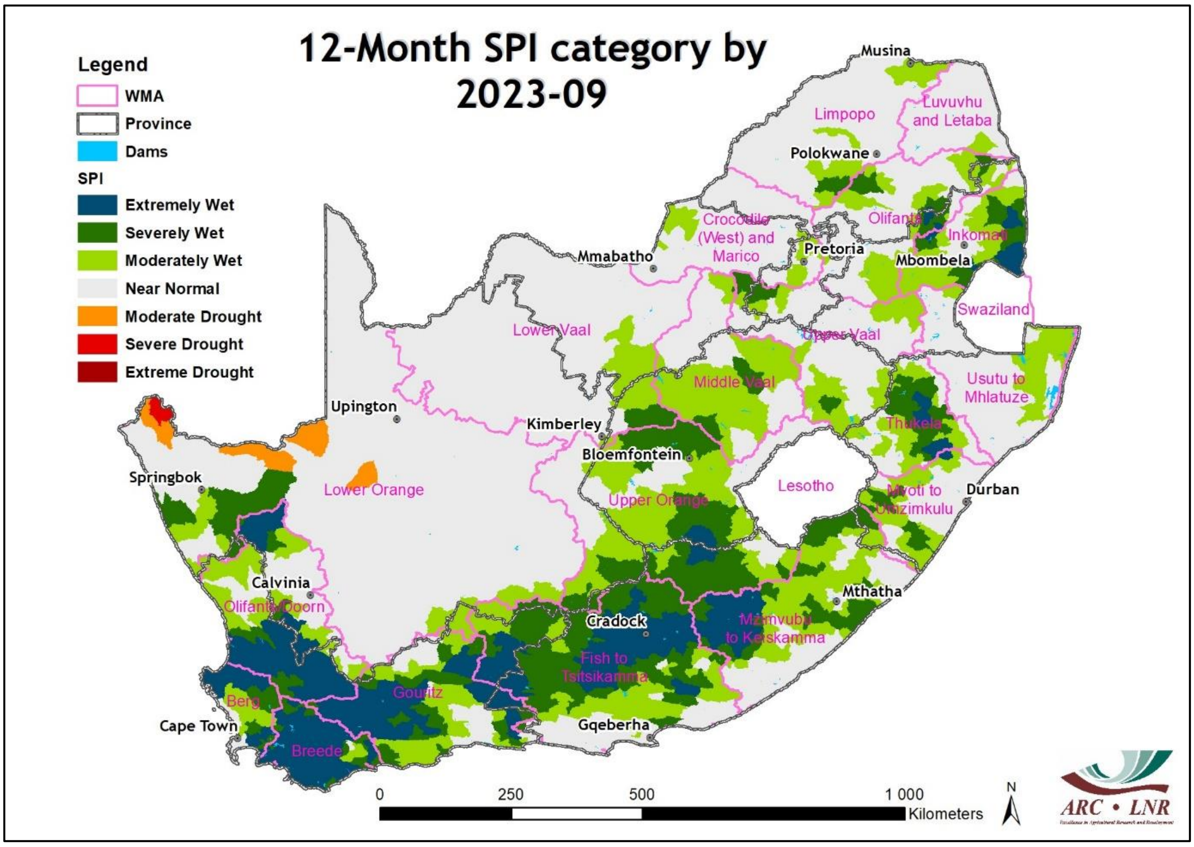


Figure 3.12 12-Month Standardised Precipitation Index (SPI) by September 2023.

When presented as a time series, the SPI shows its evolution over time. SPI values of longer timescales help determine the persistence and the magnitudes of drought events, and flash points. Additionally, it can assist in identifying areas where hydrological droughts (low streamflow, dam levels, and even groundwater levels) are likely to be experienced. This time series also makes it possible to analyse and visualise the intensity of the drought in an area of interest.

The time series of the 12-month SPI, summarised by WMA, is given in Figure 3.13 providing insight into the wetter and drier periods since 2015. Over most of the country (north-eastern central to western, eastern to south-eastern) parts, wetter periods occurred around 2017 and then again during the 2021-2023 period. Drier periods, with widespread drought, occurred during the 2015-2016 period as well as the 2018 – 2020. Over the southern to south-western parts, including the winter rainfall region, the south-western winter rainfall region experienced regular drought conditions from 2015 to 2020 (Berg WMA, Olifants WMA). Further east, the drought period only started by 2017, lasting until 2021 or 2022 in some cases. A shorter dry period also occurred in the southwest and to a lesser extent in the south during 2022. In general, the southern to south-western parts became relatively wet towards 2023.

Throughout the 2022/23 hydrological year, rainfall distribution was such that the 12-month SPI over the southern to south-western WMAs, including those in the winter rainfall region, reached a peak while WMAs over the rest of the country trended somewhat drier following a peak that occurred during 2022.

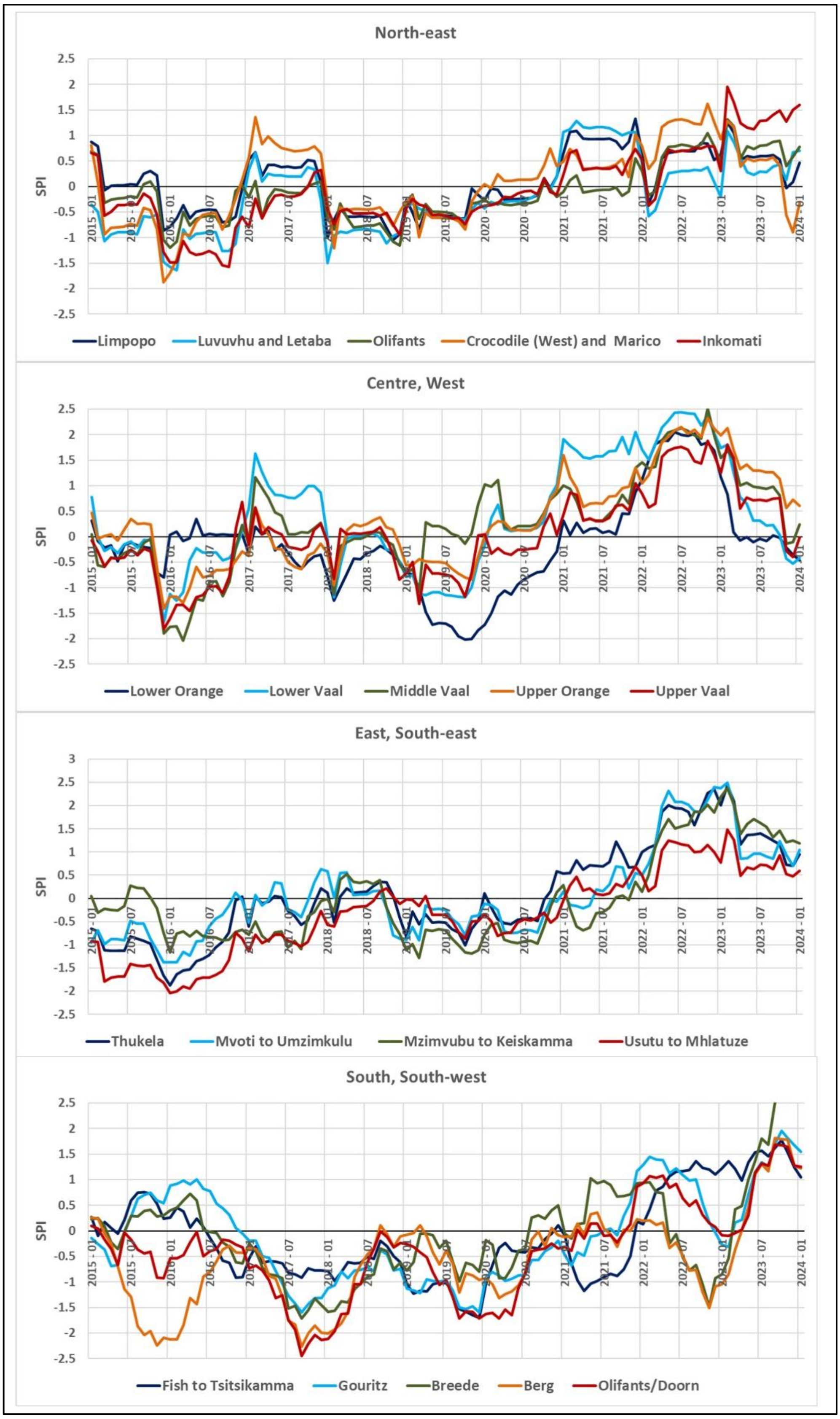


Figure 3.13 12-Month SPI, per WMA as indicated, for the north-eastern (top), central to western parts (upper-middle), eastern to south-eastern parts (lower-middle) and southern to south-western parts (bottom) of South Africa, for the period 2015 – 2023.

3.3.2 Vegetation activity

Figure 3.14 presents the cumulative vegetation activity, as represented by the cumulative Normalised Difference Vegetation Index (NDVI), expressed as a percentage of the long-term average (Percentage of Average Seasonal Greenness – PASG) calculated over the entire 2022/23 hydrological year.

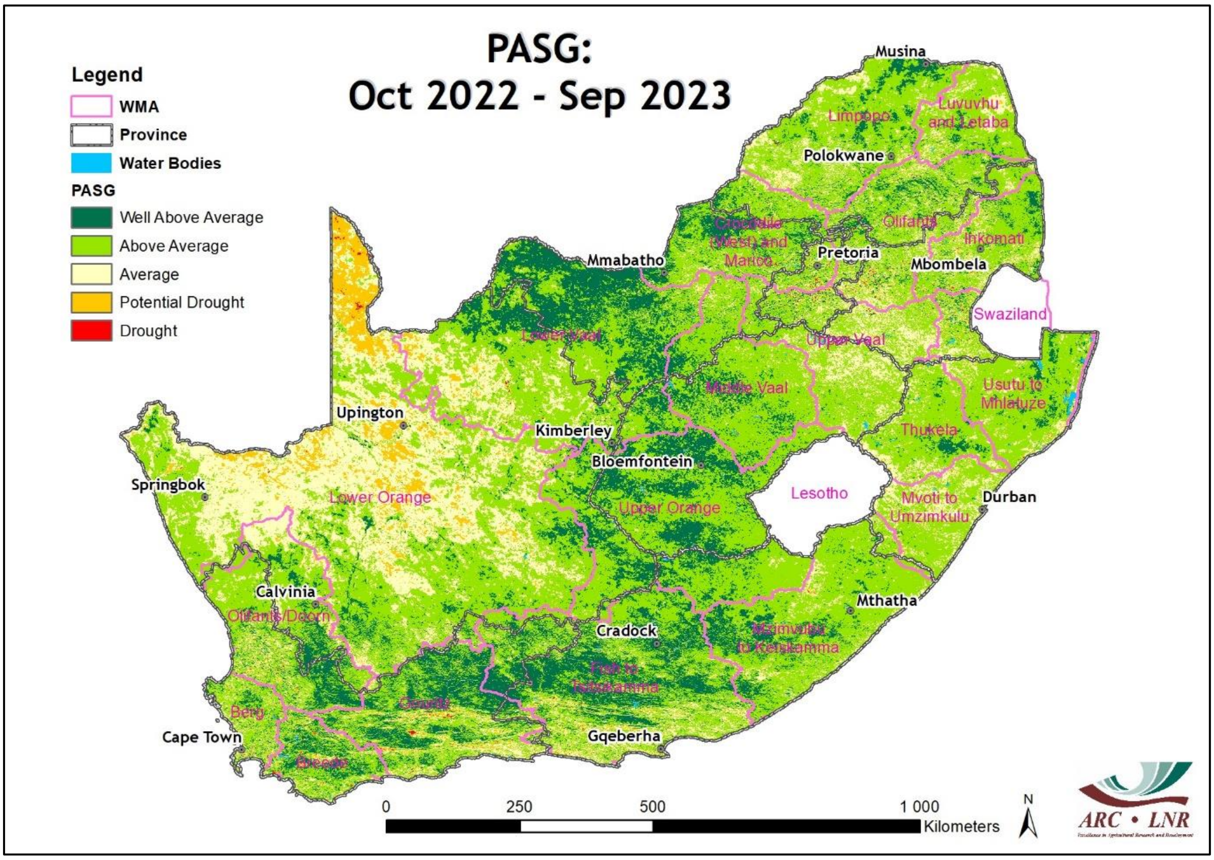


Figure 3.14 Percentage of Average Seasonal Greenness (PASG) for the 2022/23 hydrological year.

Cumulative vegetation activity as represented by the PASG was above average during the 2022/23 hydrological year over almost the entire country, associated with the above-average rainfall observed during this period over most parts. It is especially the central interior as well as the southern parts, including parts of the winter rainfall region, where vegetation activity was well above average. Over these same areas, largest positive deviations in terms of percentage of average rainfall were observed (Figure 3.6) and moderately to severely or extremely wet conditions occurred according to the SPI Map. Drier conditions over the northern to north-western parts of the Northern Cape as indicated in the rainfall and SPI maps had a negative effect on cumulative vegetation activity relative to the long-term average.

3.4 Extreme Weather Events

3.4.1 Extreme temperature event implications on water resources

Over South Africa and during October 2022 - September 2023, there were several notable periods of extremely hot or cold conditions, two of which include the anomalously hot period of 9-23 January 2023 and the anomalously cold period of 9-12 July 2023 (Figure 3.15). During 9-23 January daily average temperatures were anomalously hotter over all regions of South Africa, but were highest over central regions, reaching up to 5.5˚ C higher than normal (Figure 3.15). During 9-12 July 2023 daily average temperatures were similarly anomalously cooler over all regions of South Africa, but were lowest over central, reaching up to 6.5˚ C cooler than normal.

Many negative implications of these events were reported by media, and in the context of water resources such anomalously hot and cold events can have significant negative impacts. In the context of heatwaves (and the 9-23 January 2023 heatwave) and other extremely hot temperature events (e.g., warm spells), higher temperatures enhance evaporation of surface waters (i.e., dams, lakes and rivers) and even soil water, reducing the quantity of available water that can be used for drinking and household, irrigation and industrial use. In times of drought or when there has been limited rainfall, higher temperatures resulting from extreme temperature events can exacerbate already dry conditions by enhancing evaporation and associated high-pressure systems (often the systems causing heatwaves) can also block rain-bearing weather systems leading to even drier conditions.

With these extremely hot events, there is typically increased water demand not only for domestic consumption but also for agricultural and industrial uses. These heightened water demands coupled with increased evaporation can easily strain water resources. Above this, elevated temperatures can also impact water quality by promoting the growth of harmful algal blooms and increasing the concentration of pollutants in water bodies. In some instances, it has also been reported that extremely hot temperatures can even stress water infrastructure, leading to increased wear and tear on infrastructure components, and in extreme cases, may cause failures or disruptions in water supply systems.

On the other hand, extremely cold temperatures can also impact water resources, but to a lesser extent. In the context of cold waves (and the 9-12 July 2023 cold wave) and other extremely cold temperature events (e.g., cold snaps), the impact on water availability can be felt through freezing over of water bodies, limiting available water that can be used for drinking and household, irrigation and industrial use. However, over South Africa, this is extremely rare as the country is characterised by an overall warm climate, but in regions such as the Lesotho Highlands, representing an important water source for the country, freezing over of water resources can occur. Over these cooler regions, events of extremely cold temperatures can potentially impact water infrastructure by freezing water within pipes and potentially leading to burst pipes or water leaks or other failures as a consequence, in turn causing disruptions in water supply.

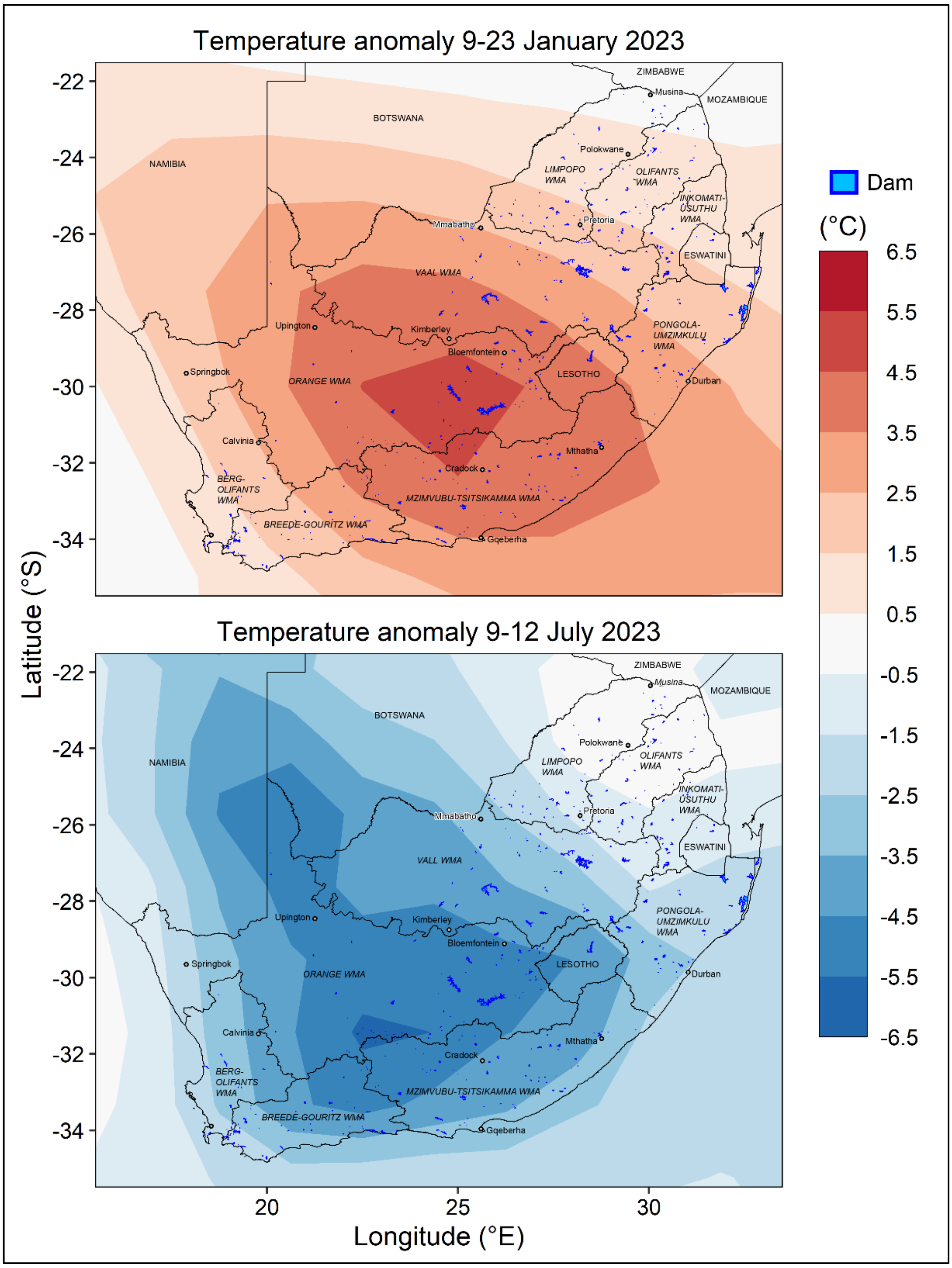


Figure 3.15 Maps of the daily temperature anomalies recorded for (a) 9-23 January 2023 and (b) 9-12 July 2023. Data source: NCEP/NCAR Reanalysis at a spatial resolution of 2.5˚ (https://psl.noaa.gov/data/gridded/data.ncep.reanalysis.html). The anomalies mapped represent the deviation of 9-23 January and 9-12 July temperatures from long-term mean temperatures for 1991-2020.

3.4.2 Extreme Rainfall Events

After relatively dry conditions during January 2023, widespread thundershowers occurred by the end of the month over the summer rainfall region. Thundershowers continued into February, with widespread significant falls over the northeastern half of the country. The 10-day total rainfall (Figure 3.16, top) exceeded 150mm over several areas, but reached a maximum extent over the eastern and northeastern escarpment, Lowveld and northern parts of KwaZulu-Natal. Several locations experienced 24-hour totals exceeding 100 mm during this period. Totals over this period exceeded 300 mm over the escarpment and Lowveld of Mpumalanga. Over these areas, flooding occurred in several rivers, including the Crocodile and Komati rivers in Mpumalanga. Localized flooding also occurred over parts of northern Kwa-Zulu Natal. The presence of a tropical low moving over the northeastern parts of the country (indicated by "L" in Figure 3.16, bottom) contributed large amounts of tropical moisture and uplift while general circulation patterns further enhanced the favourability for rainfall during this specific period.

The winter rainfall region and the rest of the southern parts of South Africa received above-normal rainfall during winter and spring of 2023. One of the wettest periods over the winter rainfall region occurred during 11 – 18 June, when a quick succession of several cold fronts moved across the southern parts of the country from the west, resulting in widespread rainfall over the western parts and significant totals especially over the southwestern mountainous areas (Figure 3.17, top). Figure 3.17, bottom, shows a frontal system with a zonal alignment moving across the southern parts during this period, responsible for widespread significant rainfall especially over the western parts of the winter rainfall region. Parts of the Swartland received in excess of 150 mm, while multi-day totals reached 300 mm in parts of the Boland.

September 2023 was an extremely wet month over the southern parts of the country and widespread heavy rain during this month over the southern parts helped ending the drought conditions that lingered over some of the southeastern to southern parts of the country. Heavy rainfall during spring is almost always associated with cut-off low pressure systems. During September 2023, this was no exception. A significant widespread heavy rainfall event occurred from 23 to 27 September, when a cut-off low (indicated with an "L", Figure 3.18, bottom) developed near the west coast and moved across the southern parts of the country, causing widespread rain and thundershowers with heavy falls especially in the mountainous region. As the system moved across the region, 2-day totals exceeded 100 mm over especially the mountainous regions in the southwest, along the Garden Route in the south and southern to southeastern parts of the Eastern Cape. Multi-day totals exceeded 150 mm in some of these mountainous areas and even exceeded 300 mm over the southwestern mountainous areas in the Western Cape (Figure 3.18, top). With river systems already full following widespread above-normal rainfall earlier during the winter, widespread flooding occurred, resulting in loss of lives and widespread infrastructure damage and road closures.

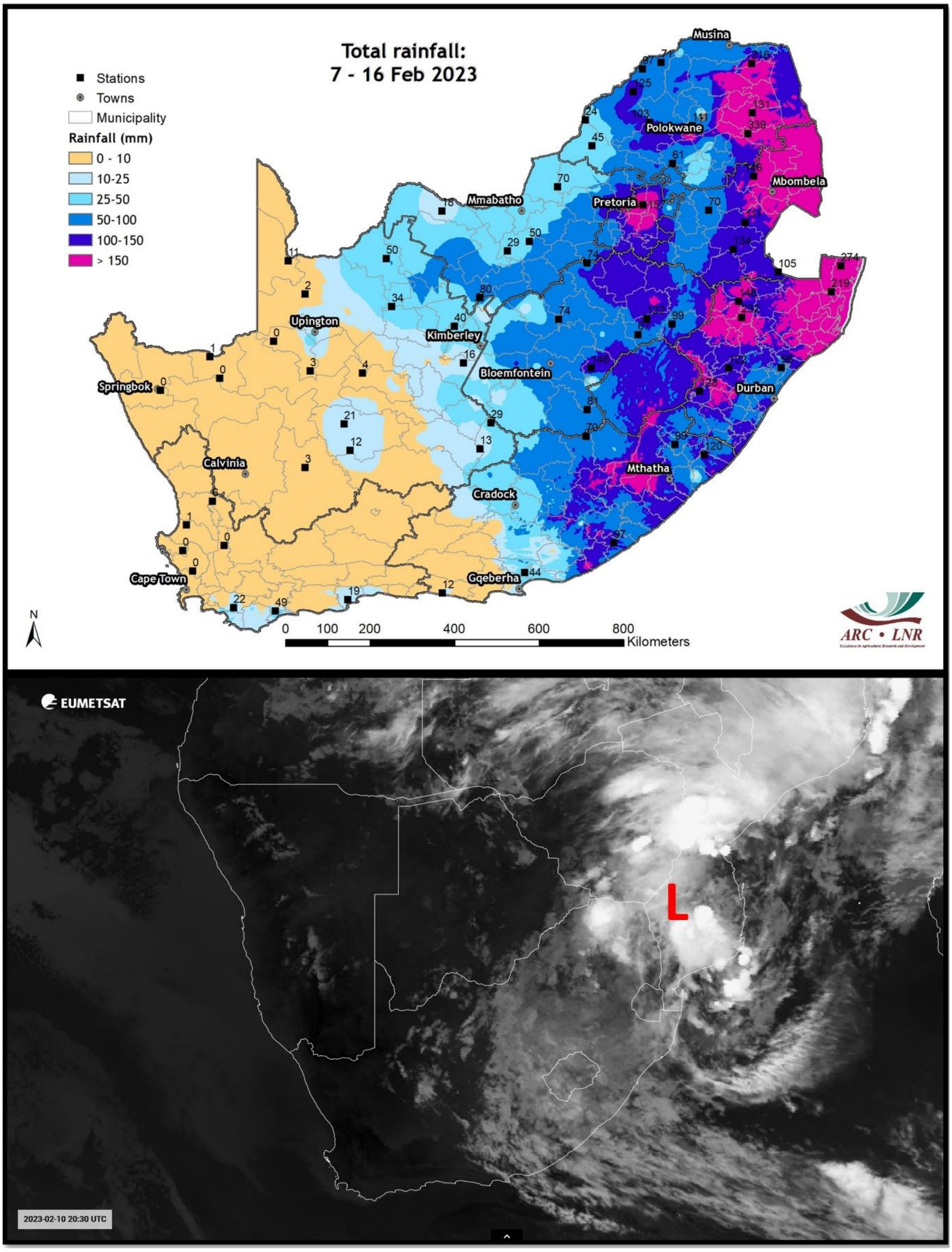


Figure 3.16 Total rainfall (mm) during 7 – 16 February 2023 (top) and Meteosat Second Generation thermal infrared image on 9 February (bottom).

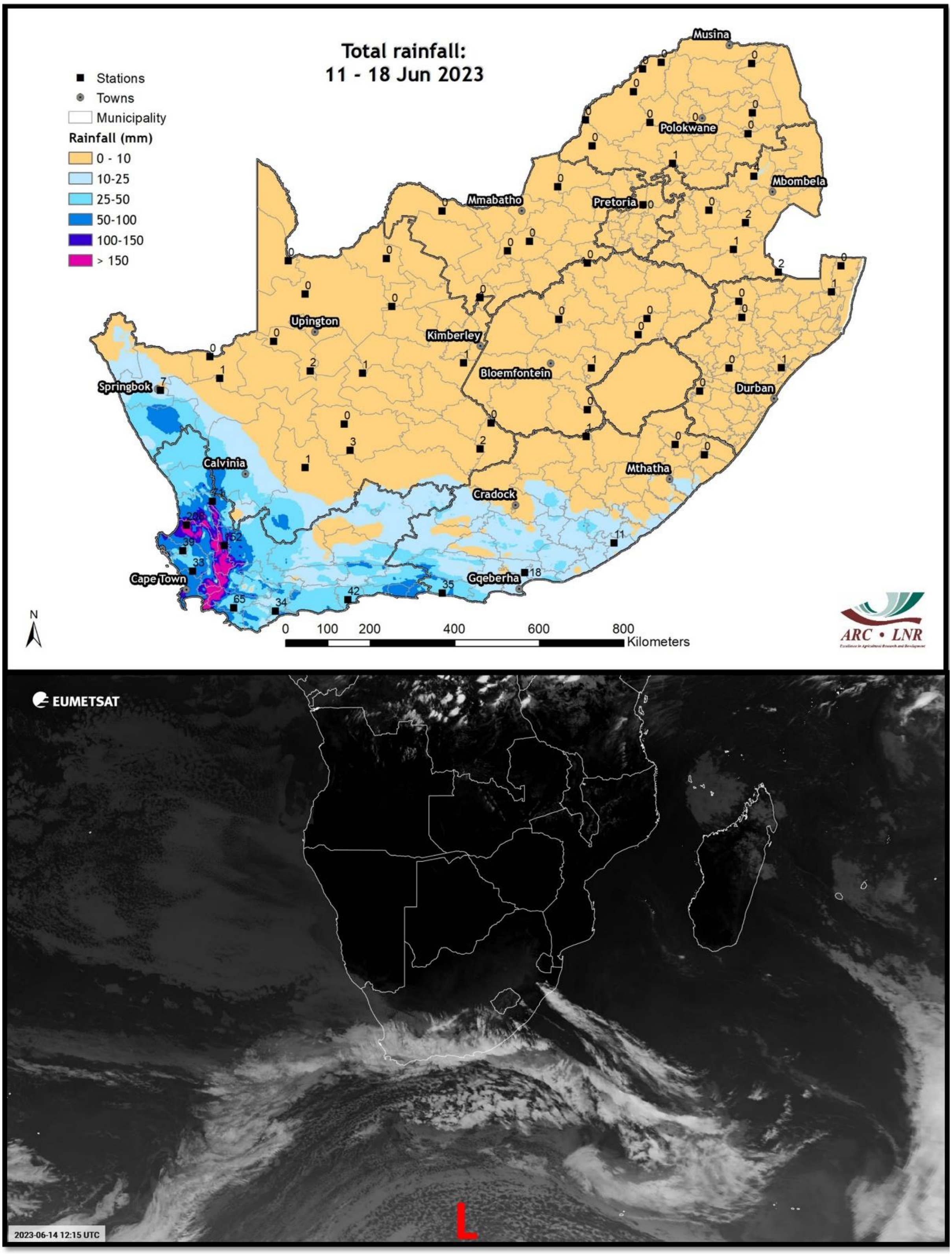


Figure 3.17 Total rainfall (mm) during 11 – 18 June 2023 (top) and Meteosat Second Generation thermal infrared image on 14 June (bottom).

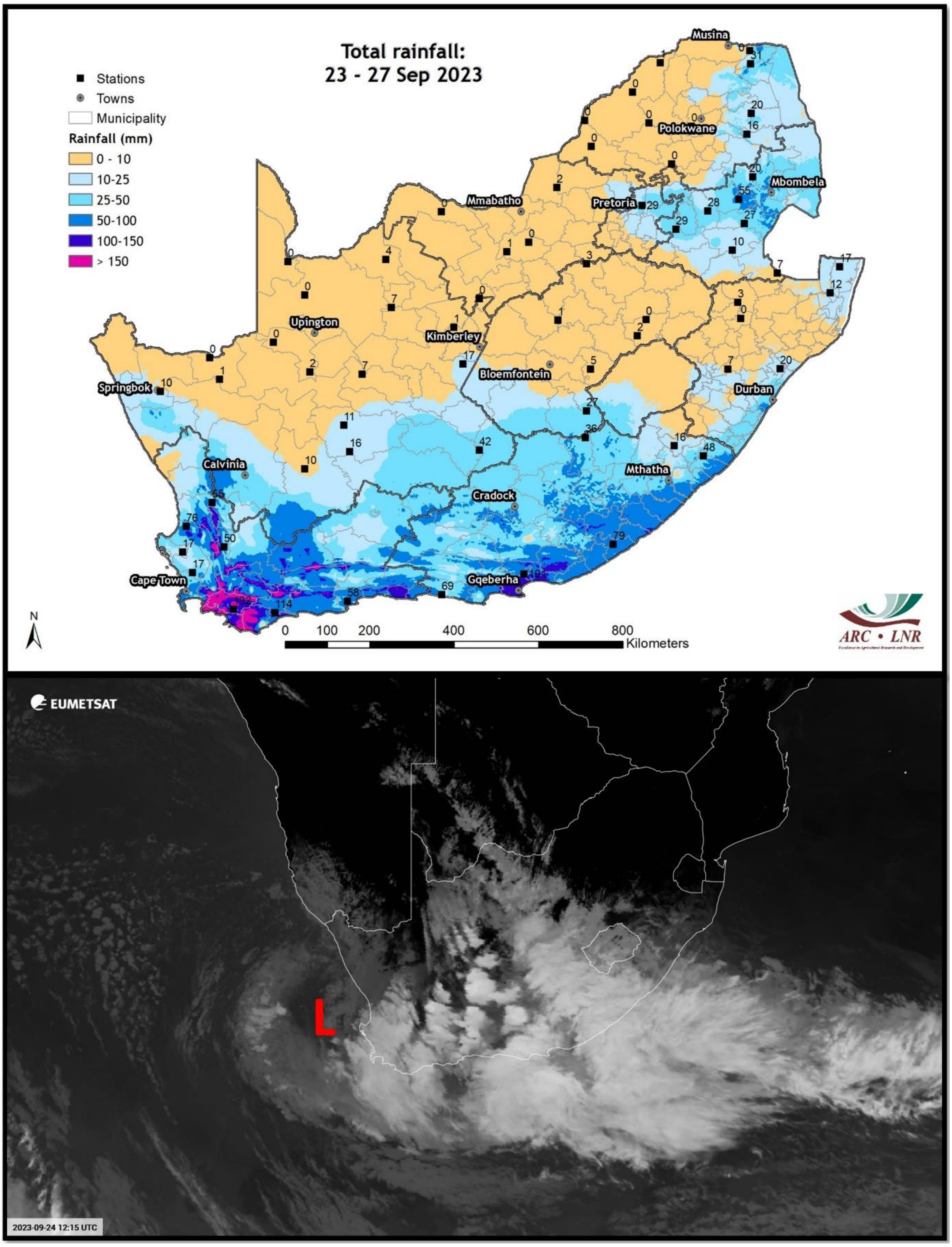


Figure 3.18 Total rainfall (mm) during 23 – 27 September 2023 (top) and Meteosat Second Generation thermal infrared image on 24 September (bottom).

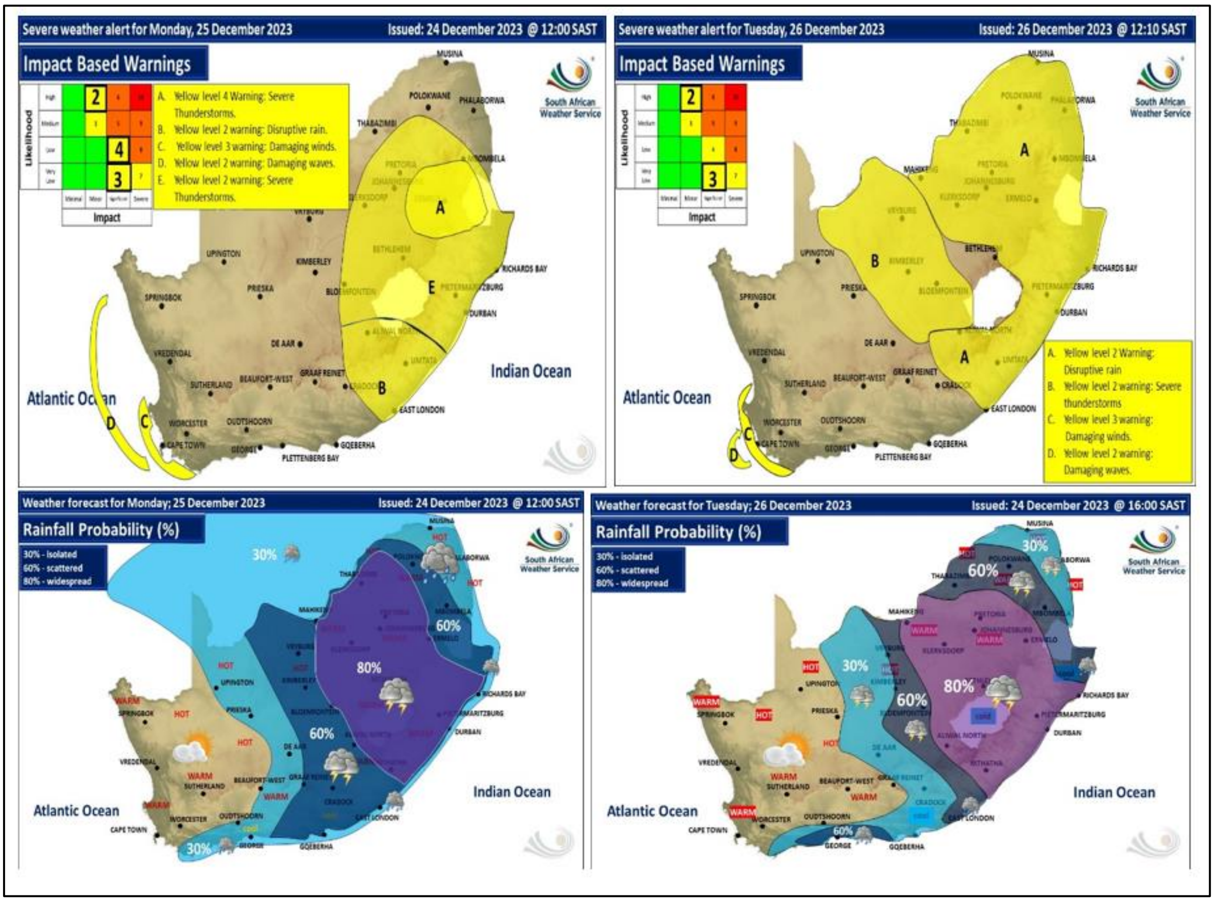
3.4.3 Floods

During the Hydrological years 2021/22 and 2022/23, El Niño-Southern Oscillation (ENSO) was in a La Niña phase, associated with above-normal rainfall over most summer rainfall regions. In November 2022, normal to above-normal rainfall occurred mainly over the country's eastern half and isolated parts of the Northern and Western Cape Provinces. As a result, some urbanised areas experienced severe flooding. Furthermore, a trough (low-pressure system) resulted in heavy rainfall, primarily over parts of Gauteng. As a result, widespread flooding was reported between 11 and 13 November 2022 for parts of Gauteng, Mpumalanga, and the southwestern parts of Limpopo. Sinkholes were reported in places over the West Rand and Pretoria. Widespread flooding across the southern Highveld of Mpumalanga near Standerton and Secunda resulted in a large inflow of water into the Vaal Dam, raising dam levels and resulting in the decision to open sluice gates several times for flood management during this period of high inflows.

The calendar year 2023 commenced with relatively wetter conditions in the central and western parts, while the coastal regions and some north-eastern parts of the country experienced drier-than-usual conditions. Port St Johns, which is located in the Eastern Cape Province, experienced floods on 23 March 2023. The heavy rains were caused by a cut-off low situated west of the country, supported by a strong high-pressure surge in the south to southeast of the country. The cut-off low resulted in thunderstorm activity for several provinces, including the Eastern Cape. The local municipalities that were affected by floods included Ingquza Hill, King Sabata Dalindyebo, and Port St John's, which were the worst affected. Tremendous destruction to infrastructure, households, and businesses was observed in all other affected areas.

In May 2023, above-normal rainfall was experienced across most parts of the country, with major flooding events occurring in the eastern and south-eastern coastal regions. On 13 May, heavy rains led to the evacuation of over 1 200 residents from their homes in the Nelson Mandela Bay Municipality in the Eastern Cape.

In June 2023, flooding occurred in three provinces: the Western Cape, the Northern Cape, and KwaZulu-Natal. A fast-moving cold front landed over the Western Cape, bringing cold temperatures and rainfall. The resultant torrential rains wreaked havoc in the Western Cape Province on 14-15 June 2023, causing flooding in several areas. It was reported that in Rawsonville, more than 1000 people were displaced and housed in Rawsonville's town hall, while Riverview residents in Citrusdal were given emergency shelters. In the Namakwa District Municipality in Northern Cape, Richtersveld, Kamiesberg, and Nama Khoi Municipal regions received higher than normal rainfall from 27 June 2023. This flooding resulted in infrastructure damage in various regions, including washed-away bridges that limited residents' access to healthcare facilities and shops. On 27-28 June 2023, KwaZulu-Natal experienced a catastrophic, unprecedented flash flood in winter. Severe weather, including high gusts and heavy rain, began on 27 June 2023. Paddock in Ugu District received 176 mm of rain in a 24-hour period ending on 28 June, Sezela in Ugu District received 84 mm, while the Greater eThekwini Metropolitan region received 72 mm. On 24 and 25 September 2023, the Western Cape faced multiple floods, resulting in 11 fatalities, the closure of over 200 roads, and more than 80,000 people enduring prolonged power outages.



[*Figure 3.19 Severe weather warnings and rainfall predictions for 25 and 26 December 2023. (Source: SAWS)*]

These heavy rains caused widespread destruction, affecting households, businesses, and public infrastructure such as schools, roads, and bridges (Figure 3.20). The uThukela District was severely affected, with 23 deaths reported during floods that hit Ladysmith on 24 December 2023 and more than 100 houses damaged.

On 24 December 2023, weather stations in the Ladysmith area reported approximately 60mm of rain within an hour, with approximately 80mm of rain falling over three hours. Strong winds also damaged over 40 homes in King Cetshwayo District, destroying several businesses in the Eshowe industrial area. By 31 December 2023, the number of fatalities from extreme weather conditions in KZN had risen to 31, with three people still missing. COGTA reported that over 600 households and over 140 dwellings were destroyed (COGTA, 2023).

Figure 3.20 Destruction caused by floods in Ladysmith, KZN. (Source: SABC News).

3.5 Weather Forecast

El Niño Southern Oscillation or ENSO is a term used to describe the naturally occurring dynamic ocean-atmosphere phases of a significant part of the Pacific Ocean. This dynamic state fluctuates over periods of months along a gradient where the two extreme states are known as El Niño versus La Niña. In essence, El Niño is characterized by warmer-than-average sea surface temperatures in the ocean adjacent to the south-central coast of the Americas, while La Niña is characterized by lower-than-average sea surface temperatures in that same region (Sweijd et al, 2024).

In early July 2023, the World Meteorological Organisation officially declared the "onset of El Niño Conditions" – this was a moment (persistent sea surface threshold exceedance) that this year's ENSO phase or state was officially recognised as an El Niño. This was anticipated as early as March 2023 supported by both the observations data and climate models. The current status of this El Niño is provided below.

Ongoing monitoring of the El Niño and a wide range of climate metrics have been conducted and data from this season's features relative to other years' seasons are now available. We have now passed the peak of this season, the metrics of the 2023 El Niño show that this season's event, while not as intense as the strongest such events of the past, was within the range of the top four such events recorded in the past. This is illustrated in Figure 3.21 which provides an index of the Sea-Surface Temperature (SST) anomalies for the 8 most intense Los Niños on record.

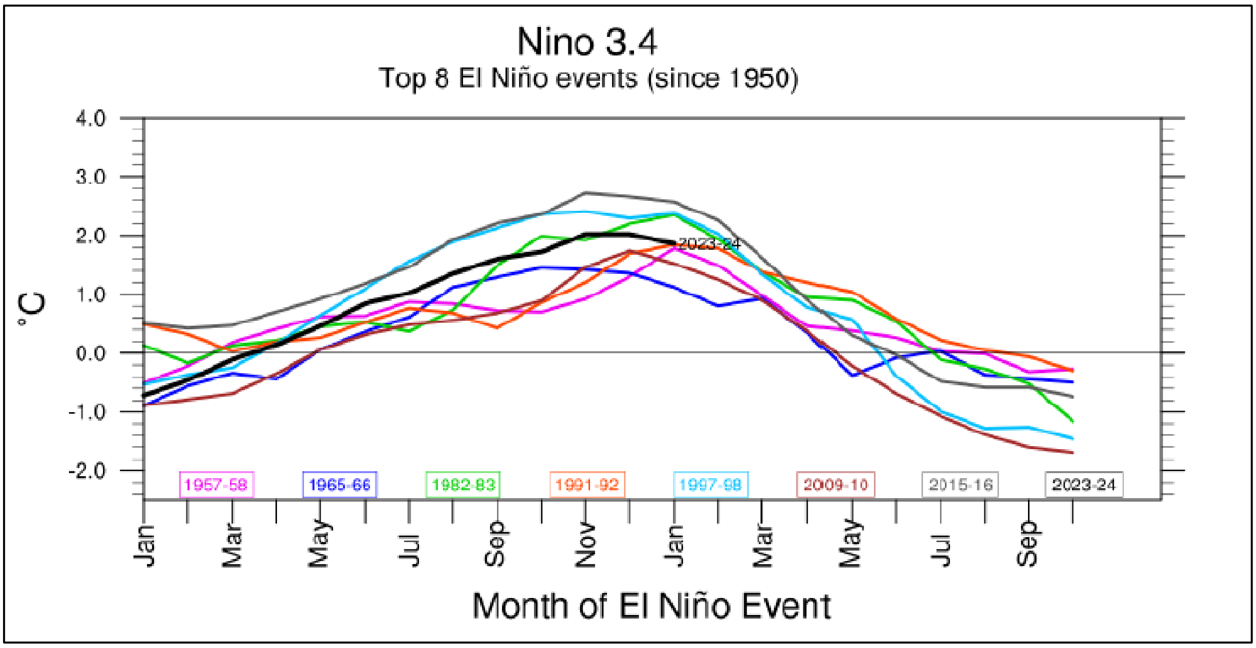


Figure 3.21 SST anomalies averaged over the NINO3.4 region 5°North-5°South;170-120°West. Calculated from the Monthly NOAA ERSST V5 (at NOAA/CPC). Sourced from NOAA PSL.

The El Niño-Southern Oscillation (ENSO) is currently in a strong El Niño state. This event is predicted to persist through the 2023/24 summer months.

- The impacts of ENSO in South Africa are drier and warmer conditions during the summer seasons.
- SAWS multi-model rainfall forecast predicts mostly **below-normal rainfall** over most of the country during Feb-Mar-Apr (FMA), Mar-Apr-May (MAM), and Apr-May-Jun (AMJ), except some central parts of South Africa during MAM, which have a higher probability of **above-normal rainfall** (Figure 3.22).
- The anticipated below-normal rainfall conditions, coupled with above-normal minimum and maximum temperatures, are likely to reduce surface water levels, particularly in drought-affected areas.
- Minimum and maximum temperatures are expected to be mostly above normal countrywide, and this is likely to increase the demand for cooling for the forecast period.

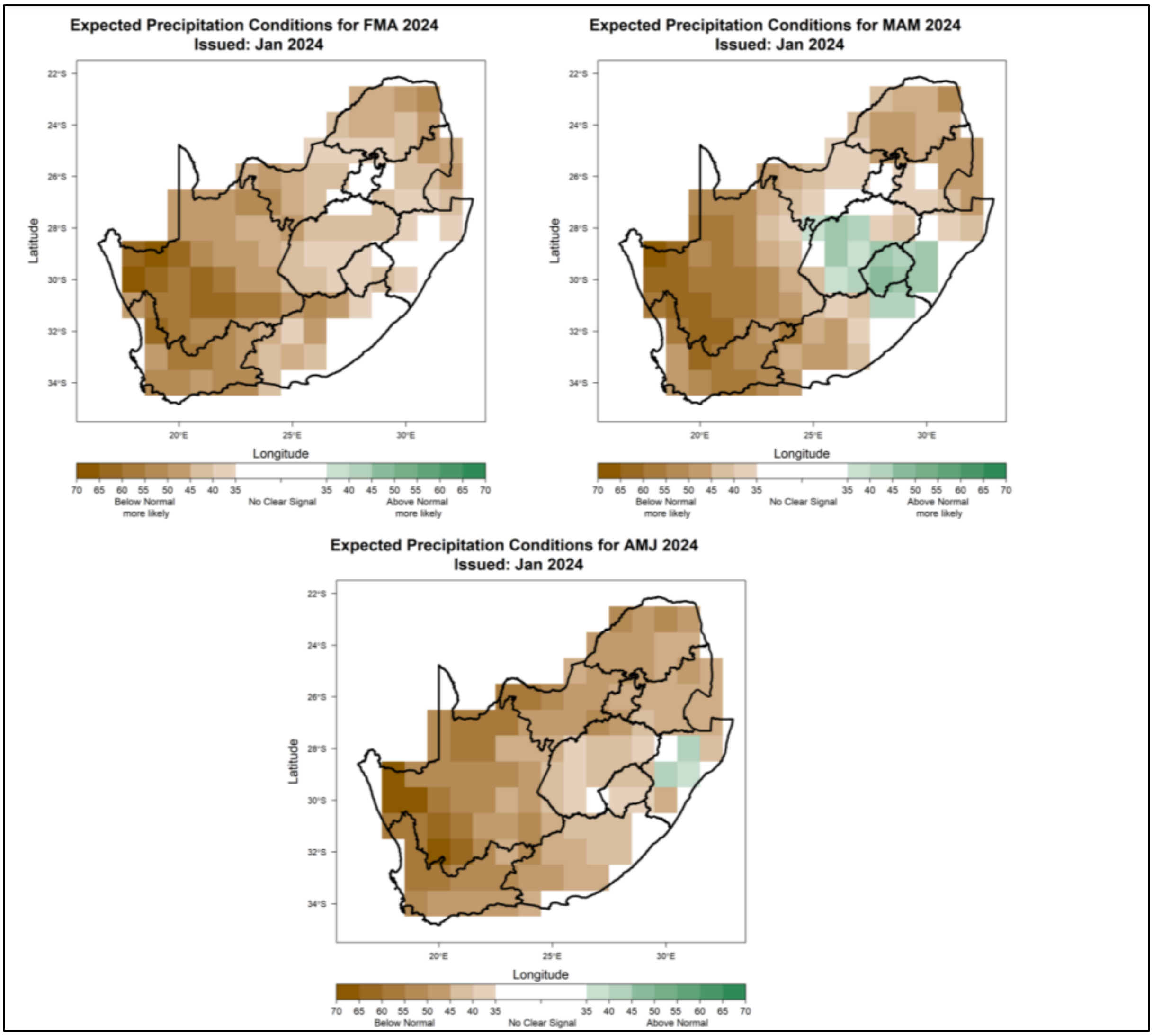


Figure 3.22 February-March-April 2024 (FMA; left), March-April-May 2024 (MAM; right), April-May-June 2024 (AMJ; bottom) seasonal precipitation prediction. Maps indicate the highest probability of the above-normal and below-normal categories.

El Niño did display some of the typical features of impact on our climate with a somewhat drier rainy season and much warmer summer season relative to the long-term average. The manifestation of this was not as severe as similar events in the past and due to the previous years' good rain (La Niña years), there was sufficient water storage to offset any impact of the drying. Nevertheless, there was a discernible impact on dam levels during this period.

4

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4 STATE OF RIVERS

4.1 Streamflow

The Department of Water and Sanitation (DWS) is mandated by the National Water Act (No. 36 of 1998) Chapter 14, Section 137, to establish and monitor streamflow in the South African rivers. The Department monitors 628 river flow gauging stations across South Africa. Several streamflow monitoring stations are equipped with data loggers that measure the amount of water passing through a point over time in cubic meters per second (m^3/s). The NWRS-2 indicated that streamflow monitoring aims to address our national concerns and is also in response to our obligations within international river basins (DWS, 2013).

Transboundary water systems account for approximately 60% of South African river streamflow. Therefore, it is critical that South Africa implements Integrated Water Resource Management (IWRM) in accordance with international water conventions and treaties, as well as the legislation governing water resource management in South Africa. The international agreements have guidelines and limits on the quantities of water that South Africa may use out of the rivers and the amount of water the country must release to the neighbouring countries.

The South African rivers demonstrate variations in flow regimes or flow patterns, continuously deviating from the historical flows. The flow regime changes are both natural and anthropogenically driven, with high variability in rainfall, population growth, land and water use changes playing significant roles. Some catchments demonstrate increased streamflow while declining trends are also observed in other catchments. The decline in streamflow affects water availability and supply, resulting in competing water requirements between different water use sectors such as agriculture, industrial, and urban water supply.

4.2 Annual Streamflow Anomaly at Strategic Points

The Department has several surface water monitoring points of strategic importance (outlet of catchments, international obligations importance and SDGs reporting). These strategic stations contain long-term data which were used to assess the deviation of total annual streamflow volume during the current reporting period from the long-term median (1980-2010).

Figure 4.1 depicts a streamflow anomaly map that shows the deviation of annual streamflow in the 2022/23 hydrological year from the long-term median (median period of 1981-2010), whereas Figure 4.2 depicts the streamflow deviation for the previous hydrological year.

Most strategic points demonstrated a significant increase in the total annual flow volume in the current hydrological year compared to the previous year. This can be attributed to well above-normal rainfall received over extensive parts of central South Africa as a result of ENSO's El Niño event, which is associated with above-normal rainfall in the majority of summer rainfall regions. Only three strategic stations were below normal, compared to five reported last year, with one being extremely below normal.

One of the highlights was a station in the Olifants WMA (B7H007 - Olifants River at Oxford) that has improved from below normal to above normal in the current hydrological year. Water from this station flows into Mozambique, and the streamflow anomaly graph in Figure 4.3 shows a significant increase in total flow volume. The total annual volume recorded at this station in the 2022/23 hydrological year was 2601 MCM, the highest ever recorded.

The flow station D8H014, which is located on the Orange River and flows into Namibia, maintained its extremely above-normal flow status from the previous year. The streamflow anomaly graph for this station indicates that both this station and the one above it (D7H005- Orange River at Upington) had good flows in the last two hydrological years, after 9 years of low flows. Overall, all rivers in the Integrated Vaal River System improved or maintained a significantly higher than long-term median pattern, except for C9H003 (Vaal River at Riverton), which was above normal and regressed to below normal in the current reporting period.

Notably, the streamflow at a station in the Pongola-Mtavuma WMA V5H002 (Tugela River at Mandeni) was again flagged as being below normal, but this was an improvement over the much lower levels reported last year. The historical observed streamflow data, and annual streamflow anomaly graph presented in Figure 4.4 revealed that the flow at this station has been below normal since the 2014/15 hydrological year. Two stations (L7H006- Groot River at Grootrivierspoort and Q9H018– Fish River at Matomela’s Location) in the Mzimvubu-Tsitsikamma WMA improved significantly from below normal to above normal in the current hydrological year, which can be associated with above-normal summer rainfall that caused flooding in some areas of the Eastern Cape.

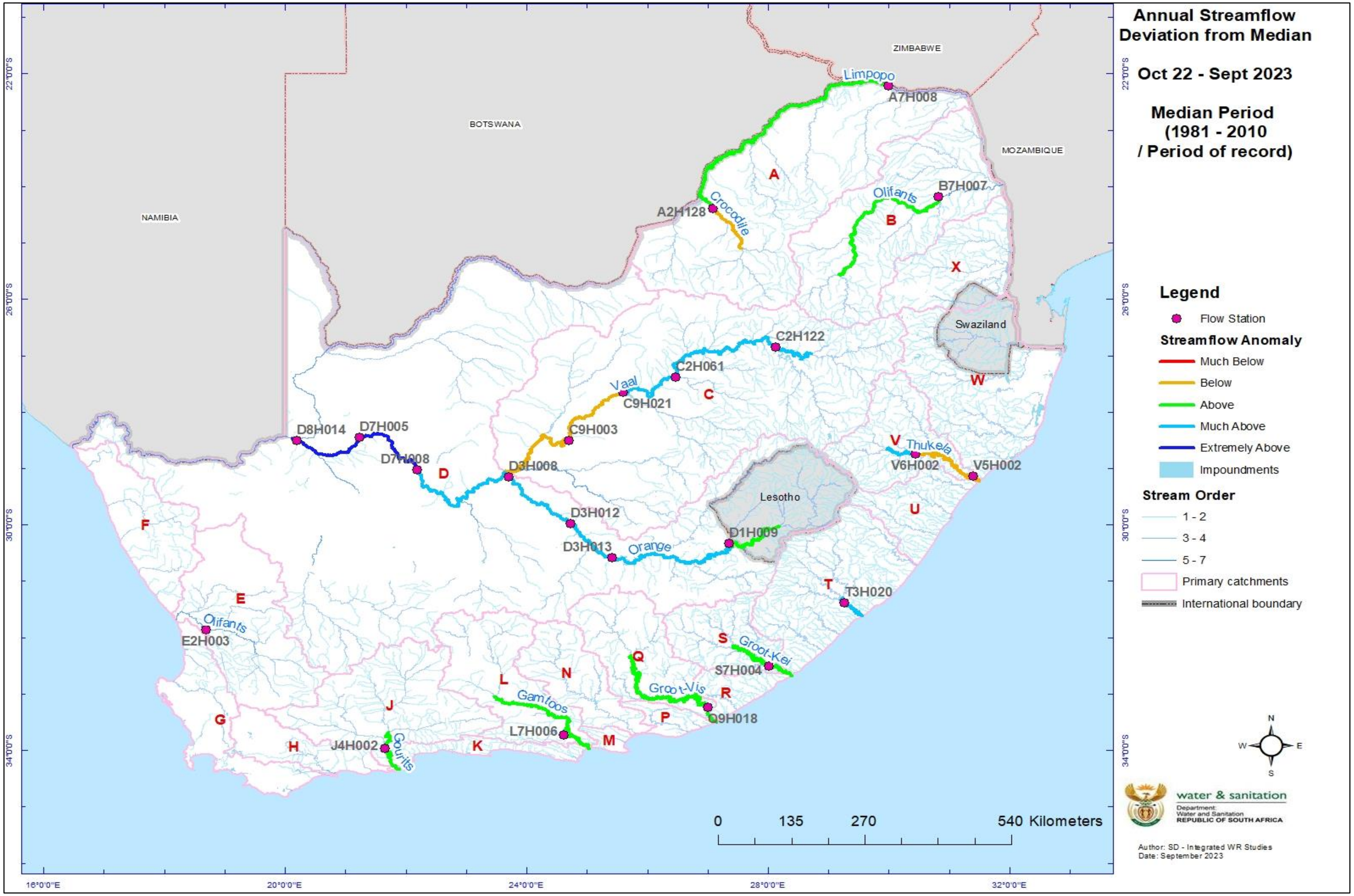


Figure 4.1: Annual Streamflow Anomaly for Strategic River Flow Monitoring Stations as of September 2023.

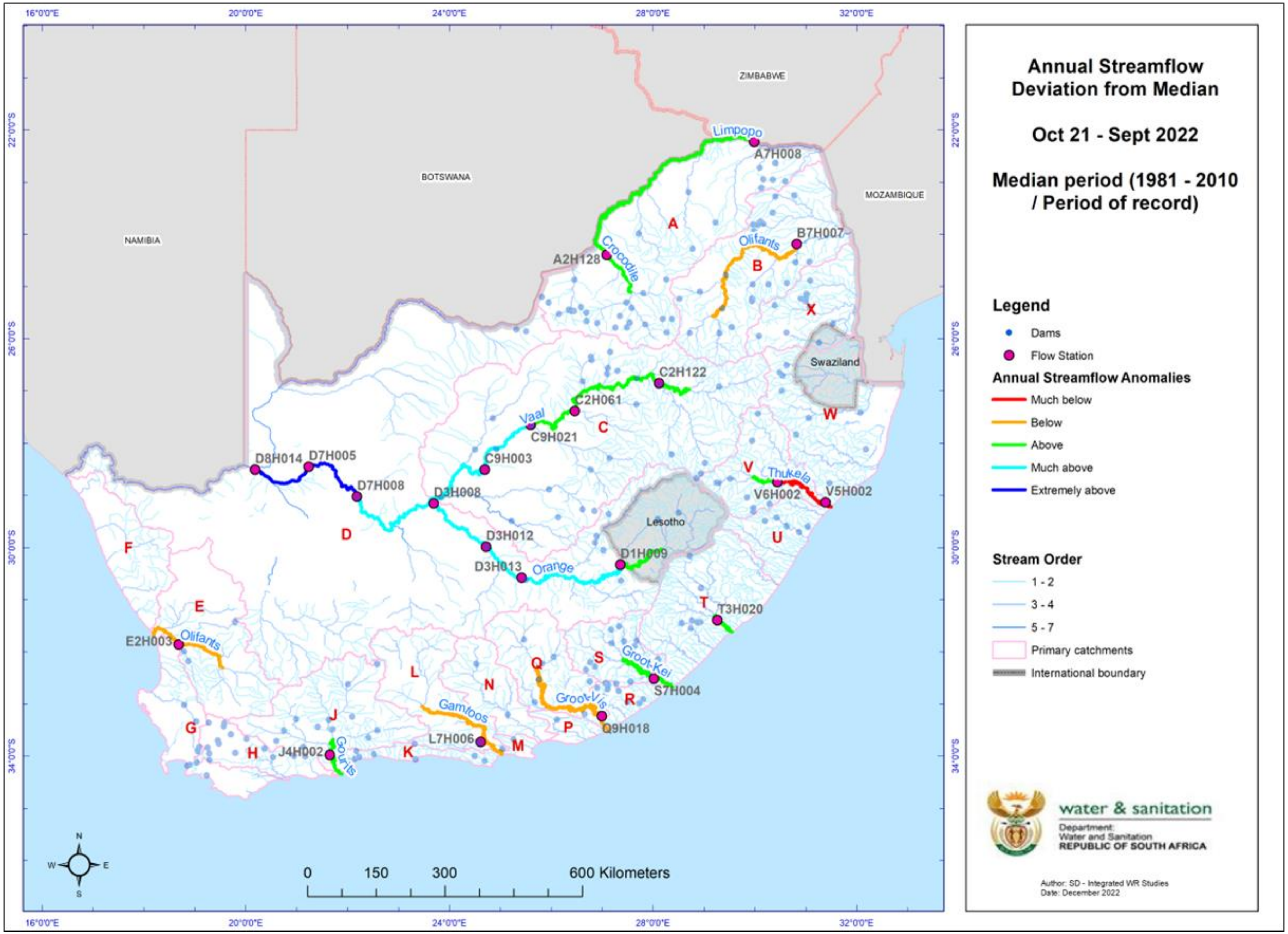


Figure 4.2: Annual Streamflow Anomaly for Strategic River Flow Monitoring Stations for 2021/22 HY.

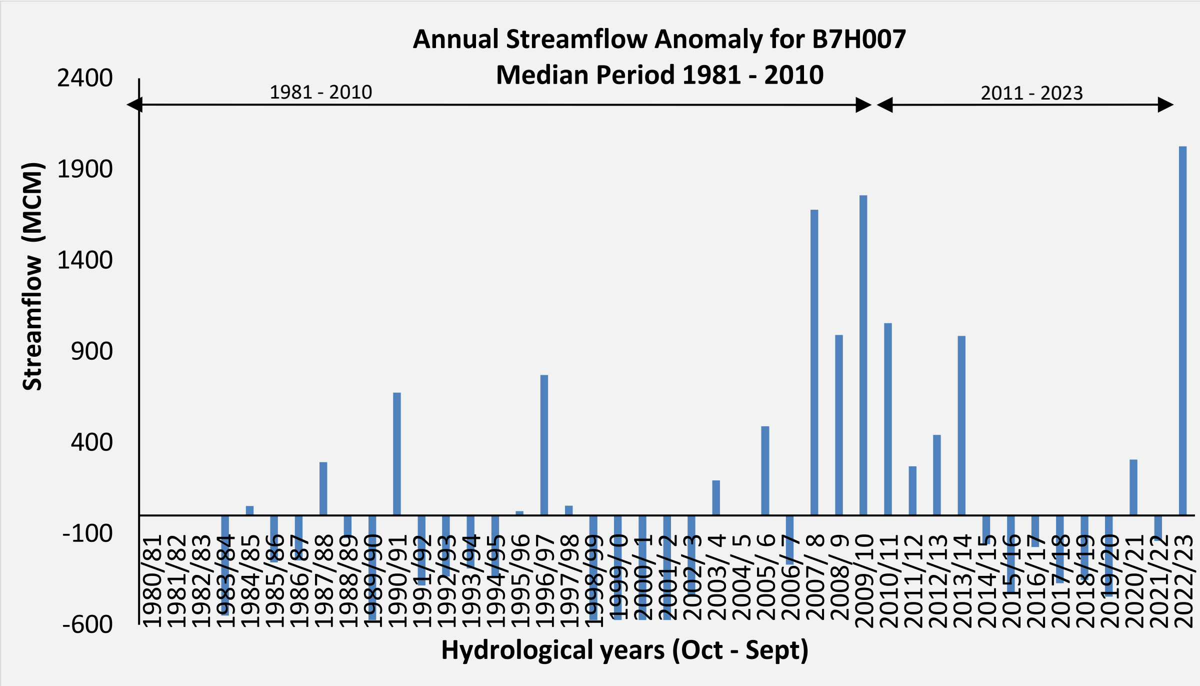


Figure 4.3: Annual streamflow deviation from the long-term median at station B7H007.

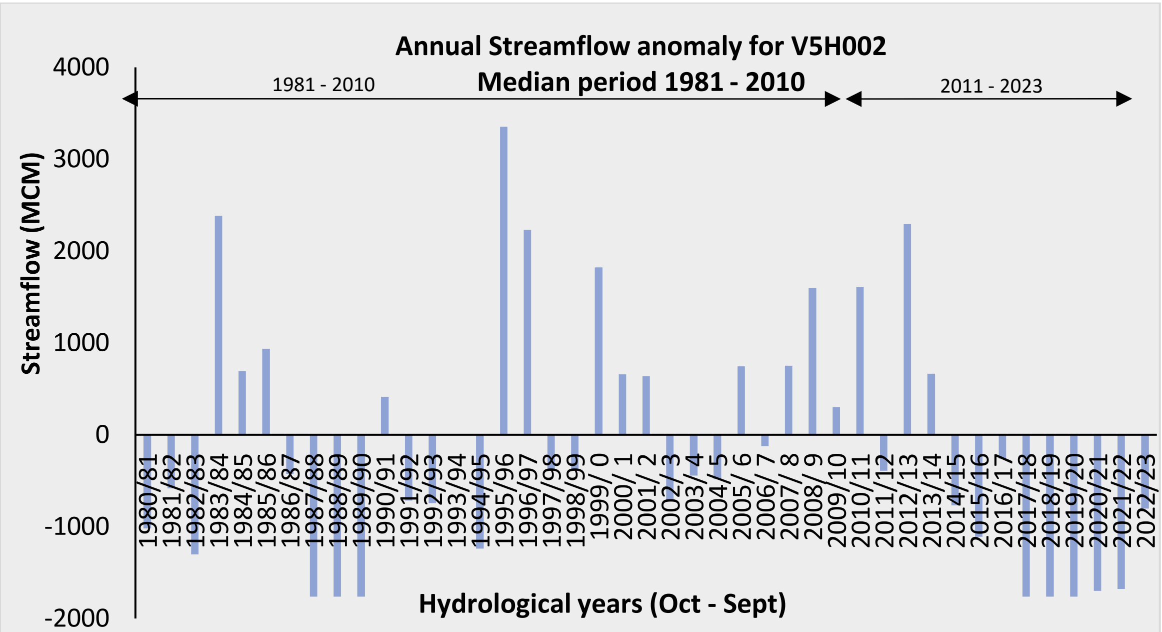


Figure 4.4: Annual streamflow deviation from the long-term median at station V5H002.

4.3 Surface Water Resource Quality

The Department of Water and Sanitation, as custodian of South Africa's water resources, seeks to ensure that water resources remain fit for recognised water uses while also maintaining and protecting the viability of aquatic ecosystems. As a result, several water quality monitoring programmes are currently in operation across the country. This section will present the country's water quality data as collected through the DWS water quality monitoring programmes in the current reporting period.

4.3.1 Inorganic Chemical Pollution

The inorganic water quality is described in terms of attributes for which the values exceeded the Ideal and Good classes specified in the guidelines for domestic and irrigated agricultural use. These water user classes were chosen where users could withdraw water directly from surface water and use it without pre-treatment. This is assumed not to be the case where domestic users have access to reticulated water that has been adequately treated to make it safe for consumption.

Figure 4.5 depicts the inorganic chemical water quality for the 2022/23 hydrological year across the country. The assessment used the available data for the hydrological year to extract information from what were, in some cases, limited sampling events during the period. Figure 4.5 shows that there was little evidence of elevated nutrient levels during the current reporting period. Therefore, this report will focus on water quality attributes related to salinity.

- ***Salinity***

Salinity is reflected by a number of water quality attributes, including: Total Dissolved Solids (TDS) or its equivalent Dissolved Major Solids (DMS); Electrical Conductivity (EC); and concentrations of individual ions such as sodium, chloride, and magnesium, potassium and sulphate, amongst others. *Increased salinity affects the taste and perceived freshness of water. When salt levels are high in water and it is used for domestic purposes, such as drinking, it can cause serious health problems in infants under the age of one year (Blue Baby Syndrome), people with heart or kidney disease who are on a salt-restricted diet, and people with chronic diarrhoea. Excessive salt levels in water can also damage water infrastructure by corroding distribution pipes, resulting in higher maintenance and replacement expenses.*

Figure 4.5 (A and B) shows the inorganic water quality attributes deemed to be especially significant for the **Domestic Fitness-for-Use**. The attributes are split into two subsets for the maps to be more legible. The **Irrigated Agriculture Fitness-for-Use** (Figure 4.5C) has fewer attributes, and Figure 4.5D displays Electrical Conductivity (EC) assessed according to Domestic use guidelines.

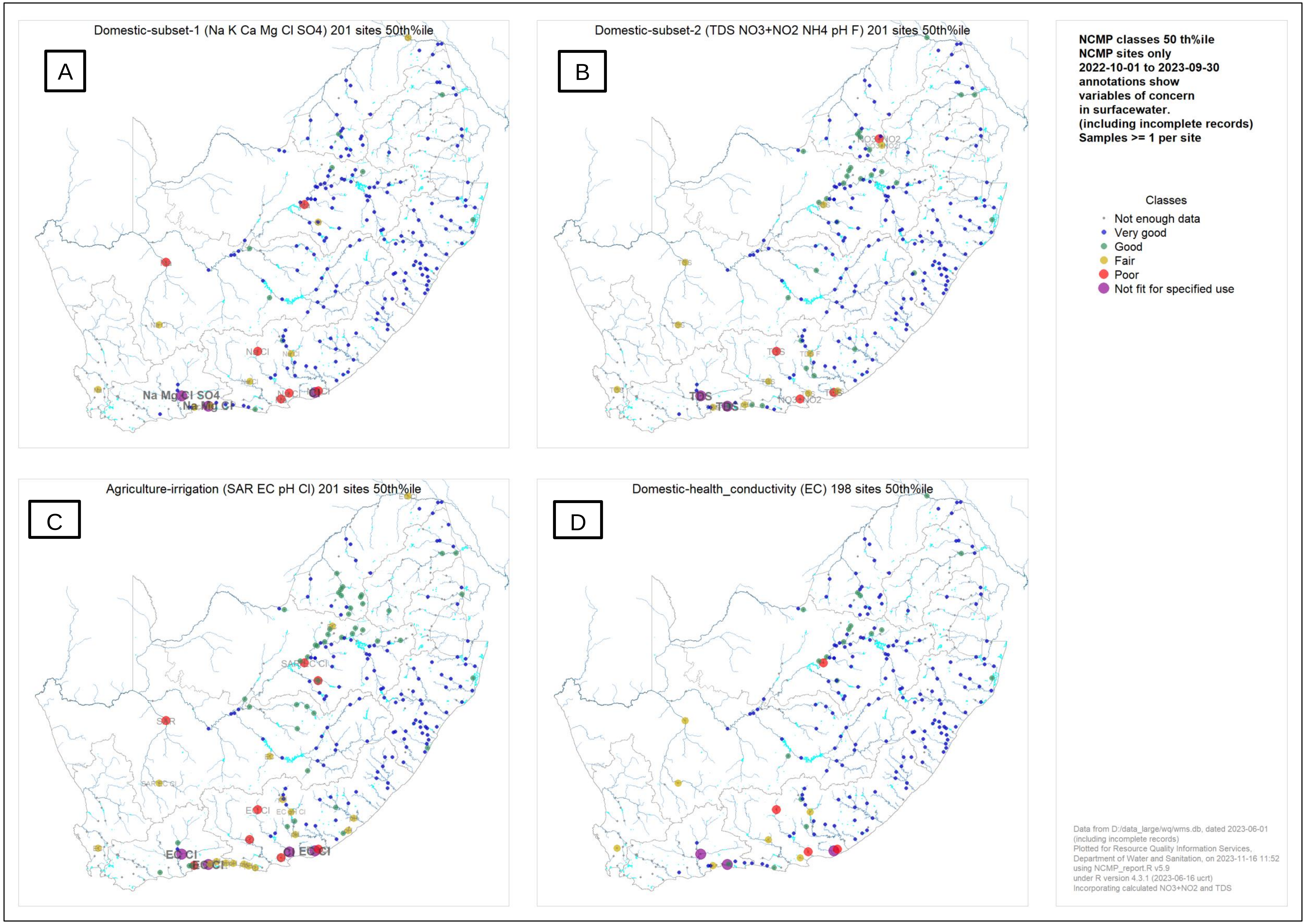


Figure 4.5: The inorganic chemical water quality situation in South Africa during the 2022/2023 hydrological year.

i. Domestic Use: Salinity (Na; K; Ca; Mg; Cl and SO_4)

Figure 4.5A shows that in the Berg-Olifants Water Management Area (WMA) and the Breede-Gouritz WMA in the Western Cape and Southern Cape, monitored sites demonstrated varying levels of Sodium (Na) and Chloride (Cl), ranging from fair to not suitable for specified uses. Additionally, there were a few instances in the Olifants River in the Breede-Gouritz WMA where Magnesium (Mg), Sulphate (SO_4), and Potassium (K) levels were higher than normal.

In a coastal vlei, it is expected that one of the sites would have high salinity levels due to the influence of the ocean. In the Vaal WMA, there were two sites with elevated Cl levels and one site with elevated Na levels. The Orange WMA also had two sites where both Na and Cl levels were elevated. Within the Limpopo WMA, a site located at the Beit-Bridge border showed slightly higher concentrations of Cl. In the Mzimvubu-Tsitsikamma WMA in the Eastern Cape, there were several instances where Na and Cl levels exceeded the acceptable range, and two of those sites also had slightly elevated Mg levels (Mackies Puts Eye at Graaff-Reinet and in the Kariega River).

ii. Domestic Use: Salinity (TDS; NO_3-NO_2; NH_4, pH and F)

Figure 4.5B shows a monitoring site in the Berg-Olifants WMA along the Diep River with slightly increased levels of TDS. In the same Breede-Gouritz WMA, two locations had elevated TDS, and one of these is situated within the Swart Vlei, which is strongly influenced by marine conditions. Additionally, the pH is low in this WMA, which may not necessarily be due to human influences. In the Mzimvubu-Tsitsikamma WMA, several locations displayed elevated TDS, with one showing increased levels of Nitrate-Nitrite (NO_3-NO_2) and Ammonium (NH_4) on the Swartkops River near Uitenhage, and slight elevations of Fluoride (F) at a site on the Tarka River (Figure B).

In the Vaal WMA, one site on the Sandspruit River exhibited slightly elevated TDS, while slightly elevated TDS levels were observed at two sites: the Sak River and the Rooiberg Dam on the Hartbees River within the Orange WMA (Figure 4.5B).

iii. Irrigated Agriculture Use (Indicator SAR; EC; pH; and Cl)

In the Berg-Olifants WMA, there is a site where the EC concentration is slightly higher than normal (Figure 4.5 C). In the Breede-Gouritz WMA, several sites demonstrated elevated SAR (Sodium Adsorption Ratio) levels. The SAR levels varied between fair and poor at three sites. Additionally, EC and Cl concentrations were often higher than usual at various sites within the Breede-Gouritz WMA.

In the Mzimvubu-Tsitsikamma WMA, SAR levels are elevated at five sites, which could negatively impact agricultural crop yield if the water is used for irrigation. Low pH levels were also observed in several sites within the Mzimvubu-Tsitsikamma WMA. Furthermore, elevated EC and Cl concentrations were found at multiple sites.

In the Vaal WMA, three sites exhibited elevated levels of factors that adversely affect the suitability of water for irrigated agriculture. This includes a poor SAR at a location on the Sandspruit, as well as varying degrees of elevated salinity indicated by EC and chloride levels across the sites. Additionally, the pH was high at the Sandspruit site. Furthermore, within the Limpopo WMA, the site at the Biet Bridge border post showed elevated levels of EC and chloride.

iv. Domestic Use Electrical Conductivity

Figure 4.5D shows one site with high EC in the Berg-Olifants WMA, while the Breede-Gouritz WMA had three sites with elevated EC, one of which was only slightly increased, while the other two were significantly elevated. The Mzimvubu-Tsitsikamma WMA had seven sites with elevated EC, ranging from acceptable to unsuitable for direct human consumption, and the Orange WMA had two sites with slightly elevated EC (Figure 4.5D).

Figure 4.6 depicts the average EC levels over the last five years in the country. It deviates from specific water quality guideline values for various water user groups and instead provides a more detailed scale for lower EC levels and broader categories as the levels rise. The inclusion of the figure/map is intended to cover a longer period of EC data and to include more sites that may have had limited or no sampling during the current hydrological year.

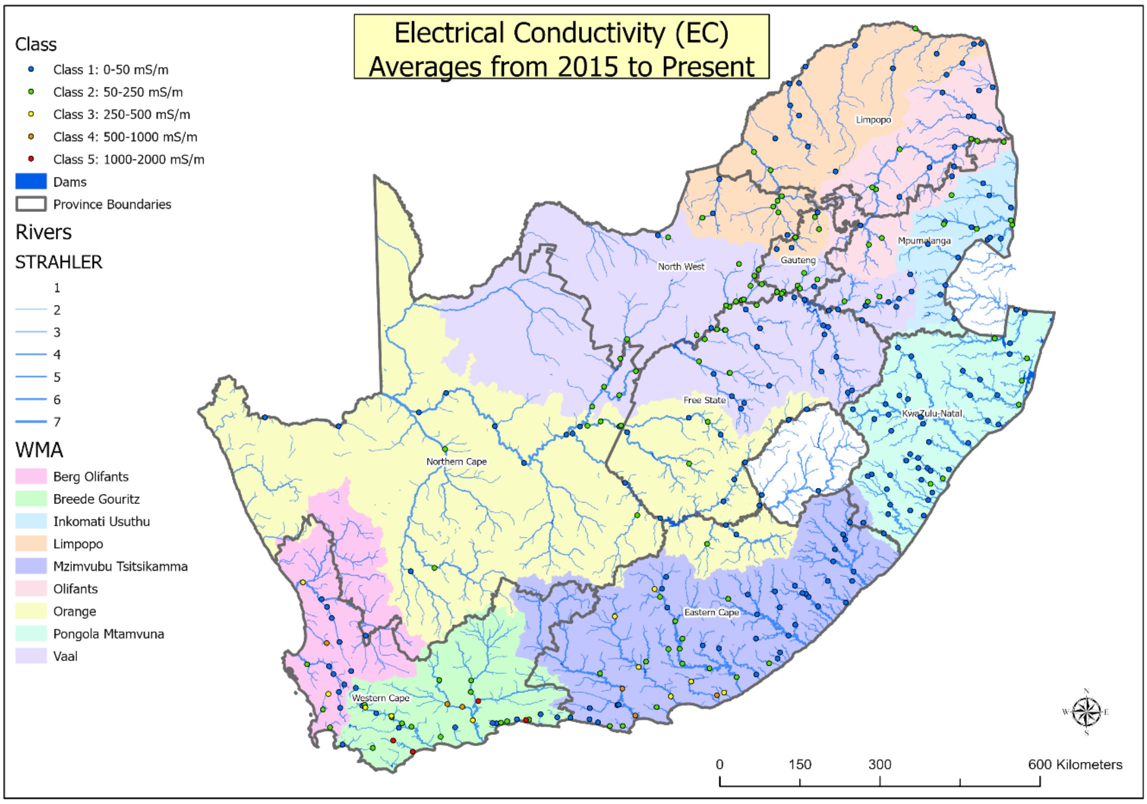


Figure 4.7:The average of the Electrical Conductivity (EC) values recorded in South Africa during the period from 2015 until the present.

Case Study: Vaal River Sulphate Levels: A Historical Overview

The persistently high sulphate (SO_4) levels in the Vaal River below Vaal Dam have long suggested the impact of mine drainage and other activities such as coal burning and the use of gypsum fertilizers, indicating pollution from industrial waste and other impacts on this section of the river. In Figure 1 below, however, it is clear that there has been a gradual reduction in sulphate levels, resulting in the successful maintenance of concentrations below the 150 mg/L management objective from 2009-2010. This achievement is largely attributed to improved catchment management and enforcement practices, which include the implementation of the Vaal River Salinity Management Programme. This program utilizes a water quality salinity model to ensure that total dissolved solids (TDS) levels remain below 600 mg/L.

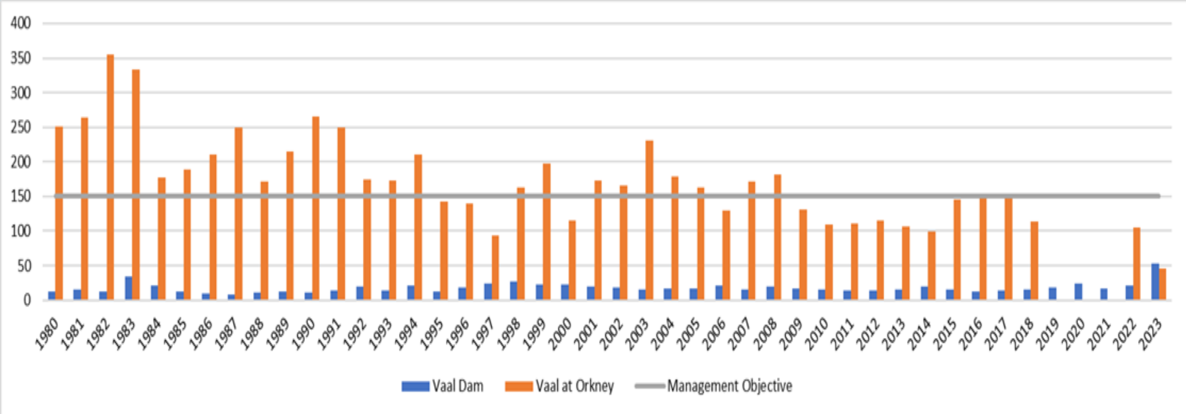


Figure 1: Vaal River Sulphate Levels Trends from 1980-2023

Case Study: National Fluoride Concentrations Overview

The impact of water fluoridation and de-fluoridation in SA is critical as these processes affects human health in both systemic and topical ways. Studies conducted on the population in SA suggest that an ideal water Fluoride level ranges from 0.54 to 0.7 mg/L (du Plessis, 1995; DWAF, 1996; SABS, 2001). However, the World Health Organization (WHO) recommends an optimal target range of 0.5 to 1 mg/L (WHO, 1994). In this specific study, the fluoride (F) levels below 0.4 mg/L were designated as the pink category, whereas those ranging from 0.5 to 1 mg/L were considered green. The yellow label was assigned to F values between 1 and greater than 1.5 mg/L, while any values equal to or above 1.5 mg/L were labelled as red (Table 1).

Table 1: Fluoride guideline used in map (Adapted from WRC, 1998)

Fluoride (mg/L)	**Drinking**		**Food preparation**	**Bathing**	**Laundry**
	Health	Aesthetic			
0.5 – 1.0 Good	Insignificant health effects	No effects	Insignificant health effects	No effects	No effects
1.0 – 1.5 Marginal	Increasing effects in sensitive groups and tooth staining	No effects	Increasing effects in sensitive groups	No effects	No effects
1.5 - 3.5 Poor	Possible health effects in all individuals, marked tooth staining; and increasing risk of health effects and severe tooth staining	No effects	Possible health effects in all individuals	No effects	No effects
≥4.0 Low	Potential fluoride deficiency in sensitive groups	No effects	Health effects in all individuals	No effects	No effects

The map (Figure 2) indicates that surface water Fluoride levels are predominantly low (i.e. 0.4 mg/L and below). However, it's important to note that the minimum Fluoride level requirements for different population groups can be influenced by various factors, therefore this is not always a concern. However, the use of fluoride containing toothpaste and a well-balanced diet is always recommended where possible. A few instances of elevated fluoride levels were discovered in the Limpopo and Eastern Cape provinces, as indicated by red dots on Figure 2. In the Limpopo province, the area with high fluoride concentrations was found in the southernmost part of the Ga-Selati River, with an average level of 3.4 mg/L. Health consequences and tooth discolouration can be expected at such high Fluoride levels (refer to Table 1). These elevated Fluoride concentrations have previously been associated with the return flows from the mining complex surrounding Phalaborwa in the Ga-Selati River (Van Veelen and Dhemba, 2011). In the Eastern Cape province, a median level of 1.5 mg/L was observed at one location in Elands River. This, however, is attributed to the natural geology and land cover at that specific point, where the area consists of forests and cultivated land at Scherp Arabie *(Hohls et al., 2001).*

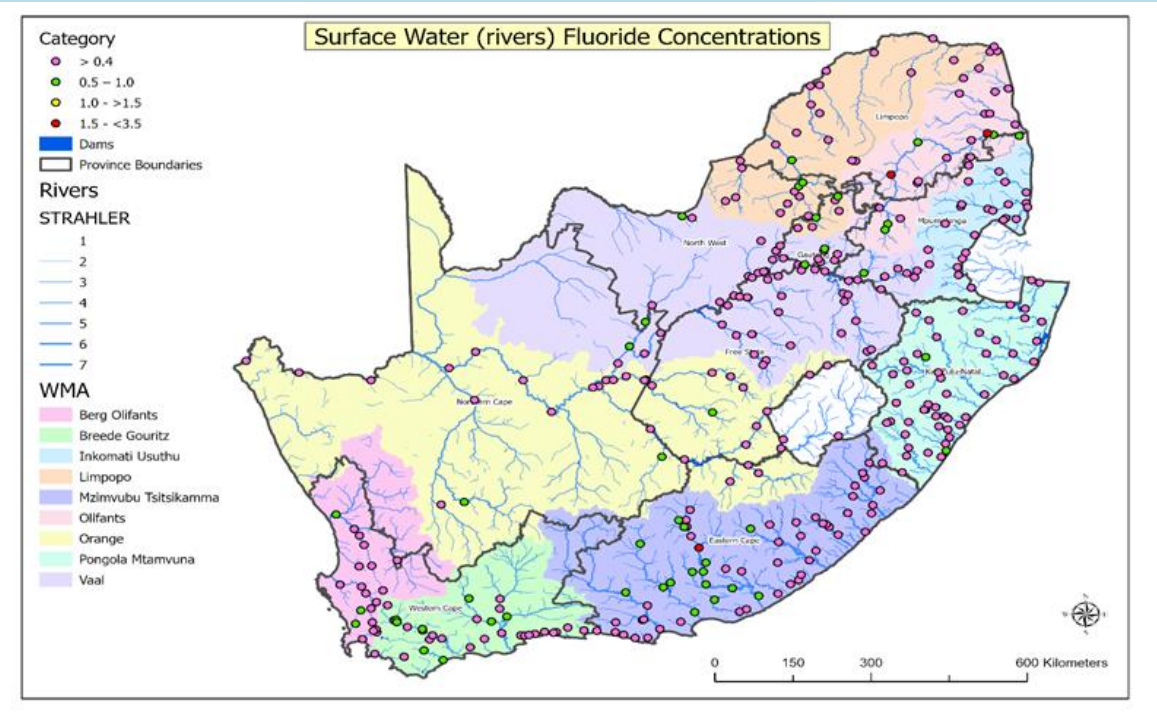


Figure 2: Map depicting median Fluoride concentrations of NCMP river sites from periods ranging from the 1970s to 2023.

4.3.2 Eutrophication

Eutrophication is the process of excessive nutrient enrichment of water that typically results in problems associated with excessive macrophyte, algal, or cyanobacterial growth. The trophic status of the water body provides a measure and description of the degree of eutrophication (nutrient enrichment) and the extent of plant growth that can be sustained. The trophic status of water resources is not only affected by nutrient concentrations but also by other factors, including abiotic, biotic, physico-chemical, and biological factors.

The four trophic status classes and colour coding used to describe trophic status are provided in Table 4-1 below, and the criterion used to assign a trophic status for the dams in South Africa is outlined in Table 4-2.

Table 4-1: Trophic status classes used for assessment of dams in South Africa

1. **Oligotrophic**	Low in nutrients and not productive in terms of aquatic and animal plant life
2. **Mesotrophic**	Intermediate levels of nutrients, productive in terms of aquatic animal and plant life and showing emerging signs of water quality problems;
3. **Eutrophic**	Rich in nutrients, very productive in terms of aquatic animal and plant life and showing increasing signs of water quality problems; and
4.**Hypertrophic**	Very high nutrient concentrations where plant growth is determined by physical factors. Water quality problems are serious and can be continuous.

Table 4-2: Criterion used to assign trophic status for the dams in South Africa

Statistic	**Unit**	**Current trophic status**			
Median annual Chl *a*	µg/L	0<x<10	10<x<20	20<x<30	>30
		Oligotrophic (low)	Mesotrophic (Moderate)	Eutrophic (significant)	Hypertrophic (serious)
% of time Chl a> 30µg/L	%	0	0<x<8	8<x<50	>50
		Negligible	Moderate	Significant	Serious
Potential for algal and plant productivity					
Median annual Total Phosphorus (TP)	mg/L	x<0.015	0.015<x<0.047	0.047<x<0.130	>0.130
		Negligible	Moderate	Significant	Serious

In the current reporting period, forty-five of the sixty-one ONEMP sites were analysed for trophic status and eutrophication potential. The trophic status assessment presented in Figure 4.7 found nine (9) dams to be hypertrophic, two (2) eutrophic, three (3) mesotrophic and twenty-four (24) were oligotrophic. Seven (7) dams did not have chlorophyll-a information and only the eutrophication potential was assigned

(Figure 4.7). The nine hypertrophic dams included Rietvlei Dam, Hartbeespoort Dam, Bon Accord Dam, Klipvoor Dam, Vaalkop Dam, Roodeplaat Dam, Modimola Dam, Bronkhorstspruit Dam and Witbank Dam**,** while the eutrophic dams included Loskop Dam and Disaneng Dam as shown in Figure 4.7. Mesotrophic sites were Rhenosterkop Dam, Middle Letaba Dam and Bloemhoek Dam.

Eutrophication potential was also calculated (based on total phosphorous (TP) concentration) as serious (13 sites), significant (11 sites), moderate (10 sites), and negligible (11 sites). The hypertrophic sites and eutrophic sites were characterised by high nutrient levels with serious potential for continued algae and plant productivity. Several sites (49) distributed across the country had high nutrient levels with significant to serious potential for algae and plant productivity (Figure 4.8).

The sites with serious eutrophication problems are mainly located in densely populated areas with over capacitated sewage treatment systems, generally increasing population growth which exceed infrastructure development such as poor sewage networks and big cities full of different industries.

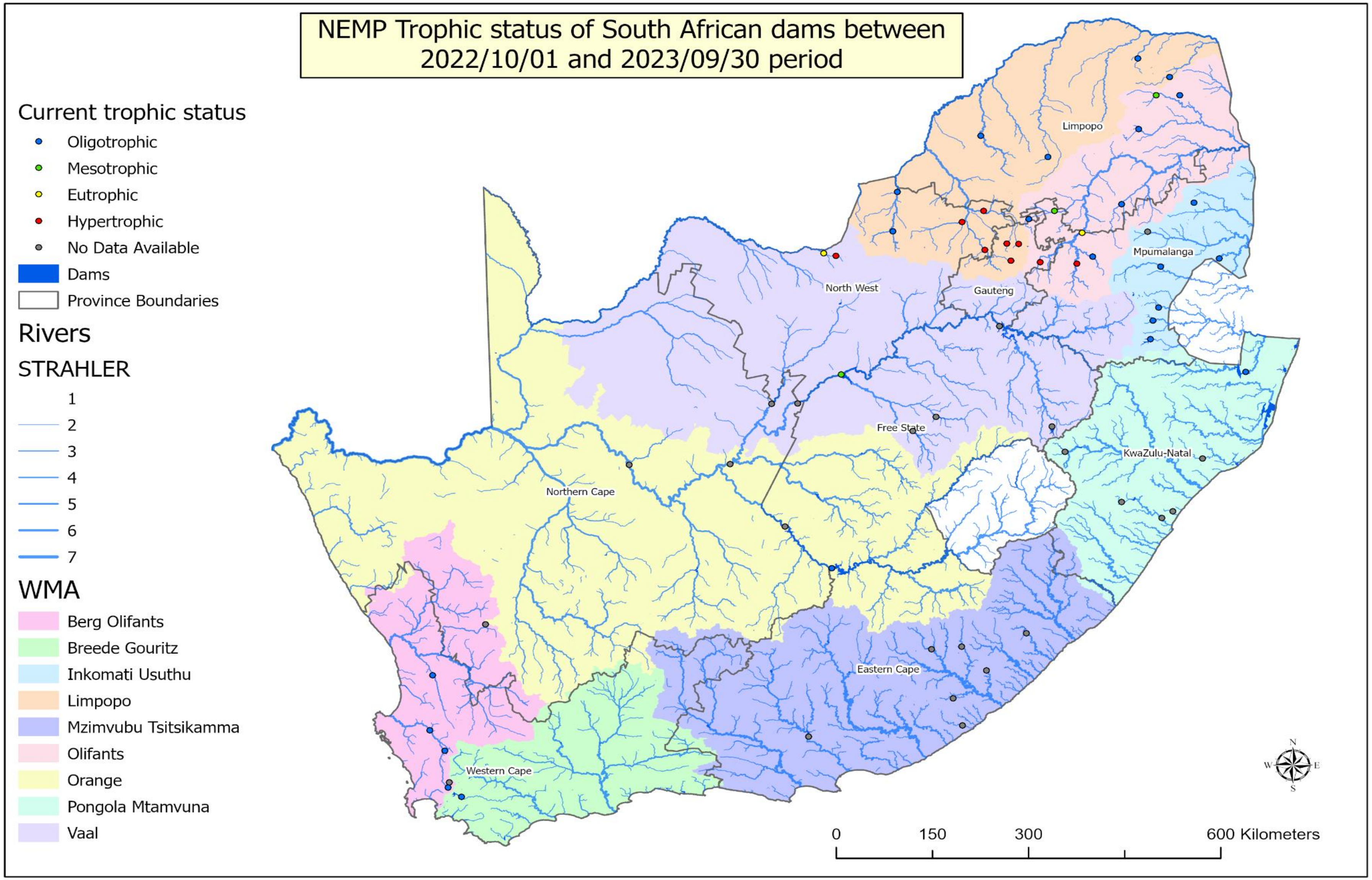


Figure 4.8: ONEMP Trophic status analysis for the sites monitored during October 2022 to September 2023 period.

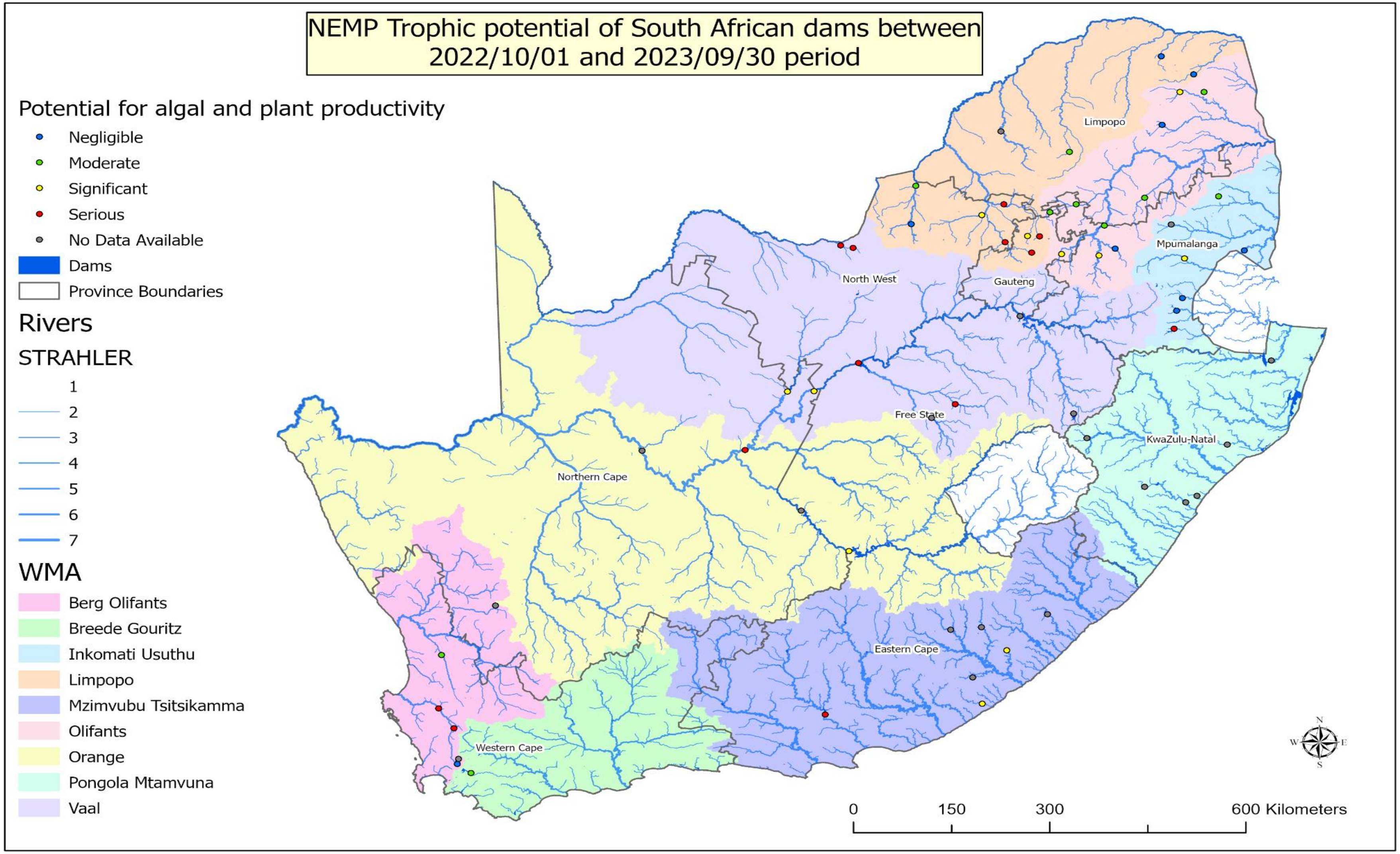
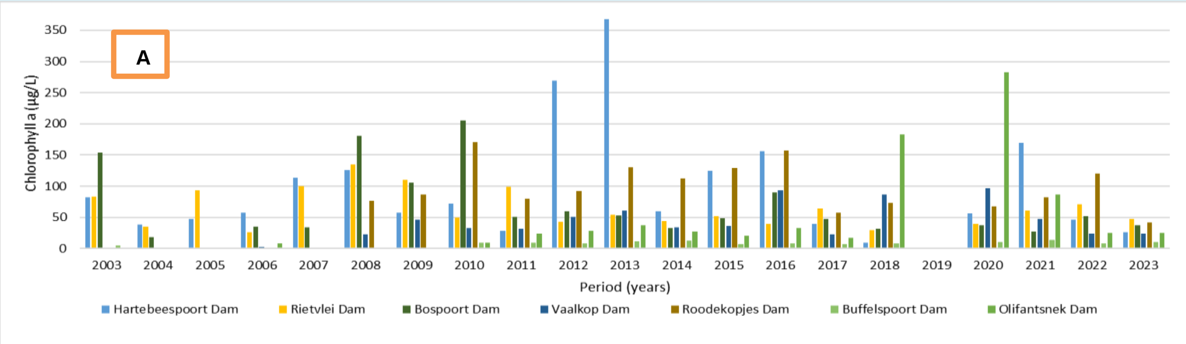


Figure 4.9: Trophic potential of the ONEMP sites for the October 2022 to September 2023 period

Case Study 1: Long-term changes in the Trophic Status of Dams in the Upper Crocodile Catchment

The trophic status of a dam is generally an indication of the level of nutrient enrichment and the resulting algal production of the particular dam. Changes in trophic status over the past two decades (2003 to 2023) for seven dams in the upper Crocodile catchment are represented in Figures 1 A and B below. The chlorophyll-*a* concentrations falling in the **eutrophic** status range were found in Olifantsnek Dam (25.5 µg/L), Vaalkop Dam (24.2 µg/L) and Hartebeespoort Dam (26.6 µg/L), while Roodekopjes Dam, Rietvlei Dam and Bospoort Dam were all found to be **hypertrophic** with mean chlorophyll-*a* values of 42.02 µg/L, 47.4 µg/L and 37.4 µg/L, respectively. Buffelspoort Dam was classified as **mesotrophic** based on its chlorophyll-*a* concentration being in the 10<x<20 range. The Total Phosphorus indicator in Bospoort Dam, Rietveli Dam, Hartbeespoort Dam and Roodekopjes Dam was in the >0.130 range, which indicates a **serious** potential for algal and plant productivity. Vaalkop Dam was in the 0.047<x<0.130 range with a mean Total Phosphorus value of 0.06 mg/L for the current year, indicating a significant potential for algal growth and plant growth, while Buffelspoort Dam and Olifantsnek Dam were found to have moderate potential for algal and plant growth.

A more comprehensive view of the two trophic status indicators for the past two decades suggests an irregular and seasonal trend in terms of the data patterns, as the fluctuations do not show constant regularity throughout the time series.



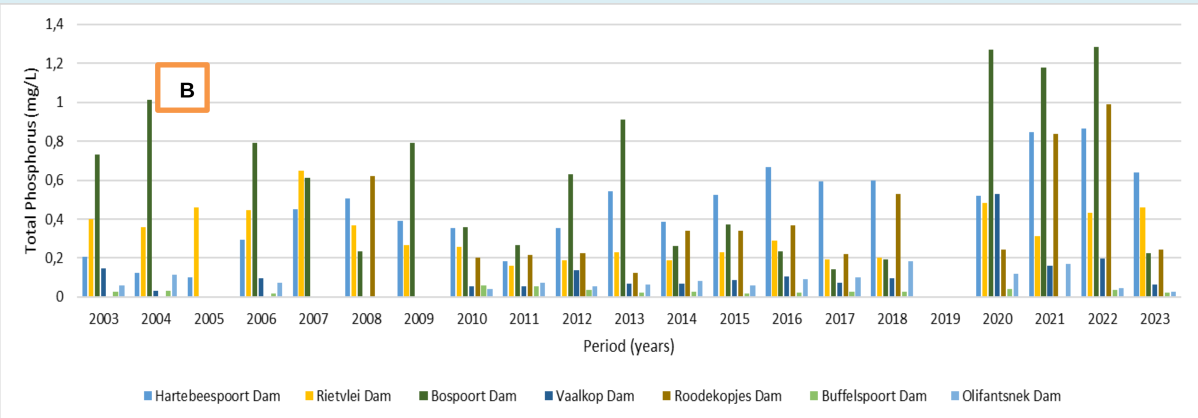


***Figure 1**. **A)** Chlorophyll-a and **B)** Total Phosphorus for the Hartbeespoort, Roodekopjes, Rietvlei, Buffelspoort, Bospoort, Olifantsnek, and Vaalkop dams.*

4.3.3 Microbial Pollution

The contamination of water resources by faecal pollutants poses significant risks to human and animal health since numerous pathogens are often associated with faeces. Microbial water quality measures the microbiological conditions of water to human health. The overall purpose of the microbial monitoring programme is to assess and manage the health risks to water users due to faecal pollution of water resources. Faecal coliforms and *E. coli* are the best indicators for the assessment of recent faecal pollution, and they also indicate the potential presence of pathogenic bacteria, viruses, and parasites. The bacteria *E. coli* results are compared to the SA water quality guidelines as indicated in Table 4-3 to analyse potential microbial health risks.

Table 4-3 : Guidelines for assessing the potential health risk of using raw water for four water uses

	Potential health risks of using raw water		
	Low	**Medium**	**High**
Water use	***E. coli* counts/ 100mL**		
1. Drinking untreated water	0	1 - 10	> 10
2. Drinking partially 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

*Partially treated water is water that has undergone some form of treatment at the household level to remove or reduce contaminants but does not meet the standards for safe drinking water.

The microbial quality of water for the current reporting period is determined based on the sampling of 43 hotspot sites in the country. Microbiological data collected from October 2022 to September 2023 (Figure 4.9) suggests that water at all 43 newly selected sites is unsuitable for drinking without treatment, as they all exhibit a high risk if consumed directly from the source. Treating water at the household level through methods such as boiling, filtration, or chlorination can help mitigate the potential health risks. However, 35% of the sampled sites still demonstrated a high risk associated with using the water even after undergoing limited treatment.

Furthermore, the findings indicated that 41% of the sites were unsuitable for irrigating crops intended for raw consumption, and 67% of the sampled sites were deemed unsuitable for recreational activities, posing a high risk of infection for individuals engaging in such activities. These recreational activities include full-contact activities such as swimming, washing laundry, and events like baptisms.

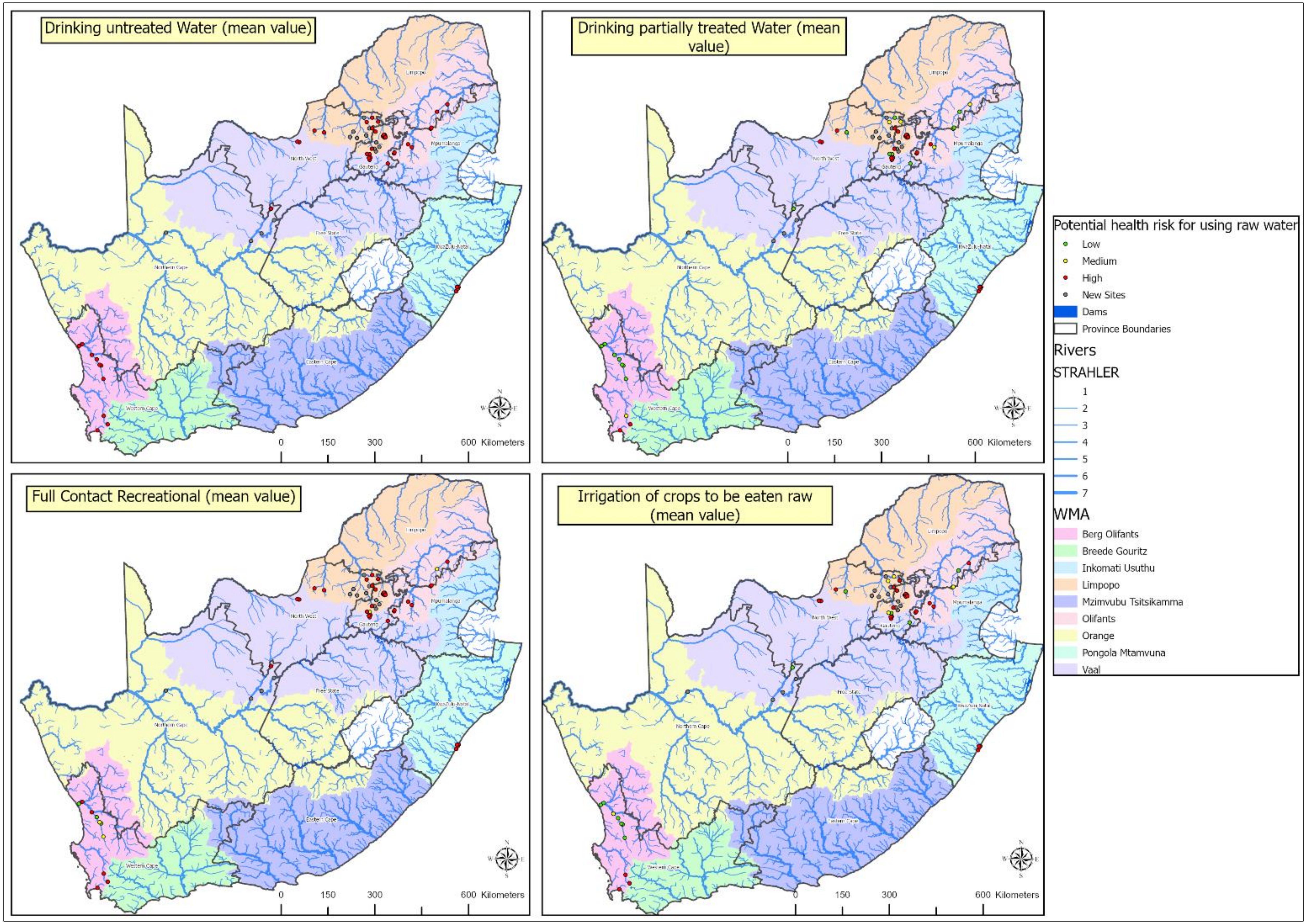


Figure 4.10 : Data representation of faecal pollution (October 2022 - September 2023)

4.3.4 Ecological Status

The riverine macroinvertebrates were assessed at 455 sites during the 2021/22 hydrological year using the Macroinvertebrate Response Assessment Index Version 2 (MIRAI v2). Some sites used other indices in addition to the MIRAI. The Riparian Vegetation Response Assessment Index (VEGRAI) was done at 212 sites, fish indices at 165 sites, the Index of Habitat Integrity (IHI) at 118 sites, and the Geomorphology Driver Assessment Index (GAI) at 46 sites. The Guidelines for interpreting River EcoStatus results are provided in Table 4-4, and the 2021/22 results are shown in Figure 4.11

Table 4-4: Generic guidelines for interpreting change in ecological categories (modified from Kleynhans 1996 & Kleynhans 1999).

ECOLOGICAL CATEGORY	GENERIC DESCRIPTION OF ECOLOGICAL CONDITIONS	GUIDELINE SCORE (% OF MAXIMUM THEORETICAL TOTAL)
A	Unmodified/natural. Close to natural or close to predevelopment conditions within the natural variability of the system drivers: hydrology, physico-chemical and geomorphology. The habitat template and biological components can be considered close to natural or to pre-development conditions. The resilience of the system has not been compromised.	>92 - 100
A/B	The system and its components are in a close to natural condition most of the time. Conditions may rarely and temporarily decrease below the upper boundary of a B category.	>88 - ≤92
B	Largely natural with few modifications. A small change in the attributes of natural habitats and biota may have taken place in terms of frequencies of occurrence and abundance. Ecosystem functions and resilience are essentially unchanged.	>82 - ≤88
B/C	Close to largely natural most of the time. Conditions may rarely and temporarily decrease below the upper boundary of a C category.	>78 - ≤82
C	Moderately modified. Loss and change of natural habitat and biota have occurred in terms of frequencies of occurrence and abundance. Basic ecosystem functions are still predominantly unchanged. The resilience of the system to recover from human impacts has not been lost and it is ability to recover to a moderately modified condition following disturbance has been maintained.	>62 - ≤78
C/D	The system is in a close to moderately modified condition most of the time. Conditions may rarely and temporarily decrease below the upper boundary of a D category.	>58 - ≤62
D	Largely modified. A large change or loss of natural habitat, biota and basic ecosystem functions have occurred. The resilience of the system to sustain this category has not been compromised and the ability to deliver Ecosystem Services has been maintained.	>42 -≤58
D/E	The system is in a close to largely modified condition most of the time. Conditions may rarely and temporarily decrease below the upper boundary of an E category. The resilience of the system is often under severe stress and may be lost permanently if adverse impacts continue.	>38 - ≤42
E	Seriously modified. The change in the natural habitat template, biota and basic ecosystem functions are extensive. Only resilient biota may survive and it is highly likely that invasive and problem (pest) species may dominate. The resilience of the system is severely compromised as is the capacity to provide Ecosystem Services. However, geomorphological conditions are largely intact but extensive restoration may be required to improve the system's hydrology and physico-chemical conditions.	20 - ≤38
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete change of the natural habitat template, biota and basic ecosystem functions. Ecosystem Services have largely been lost This is likely to include severe catchment changes as well as hydrological, physico-chemical and geomorphological changes. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. Restoration of the system to a synthetic but sustainable condition acceptable for human purposes and to limit downstream impacts is the only option.	<20

Figure 4.11 depicts the distribution and condition of macroinvertebrates monitored at various sites. The majority (272) of the country's sites, or approximately 60%, were moderately modified (C). Most river systems had moderately modified conditions as their dominant condition. The upper portions of the Crocodile West catchment are located in Gauteng's industrial and urban areas and thus are heavily impacted. The Jukskei River, Modderfonteinspruit Riverand Crocodile Rivers upstream of Hartbeespoort Dam, Hartbeesspruit just upstream of Roodeplaat Dam, the Apies and Hennops Rivers were all in very poor condition (D/E and E).

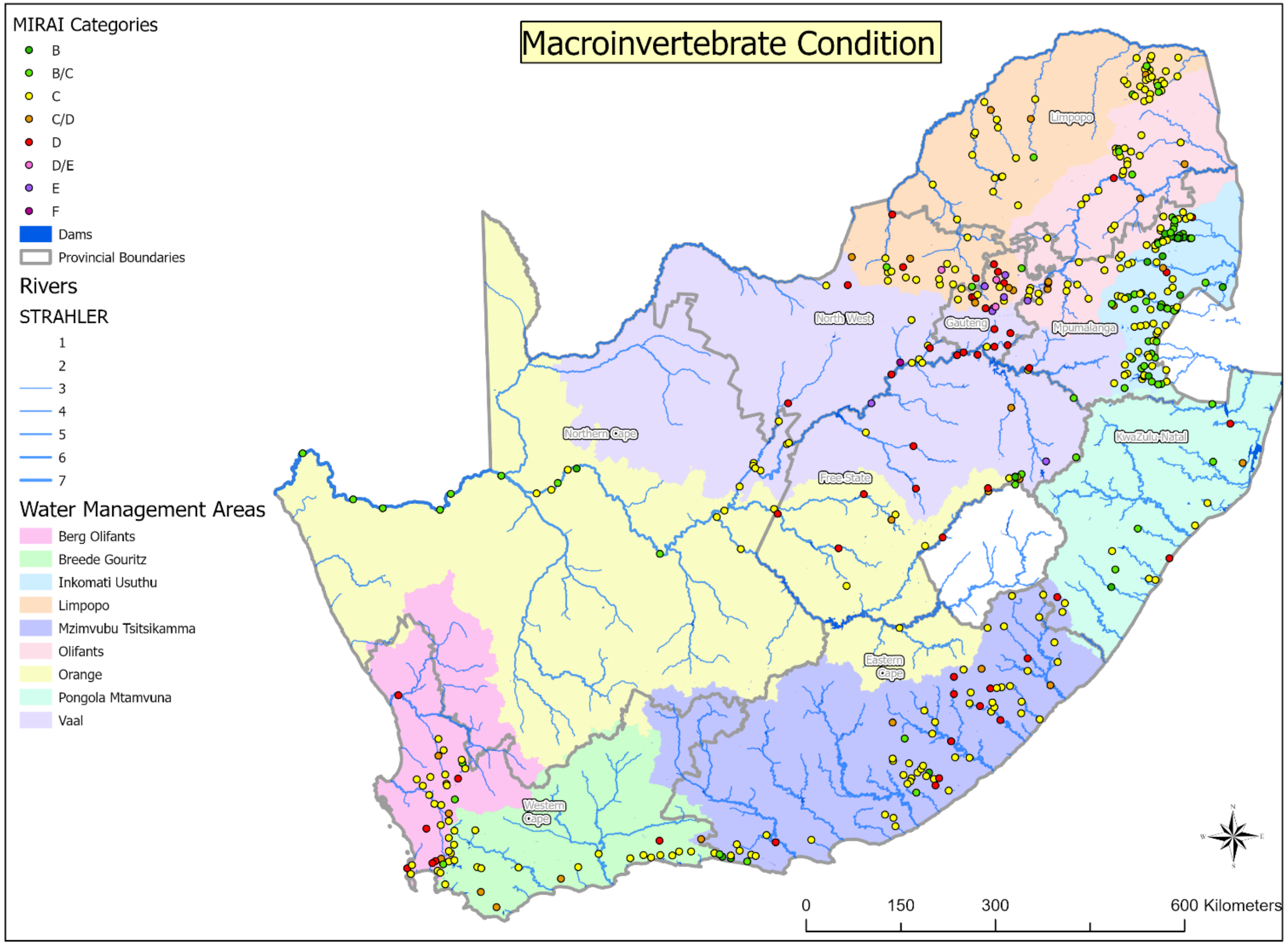


Figure 4.11: Summary of Ecological Categories reflecting the macroinvertebrate condition for selected sites monitored during 2021-2022 hydrological year. The colour of the circles indicates the Ecological Condition with green representing relatively good conditions (B and B/C) while the red and purple reflect relatively poor condition.

Figure 4.12 shows that the Sabie (20 sites), Komati (14 sites), and Usuthu (13 sites) catchments had a high proportion of sites in largely or nearly largely natural conditions (B and B/C categories). The remaining largely natural sites were either in the upper reaches closer to the source 4 (Magalies, Debengeni, Berg, and Breede-Gouritz sites), protected areas (Eerste, Klerkspruit, Perskeboomspruit, Glen Reenenspruit, Ribbokspruit), or rural areas (the former Transkei, Mkomazi, Mhlatuze, and Pongola catchments).

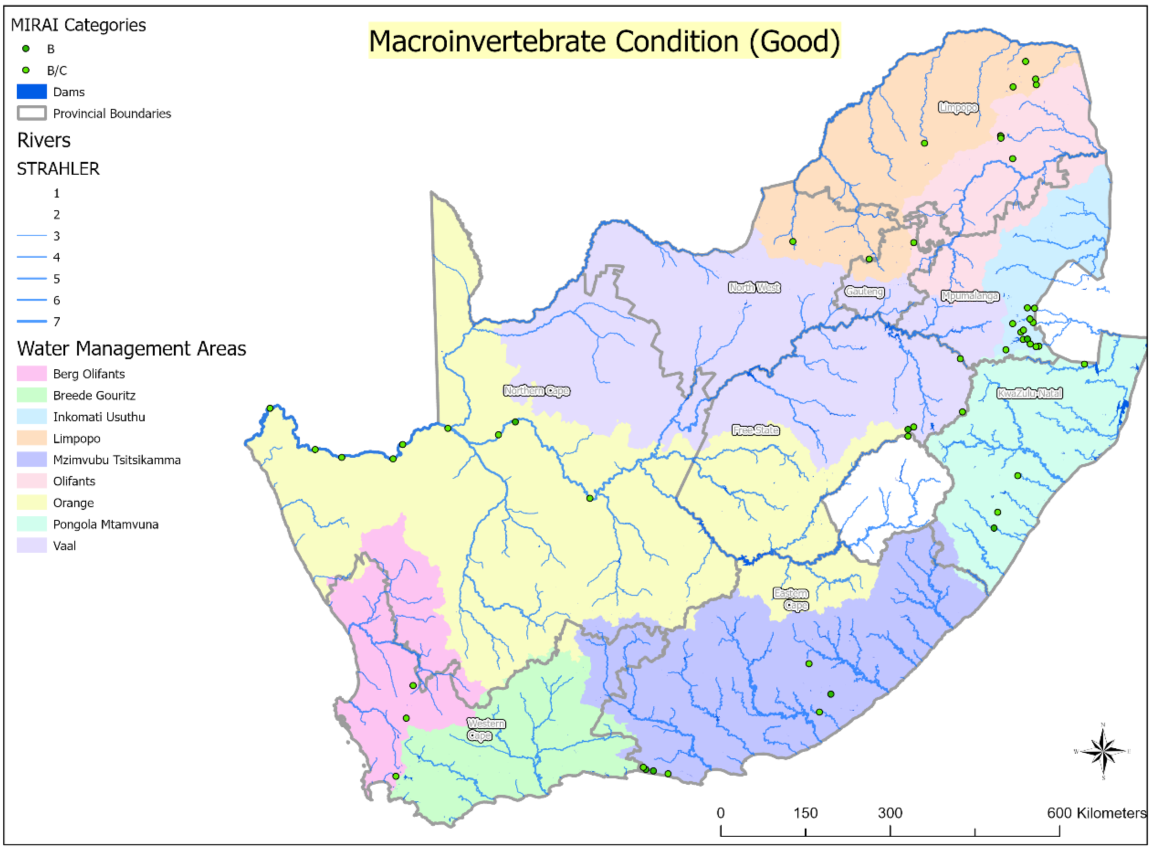


Figure 4.12: Monitored sites with good ecological condition.

The majority (85%) of the sites monitored in the 2021/22 hydrological year were also monitored in the previous years. The river condition trends depicted in Figure 4.12 show that approximately 57% of sites remained in the same category as the previous reporting period; most of these were sites in the C category. Sites in moderately modified condition (C category) seem to be resilient and not easily responsive to changes, maintaining basic ecosystem functions, provided the catchments around them are not subjected to severe disturbances. There was an improvement at 27% of the sites and a decline in ecological condition at 16%.

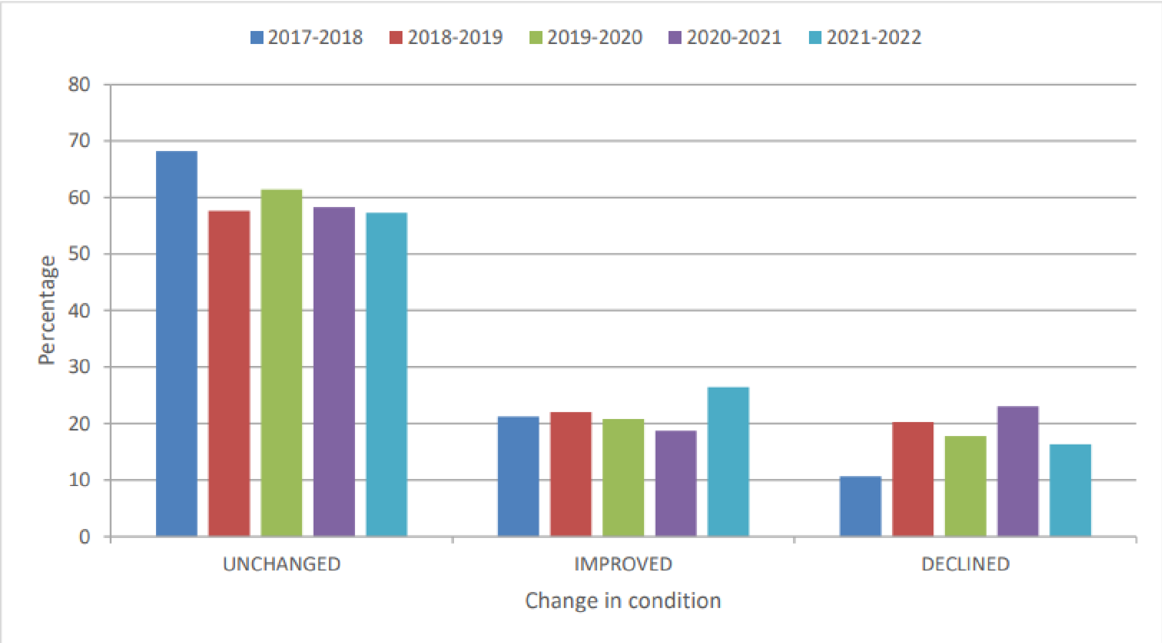


Figure 4.13: Trends of ecological condition at monitored sites

5

SURFACE WATER STORAGE

5 SURFACE WATER STORAGE

5.1 National Storage

The surface water storage volume is expressed as a percentage of a combined volume: full supply capacity (FSC) of 221 dams being monitored nationally. The national dam levels for the past five hydrological years are presented in Figure 5.1 below.

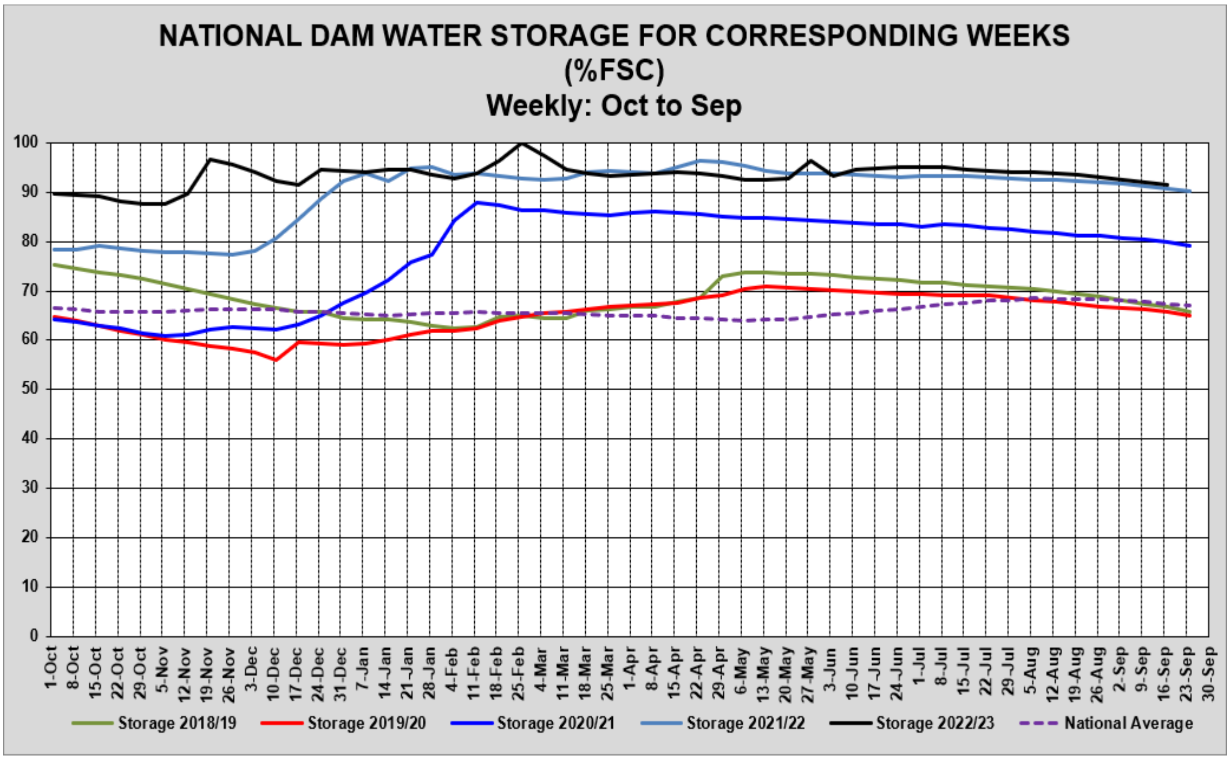


Figure 5.1 National Dam storage levels for the past five years compared to a national average.

The national dam storage levels for the 2021/22 and 2022/23 hydrological years, were the highest for most of the months in the past five hydrological years, especially after the beginning of summer rainfalls received between November and February 2023 for the eastern parts of the country.

Given in Table 5-1 is the classification of surface storage levels for Provinces ranging from critical storage levels, closer to dead storage of the dams (<10% of FSC); at risk of non-supply (>10% - <50% of FSC); optimal water levels for supply operations (>50% -<100%); and >100% of FSC (Full or spilling dams).

At the end of the hydrological year (September 2023), **1%** of the dams were at critical storage levels, **4%** were at risk storage levels, and **29%** were either spilling or at optimal storage levels.

Table 5-1 Surface storage at the end of September 2023

Provinces/ Countries sharing Water Resources with RSA	FSC million m^3	Total	Number of Dams per Province/Country <10%	>=10%<50%	>=50%<100%	>=100%
Kingdom of Eswatini	333.75	1			1	
Eastern Cape	1729.39	46	1	4	28	13
Free State	15656.69	21			20	1
Gauteng	128.08	5			2	3
KwaZulu-Natal	4909.66	19		1	18	
Kingdom of Lesotho	2362.63	2			2	
Limpopo	1480.06	28	1		21	6
Mpumalanga	2538.57	22			20	2
Northern Cape	146.32	5			2	3
North West	867.29	28			21	7
Western Cape - Other Rainfall	271.35	22		3	8	11
Western Cape - Winter Rainfall	1596.80	22			5	17
Western Cape - Total	1868.15	44		3	13	28
Grand Total:	**32020.59**	**221**	**2**	**8**	**148**	**63**

The dams that were at critical storage conditions at the end of the reporting period were each from Eastern Cape, and Limpopo. The list of dams at critical low storage levels (<10% of FSC) is given in Table 5-2. Most dams still full or spilling at the end of the reporting period were in Eastern Cape (21%), Limpopo (10%), North West (11%), and Western Cape (44%).

Table 5-2 Dams below 10% of FSC September 2023

Reservoir	River	Province	25 September 2023 (% FSC)
Middle-Letaba Dam	Middle-Letaba River	Limpopo	3.9
Nuwejaars Dam	Nuwejaarspruit River	Eastern Cape	4.6

The dam storage levels classifications depicted with four colour codes integrated with the water supply systems areas are presented in Figure 5.2. Dam levels were between 50 to 100% of FSC for most water supply systems, spilling dams were observed in the Crocodile West, IVRS; Crocodile/Komati, Amathole, Algoa and the Western Cape. However, at the end of the hydrological year, dams with storage levels below 50% of FSC could still be observed in the Umngeni and Algoa in the Eastern Cape.

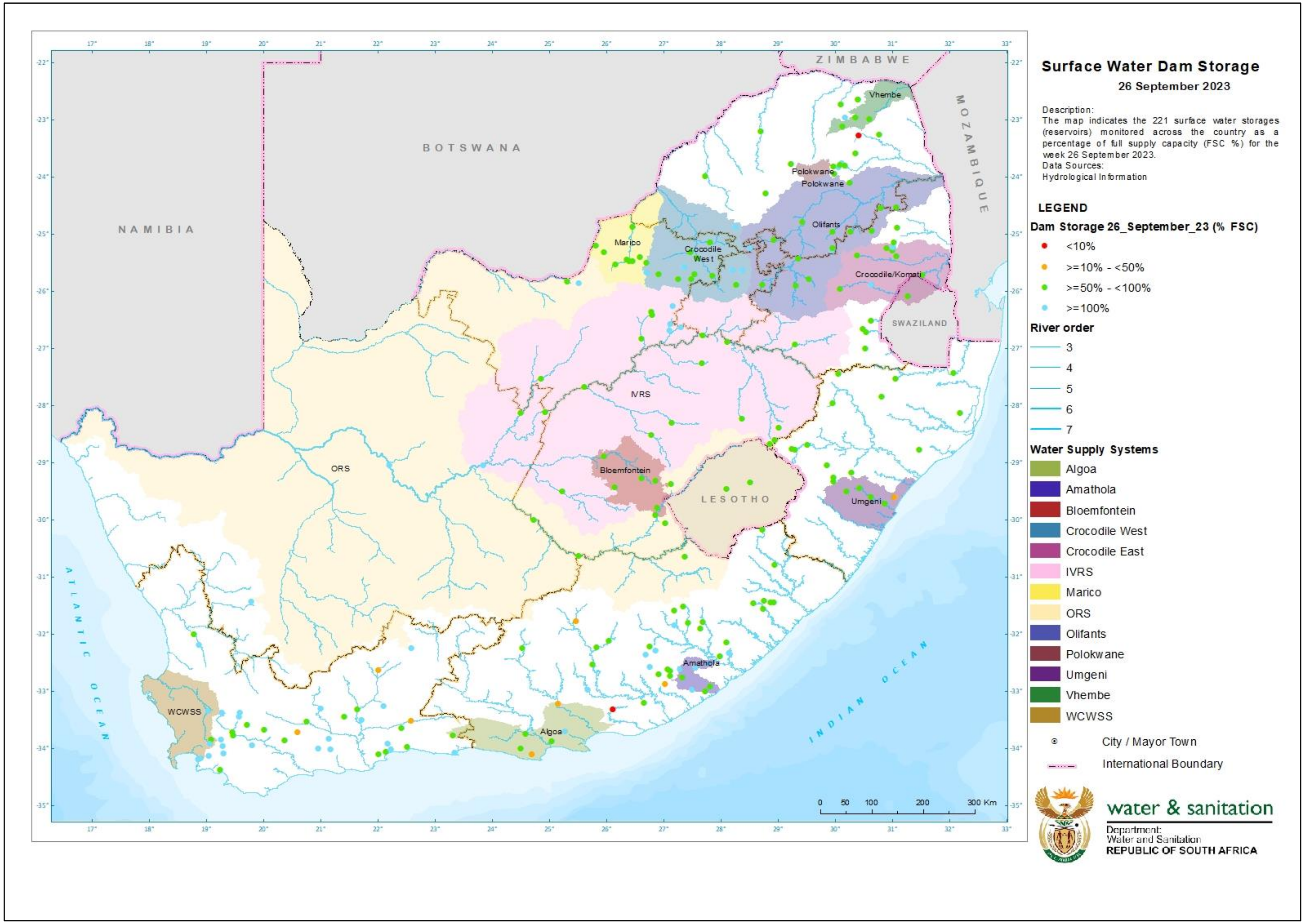


Figure 5.2 Water Supply System and dam storage – end September 2023.

5.2 Provincial Storage

The comparison of the long-term median storage for each province during the 2022/23 hydrological year, compared with the previous hydrological year is presented in Figure 5.3 below.

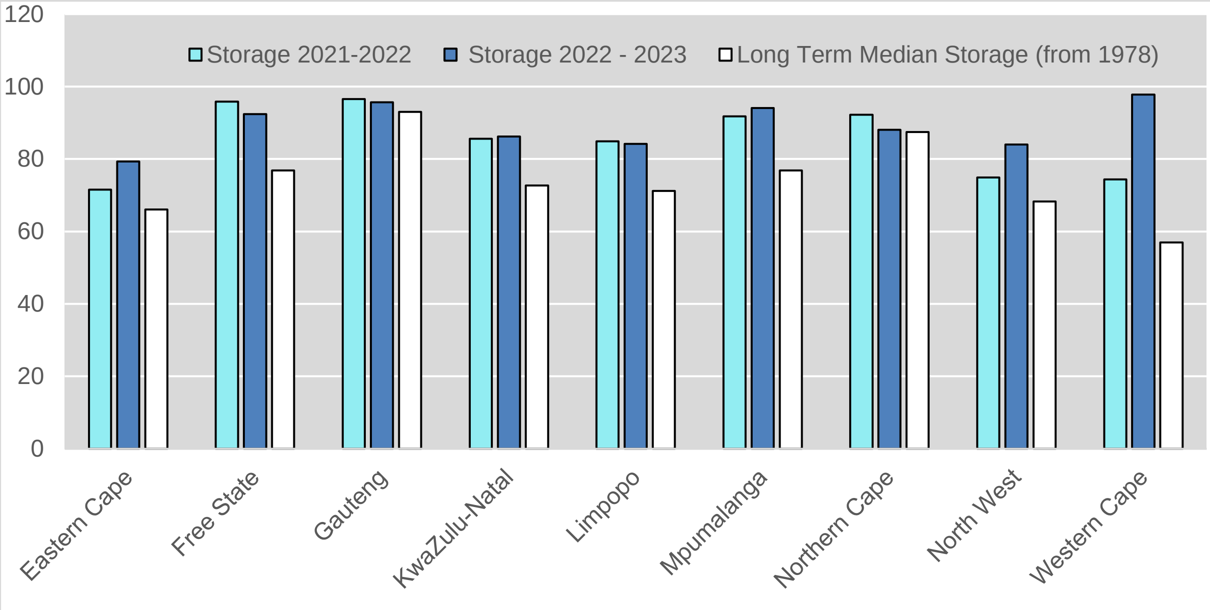


Figure 5.3 The storage situation in each Province during 2022/2023, compared with the previous hydrological year and the median.

For the hydrological year 2022/23, the dam levels for all provinces were above the long-term median storage levels. Notably, all median storages for the 2022/23 hydrological year were higher than the previous hydrological year. A significant recovery from last year is observed for the Western Cape Province, due to high rainfalls received in June 2023.

5.3 Water Management Area storage

The comparison of the long-term historical median storage levels (2016-2022) of WMAs and the past two hydrological years' median storage is presented in Figure 5.4.

The 2022/23 storages have been above the historical median for all water management areas, which is indicative of a hydrological year which was characterised by above-normal rainfall for almost all parts of the country with major dams. A similar pattern was observed for the previous hydrological year (2021/22) for all WMAs.

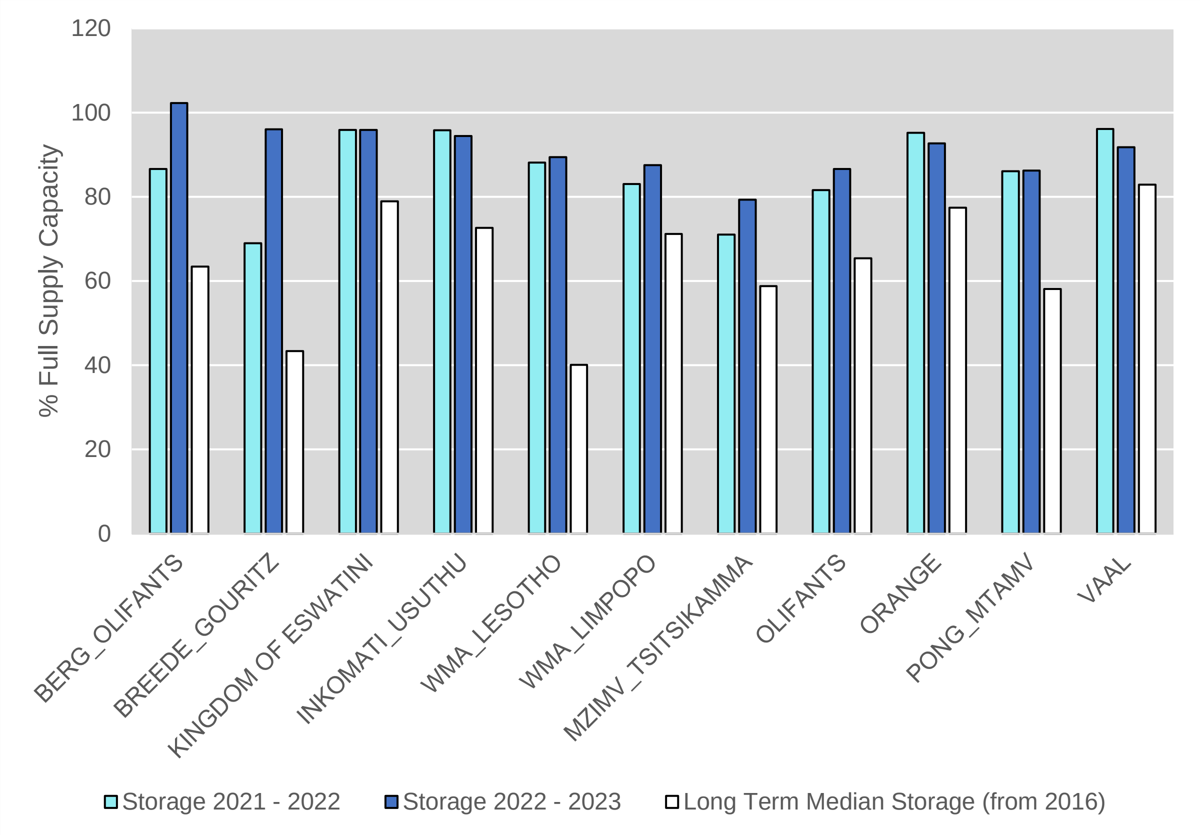


Figure 5.4 The storage situation in each WMA during 2022/23, compared with the previous hydrological year and the median.

Notably, all median storages for the 2022/23 hydrological year are higher than the previous year for all WMAs, apart from the Inkomati-Usuthu, Orange and Vaal WMAs. However, the dam storage levels in these three WMAs remained higher than the long-term median dam levels.

5.4 District Municipality Storage

The dam storage levels comparison per District Municipality (DM) is presented in Figure . Namakwa DM, Sarah Baartman DM, Central Karoo DM, Garden Route DM, and Overberg DM have experienced a significant increase compared to last year. In contrast, the uMgungundlovu DM, Zululand DM, Sedibeng DM, Alfred Nzo DM, Amajuba DM, Fezile Dabi DM, Capricon DM, Pixley ka Seme DM and Francis Baard DM experienced the worst decline in dam levels compared to last hydrological year.

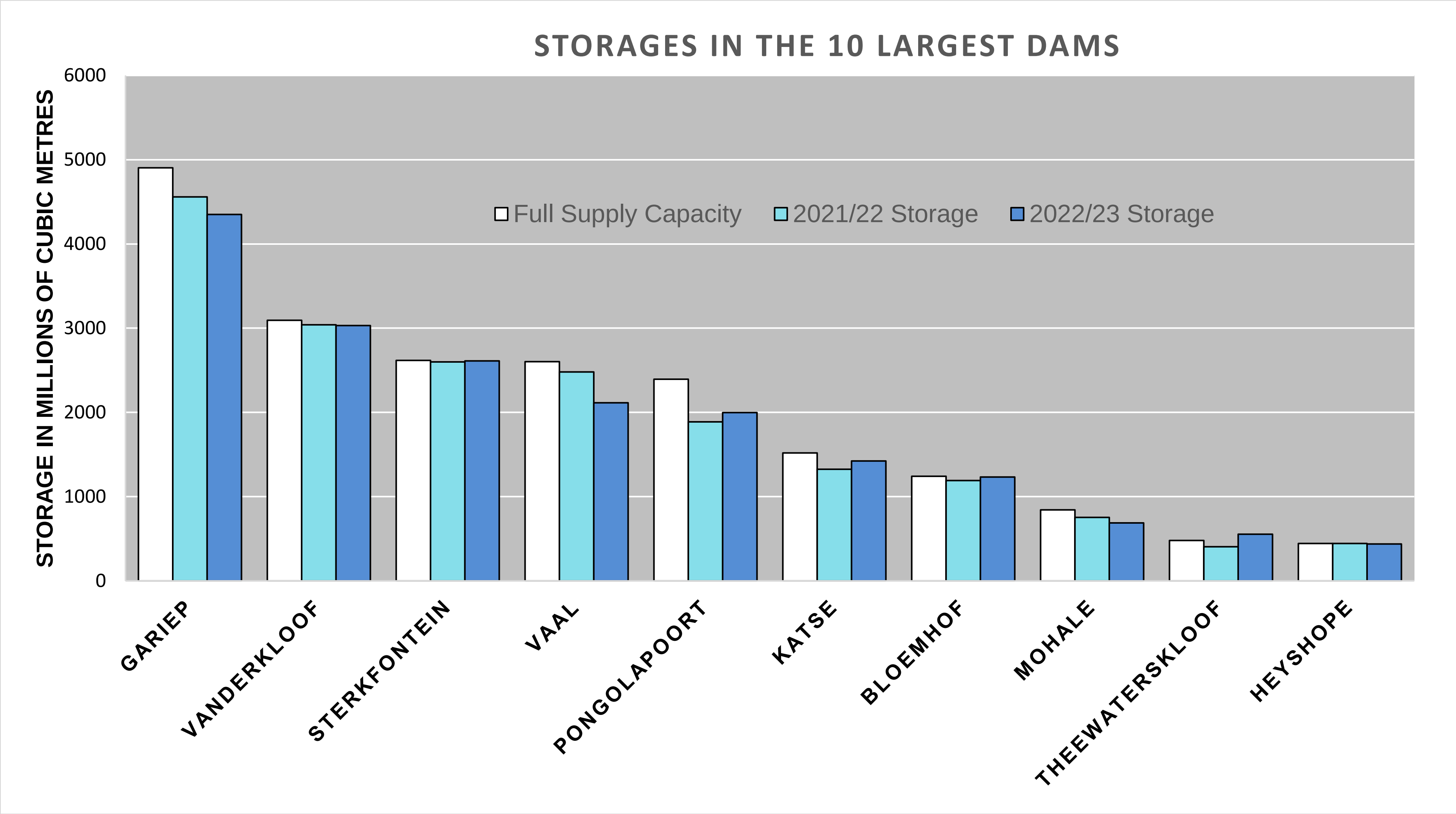


Figure 5.5: Storage volume comparison 2021/22 & 2022/23 of the ten largest dams, as at the end of September 2023.

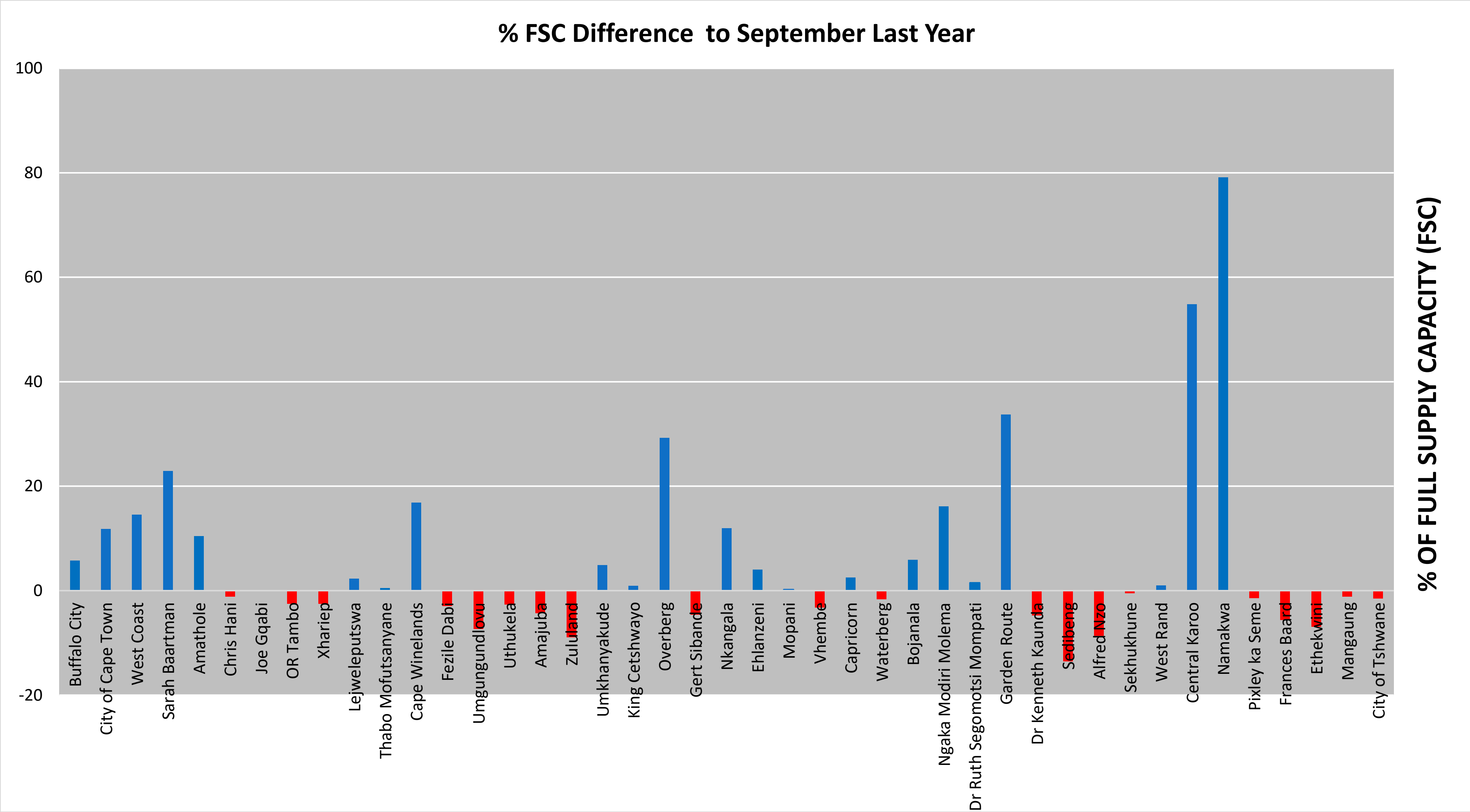


Figure 5.6 Difference in Water Storage Levels per District Municipality September 2022 vs September 2023.

5.5 Water Supply Systems and Restrictions

The dam storage levels in water supply systems (WSSs) at the end of the HY 2021/22 and 2022/23 are presented in Table 5-3, and the applicable restrictions are given in Table 5-4.

Some parts of the country are still experiencing dry conditions, for example, the southern parts of the Eastern Cape, parts of the Northern Cape, and the southwestern parts of the Western Cape Province. The Department implements water use restrictions in these areas that are experiencing dry conditions, which affect dam storage levels in stand-alone dams or dams within a WSS or cluster to avoid the risk of failure of water supply or non-supply to the various water use sectors, including users with a high assurance of water supply such as strategic users in the power generation industries.

The Algoa WSS remain with water restrictions in response to the low water storage levels. Notably, restrictions have been lifted for the Amathole WSS as the system recovered. Due to infrastructure limitations, permanent restrictions are still applicable for the Polokwane WSS in Limpopo and Bloemfontein WSS in the Free State Province.

Table 5-3 Water Supply Systems storage levels

Water Supply Systems/clusters	Capacity in $10^6 m^3$	25 September 2022 (% FSC)	25 September 2023 (% FSC)	System Description
Algoa System	282	19	49.8	The following 5 dams serve the Nelson Mandela Bay Metro, Sarah Baartman (SB) DM, Kouga LM and Gamtoos Irrigation: Kromrivier Dam, Impofu Dam, Kouga Dam, Loerie Dam, Groendal Dam
Amathole System	241	84.2	99.7	The following 6 dams serve Bisho & Buffalo City, East London: Laing Dam, Rooikrans Dam, Bridle Drift Dam, Nahoon Dam, Gubu Dam, Wriggleswade Dam
Klipplaat System	57	100.6	100.7	The following 3 dams serve Queenstown (Chris Hani DM, Enoch Ngijima LM): Boesmanskrantz Dam, Waterdown Dam, Oxkraal Dam
Luvuvhu	225	100.6	97.7	The following 3 dams serve Thohoyandou etc: Albasini Dam, Vondo Dam, Nandoni Dam
Bloemfontein	219	100.1	95.5	The following 4 dams serve Bloemfontein, Botshabelo and Thaba Nchu: Rustfontein Dam, Groothoek Dam, Welbedacht Dam, Knellpoort Dam
Butterworth System	14	100.2	100.2	Xilinxa Dam and Gcuwa weirs serve Butterworth
Integrated Vaal River System	10 546	94.6	91.6	The following 14 dams serve Gauteng, Sasol, and ESKOM: Vaal Dam, Grootdraai Dam, Sterkfontein Dam, Bloemhof Dam, Katse Dam, Mohale Dam, Woodstock Dam, Zaaihoek Dam, Jericho Dam, Westoe Dam, Morgenstond Dam, Heyshope Dam, Nooitgedacht Dam, Vygeboom Dam
Polokwane	254.27	97.5	96.8	The following 2 dams serve Polokwane: Flag Boshielo Dam, Ebenezer Dam
Crocodile West	444	91.4	94.5	The Following 7 dams serve Tshwane up to Rustenburg: Hartbeespoort Dam, Rietvlei Dam, Bospoort Dam, Roodeplaat Dam, Klipvoor Dam, Vaalkop Dam, Roodekopjes Dam
uMgeni System	923	95.3	87.5	The following 5 dams serve Ethekwini, iLembe & Msunduzi: Midmar Dam, Nagle Dam, Albert Falls Dam, Inanda Dam, Spring Grove Dam
Cape Town System	889	85.3	109.4	The following 6 dams serve the City of Cape Town: Voelvlei Dam, Wemmershoek Dam, Berg River Dam, Steenbras-Lower

Water Supply Systems/clusters	Capacity in 10^6m^3	25 September 2022 (% FSC)	25 September 2023 (% FSC)	System Description
				Dam, Steenbras-Upper Dam, Theewaterskloof Dam
Crocodile East	159	93.8	92.6	Kwena Dam supplies Nelspruit, KaNyamazane, Matsulu, Malelane and Komatipoort areas and Surroundings
Orange	7 996	94.8	92.3	The Following two dams service parts of the Free State, Northern and Eastern Cape Provinces: Gariep Dam, Vanderkloof Dam
uMhlathuze	301	97.8	98.7	Goedertrouw Dam supplies Richards Bay, Empangeni Towns, small towns, surrounding rural areas, industries and irrigators, supported by lakes and transfer from Thukela River

Table 5-4 Water Supply Systems with Restrictions

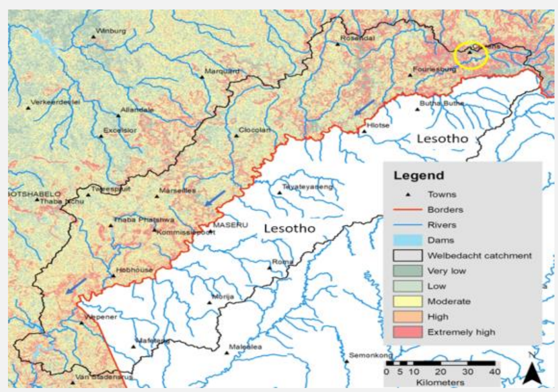
Water Supply Systems/clusters	Restrictions
Algoa	The decision date was changed from 1 June to 1 November, therefore new AOA were conducted, and water restrictions imposed as from 1 November 2023, Urban (Domestic and Industrial) = 5%, Irrigation = 15% for Kouga Subsystem and Urban (Domestic and Industrial) = 40%, Irrigation = 50% for the Kromme Subsystem, these are yet to be gazetted.
Bloemfontein	A 15% restriction has been recommended on Domestic and Industrial water supply when the system drops below 95%, notice yet to be gazetted.
Polokwane	20% restrictions on Domestic and Industries

Navigating Climate Challenges: A Case Study on Welbedacht Dam Catchment Climate Adaptation through Siltation Management

The highly erodible catchment of the Welbedacht Dam on the highveld is situated on the Caledon River near Wepener in the Free State in quaternary D23J (De Villiers & Basson, 2007). Welbedacht dam has long been a vital water source for both agricultural and urban communities, sustaining the backbone of the country's economy through mining and industrial activities (Hirji, 2002). For the quaternary catchment that Clarens falls in, the climate is largely dry sub-humid with a high erodibility index. The land cover is largely grassland (81%) followed by cultivation (7%) (Nhlabathi N et al., 2023). However, the region's susceptibility to siltation is exacerbated by climate change impacts (Le Roux, 2014), prompting a comprehensive climate adaptation strategy centred around sustainable siltation management practices to be implemented.

To tackle the problem, the Department of Water and Sanitation (DWS), through the Water Research Commission (WRC), initiated a programme targeting the source and impact of the issue. The National Dam Siltation Management Programme, implemented by the Water Research Commission, has developed a draft dam siltation management strategy to manage national water resources more sustainably. This strategy enables effective decision-making in addressing siltation challenges. The approach is systematic and focuses on integrated dam catchment prioritisation. The systematic approach looks at interventions in the catchment and river to reduce soil erosion and its transfer, as well as in the reservoir, which could involve releasing, bypassing, or extracting sediment. The integrated approach includes both engineering and socio-ecological interventions that target the sediment source, sediment transfer, and sink zones. The strategy promotes the implementation of appropriate sustainable land management principles and ecosystem rehabilitation interventions at the source, transfer, and sink zones to reduce erosion and sediment transfer in the catchment and implement adaptive interventions in the reservoir.

The Caledon River drains the catchment area that is mostly situated on the Highveld of South Africa and the Western Maluti Mountains in Lesotho. The soils in this catchment area are highly susceptible to erosion, and due to prolonged grazing and agriculture, the vegetation cover in significant parts of the catchment has greatly deteriorated and changed. This can be seen in a map below, where the project site is. clearly indicated with a yellow circle. The primary objective of the project was to implement siltation management practices to mitigate the impacts of high sediment concentrations that have impacted the water capacity. The secondary objectives were to reduce sediment yield, improve the resilience of ecosystems to climate change, enhance vegetation cover, and implement practical interventions to stabilize and monitor the riverbanks.



Water erosion risk for the Welbedacht Dam catchment

Soil degradation near a wetland

Based on site observations and spatial mapping, it has been identified that certain areas within the Clarens project site are experiencing overgrazing and have poor or low vegetation cover, resulting in degraded wetlands and actively eroding gullies. Additionally, invasive alien vegetation is outcompeting grasses on hillslopes and riparian reaches, leaving the soil bare.

The methodology used involved conducting a needs analysis for the catchment and the community, stakeholders & community engagement, ecosystem services mapping with the community, using aerial imagery, making on-site observations, capacity building and knowledge sharing workshops, implementing interventions, and monitoring activities. A spatial plan was developed to indicate where activities and interventions would be implemented, taking into consideration the rainy season.

The adaptation journey of Welbedacht Dam Catchment is a long-term project that requires ongoing work to improve the climate resilience of the catchment. There are significant challenges such as funding constraints and the need for continuous community engagement. Innovative financing models need to be developed to improve vegetation management. The lessons learned from this project highlight the importance of ongoing monitoring, flexible adaptation strategies, and collaboration between stakeholders. As the Caledon River system is transboundary, the Welbedacht dam catchment is essential for both South Africa and Lesotho. Therefore, this project can be replicated in other areas within the catchment for improved water resource management in the transboundary area.

This case study highlights the importance of proactive and integrated approaches to protect essential water resources from the challenges brought by climate change and siltation. The project's participatory and collaborative approach emphasises that sustainable siltation management requires a broader engagement, moving beyond the roles of users, stakeholders, policymakers, and regulators to cooperation, partnership, and stewardship. This requires the development of robust and practical management tools, along with effective communication and capacity building. The case study also provides an excellent example of how managing siltation to adapt to climate change can have positive socioeconomic impacts on communities. In this project, eleven local youths were employed and trained, and community members established nurseries to procure seedlings. This initiative not only helped to stimulate the local economy but also created opportunities for skill development and community involvement.

6

GROUNDWATER

6 GROUNDWATER

6.1 Background

South Africa is mainly reliant on surface water with over 33 billion m^3 total gross storage capacity, from 5 551 registered dams. While the total groundwater recharge for South Africa is estimated to be over 34 billion m^3/a. Groundwater refers to the water in saturated layers or zones below the land surface. The maximum national potential for accessible groundwater, is approximately 4.5 billion m^3/a; of which only 3.2 billion m^3/a is being utilised. Hence, groundwater is a strategic resource in many parts of South Africa, especially in rural areas. It plays an important role in the supply of water to small towns and villages in the drier parts of the country. Discharges or outflows of groundwater sustain springs and river flows in the dry season. Sustained river flows are important as they support people and communities who depend directly on rivers for their water, particularly during the dry season and droughts. There is considerable potential for additional development of groundwater resources to augment existing resources. The need for improved groundwater management to ensure sustainable and efficient use of the resource was first recognised in the National Water Resource Strategy-1 and led to the formulation of a National Groundwater Strategy through which strategic actions were undertaken.

South Africa is experiencing increasing water scarcity mainly due to its semi-arid climatic location coupled with its growing population, urbanisation, and climate change. Surface water, the traditional bulk supply source, is becoming unreliable and unavailable in some parts of the country. The costs of piping water from dams to supply the water needs of 59 million people are becoming increasingly challenging to meet. Groundwater is vital in sustaining water security and contributing to the water mix to augment conventional resources.

6.1.1 Groundwater Strategic Water Source Area

South Africa's water supply is dependent on Strategic Water Source Areas (SWSAs). SWSAs are defined as areas of land of national importance that either: (a) supply relatively large quantities of mean annual surface water runoff compared to their size or (b) have high groundwater recharge and high dependence or (c) areas that meet both criteria (a) and (b). All surface water SWSAs are located in high rainfall areas where baseflow is at least 1 125 mm/a, which is evidence of a strong link between groundwater and surface water in the SWSAs. The water produced by these areas supports at least 50% of the population, 64% of the economy, and supplies about 70% of the water used by irrigated agriculture. Gauteng gets about 65% of its water from these areas, and Cape Town and eThekwini about 98%. About 24% of the settlements reliant on groundwater are located within groundwater SWSAs, which is equivalent to 10% of all settlements in South Africa. These SWSAs supply about 46% of the groundwater used by agriculture and 47% of the groundwater used for industrial purposes in South Africa.

There are 37 national groundwater Strategic Water Source Areas (Gw-SWSA), which cover around 9% of the land surface of South Africa. They account for up to 42% of the river baseflow generated by these water source areas and have a key role in sustaining surface water flows during the dry season. The total groundwater recharge for South Africa is estimated to be 34 912 million m^3/a. About 24% of the settlements reliant on groundwater are located within groundwater SWSAs, which is equivalent to 10% of all settlements in South Africa. These SWSAs supply about 46% of the groundwater used by agriculture and 47% of the groundwater used for industrial purposes in South Africa.

6.2 Groundwater Level Status

The DWS has over 1800 active groundwater level monitoring sites across the country. The frequency of the data collection varies, some are monthly, while others are bi-monthly, quarterly, or bi-annual. Groundwater level fluctuations are influenced by recharge, discharge and water abstractions. Recharge naturally comes from rain and can also be artificial. Depth to water table is a dynamic, not static value, shallow water tables, usually fluctuate annually in response to wet season recharge and dry season depletion. The rate of depletion is a combination of natural and manmade factors. Groundwater resources are significantly stressed when abstractions exceed recharge, which usually takes place during drought. Water-level measurements provide insight into the physical properties that control aquifer recharge, storage, and discharge.

The groundwater level is presented as a percentage of the groundwater level status (GwLS). The historical groundwater level monitoring record is per borehole to ensure a constant point of reference. The GwLS of the geosites is averaged within the topo-cadastral 1:50 000 map sheet grid. The groundwater level status is not linked to groundwater availability and storage levels within an aquifer but only gives an indication of the relative water level over time.

The GwLS approach allows the comparison of groundwater level data of any geosite/borehole on the same scale.

Figure 6.1 shows GwLS for the month of September 2023 and the available data at the time of reporting. GwLS average greater than 60% dominates over level below 25%, indicating another year of adequate recharge from above-normal rainfall received for almost all parts of South Africa, apart from some isolated parts in Northern Cape as reported in Chapter 3. 2023 marks a third consecutive year of above-normal annual rainfall, which significantly improved groundwater levels (Figure 6.2).

There is a need for groundwater data collaborations whereby DWS can include all locally collected data from key water sector institutions like local municipalities and the South African Environmental Observation Network (SAEON).

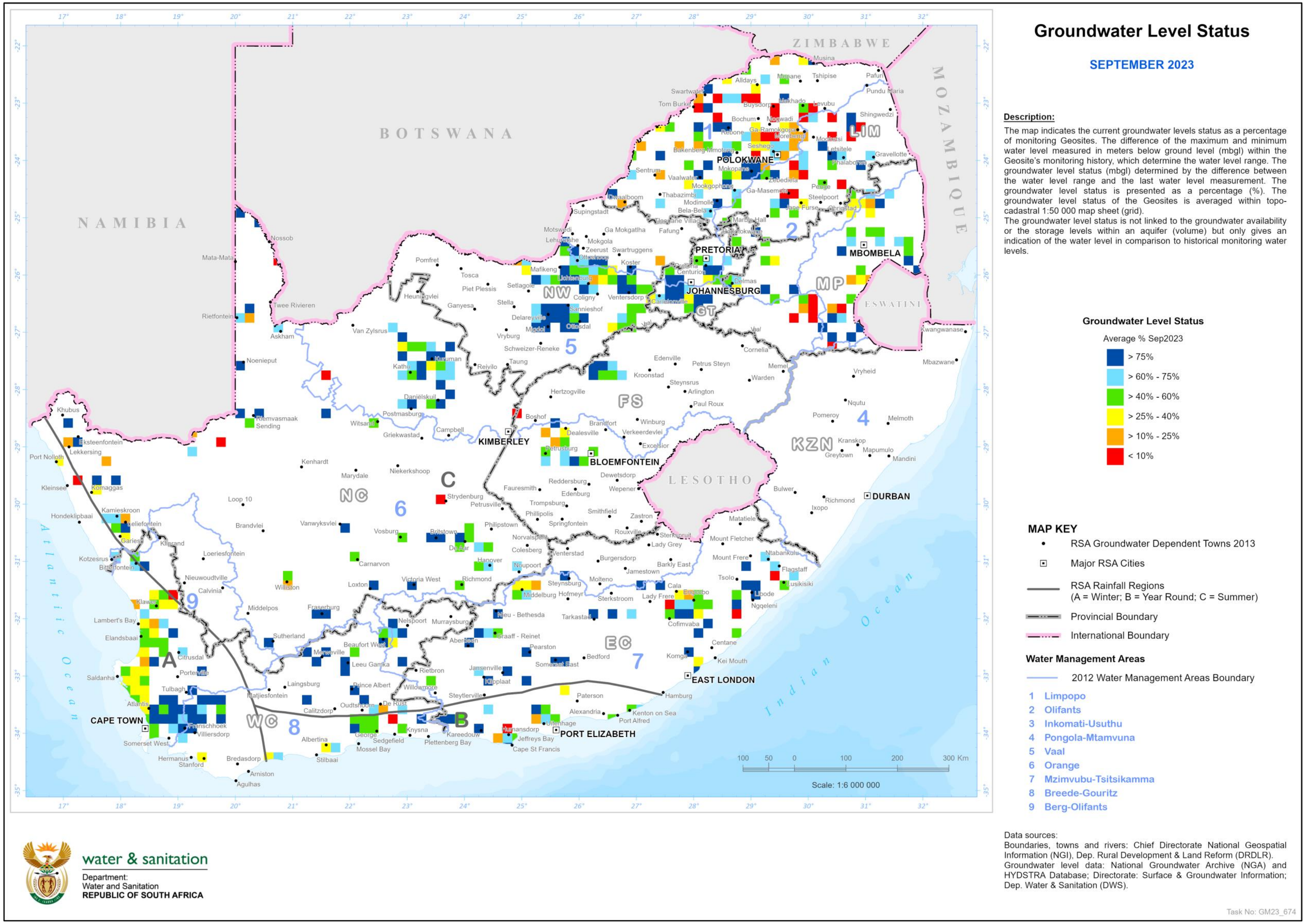


Figure 6.1 Groundwater Level Status Map – September 2023

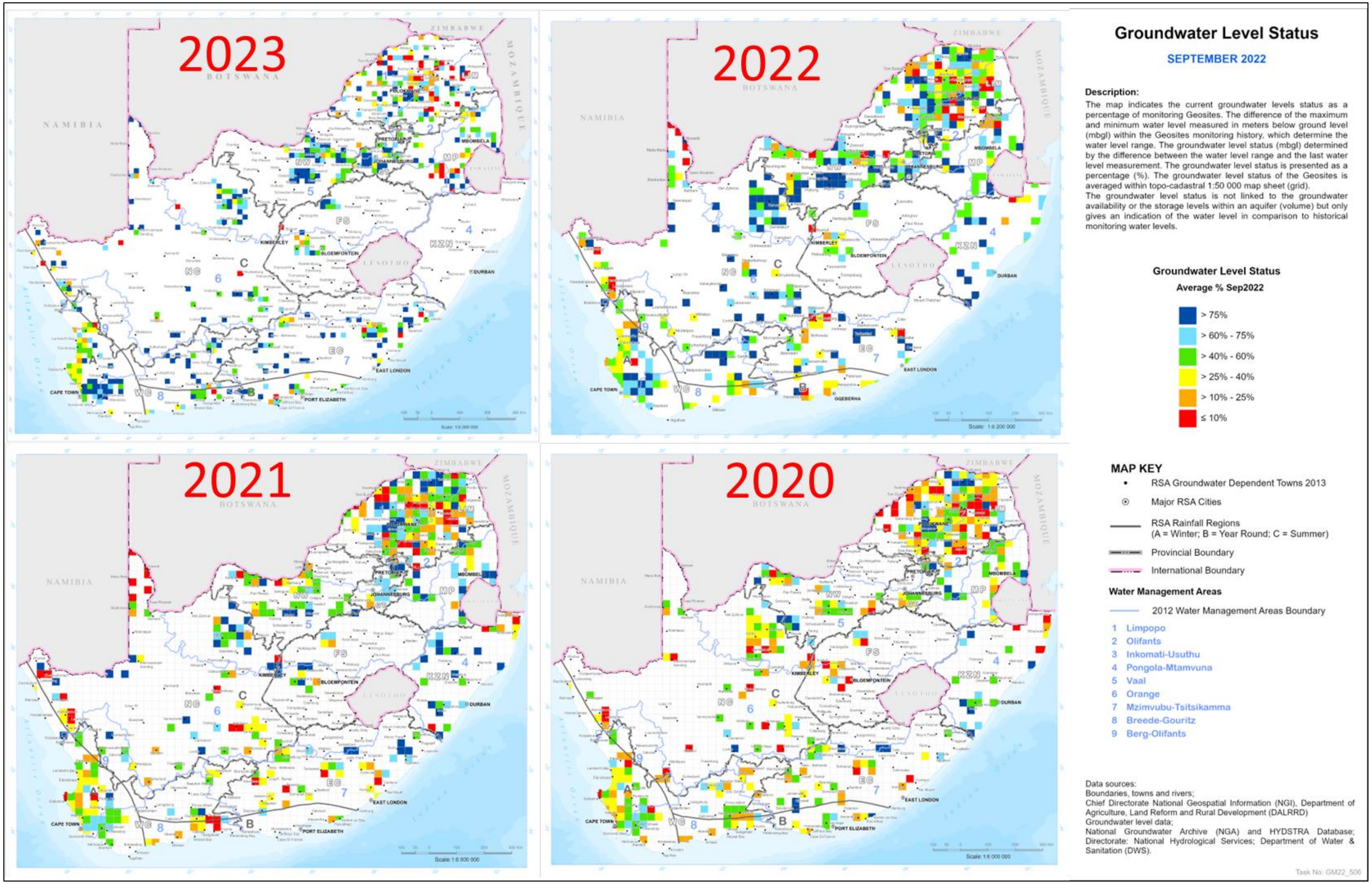


Figure 6.2: Groundwater Level Status comparison – past four hydrological years.

The impact of groundwater over-abstraction during drought can be presented by its severity on the groundwater resource (average groundwater level status). There are seven percentile ranges used to classify GwLS. The average GwLS is presented against the percentiles of the historical groundwater levels Figure 6.3.

The graph provides a visual presentation to alert of drought conditions. Restrictions on groundwater abstraction can be implemented timeously before any negative impacts occur. Each grouping of boreholes will have a different severity range.

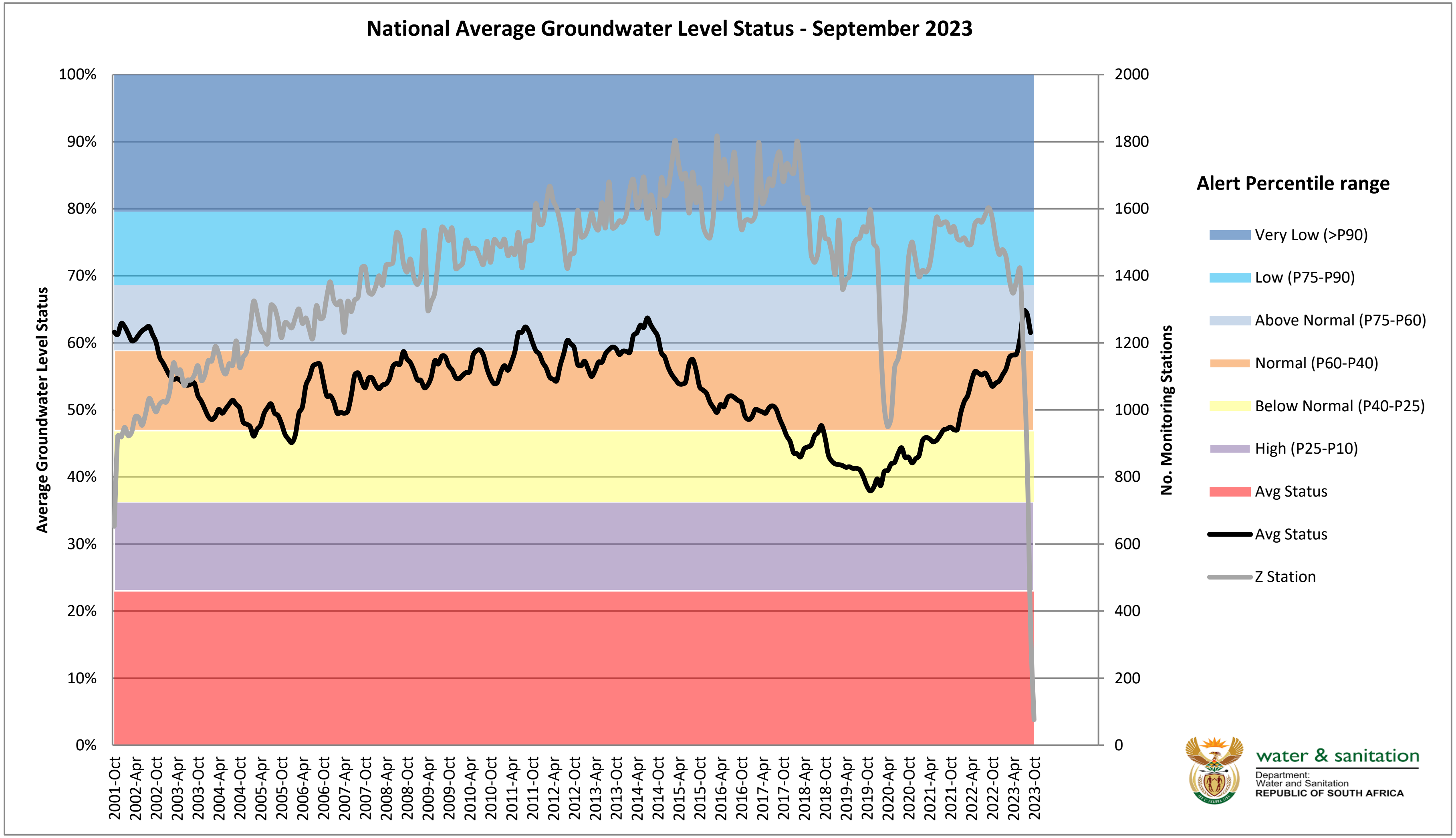


Figure 6.3: National Average Long Term Groundwater Level Status

The groundwater level status is not linked to groundwater availability and storage levels within an aquifer but only gives an indication of water level based on individual geosite's entire historical groundwater level monitoring record.

The national average groundwater level status indicates a recovery trend from below normal in 2019 to above normal at the end of September 2023 (Figure 6.3). This can be attributed to the above-normal rainfall received in the current and previous years, which has significantly recharged aquifers, now showing above-normal percentile levels. At levels below normal, restrictions on groundwater abstraction can be implemented to stabilise groundwater levels and mitigate risks of groundwater depletion.

6.3 Groundwater Quality Status

The frequency of the data collection is bi-annual, before rainfall (September/October) and after rainfall (April/May). In addition to these national stations, we have the Acid Mine Drainage (ADM) special monitoring programme, located at the CoH-WHS, where monitoring frequency is four times a year. The collected data is archived on WMS and the National Groundwater Archive (NGA).

The most noticeable element of concern for groundwater quality in South Africa is nitrate measured as nitrogen (N), with some exceedances observed for fluoride. Nitrate is a known persisting problem and has been flagged by Marais (1999) as the single most common reason for groundwater sources to be declared unsuitable for drinking in South Africa. High nitrate concentration in drinking water is a major health risk for bottle-fed infants, it causes methaemoglobinaemia also known as “blue-baby syndrome”.

Relatively high groundwater nitrate concentrations are found in some parts of South Africa, particularly the Limpopo and Vaal WMAs (Figure 6.4). Fluoride concentrations higher than 1.5 mg/L are found in the Limpopo WMA mainly associated with geothermal springs (Figure 6.5). The spatial Electrical Conductivity (EC) data shows higher salinity dominating the following WMAs: Limpopo, Vaal, Mzimvubu-Tsitsikamma; and Berg-Olifants (Figure 6.6). Evidently, the Limpopo WMA has nitrate, Fluoride and EC water quality concerns. Groundwater in Limpopo and North West plays a significant role in the water supply regime, together the two provinces have the most Groundwater Strategic Water Sources Areas (Gw-SWSAs). Gw-SWSAs provide water to 126 towns and rural supply schemes. Key regional centres that are highly dependent on groundwater are: Mafikeng with >75%, Lichtenburg >50%, Giyani >26% and Polokwane >11% (Le Maitre et al.2018).

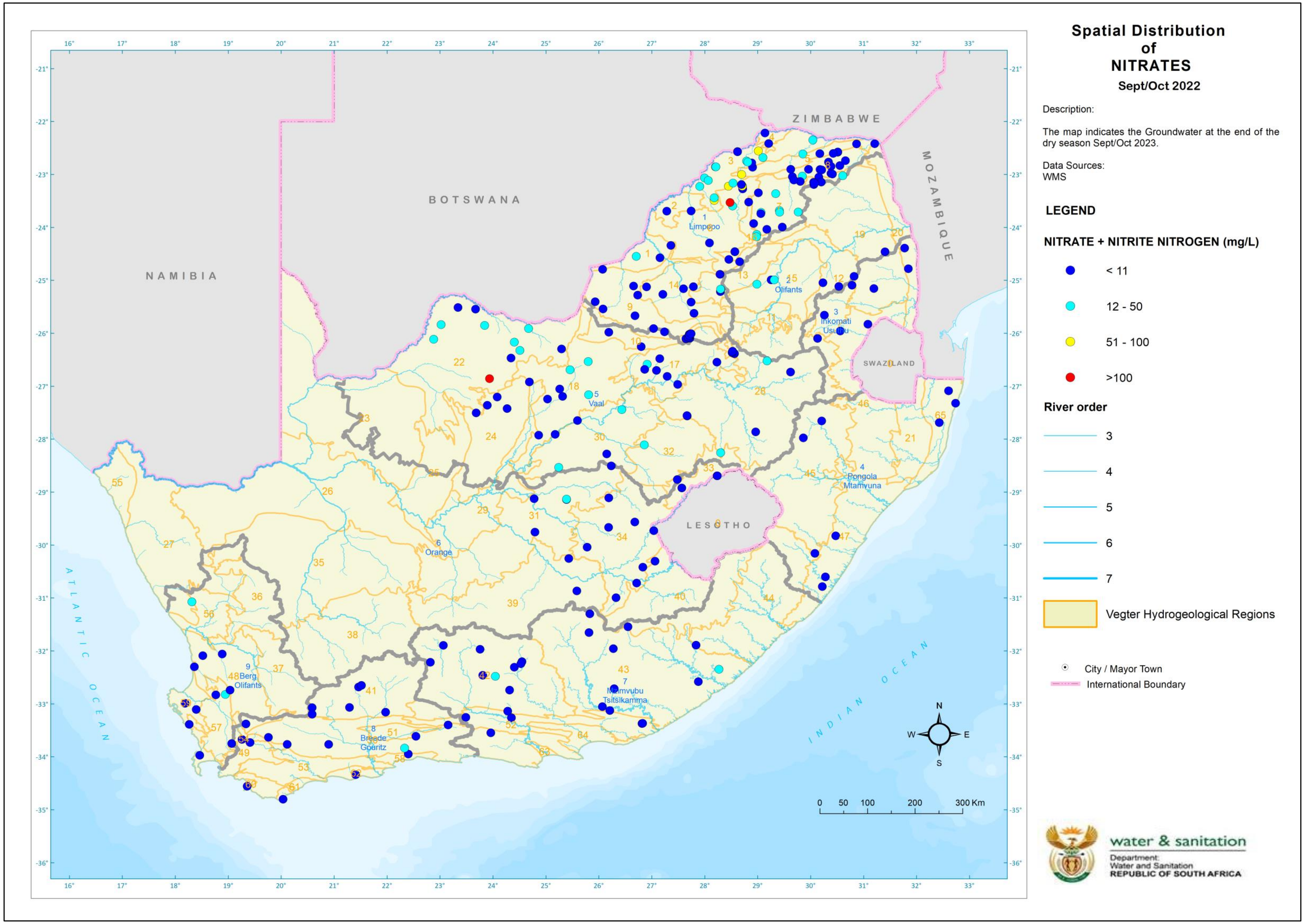


Figure 6.4: Spatial distribution of nitrate in groundwater Sept/Oct 2022.

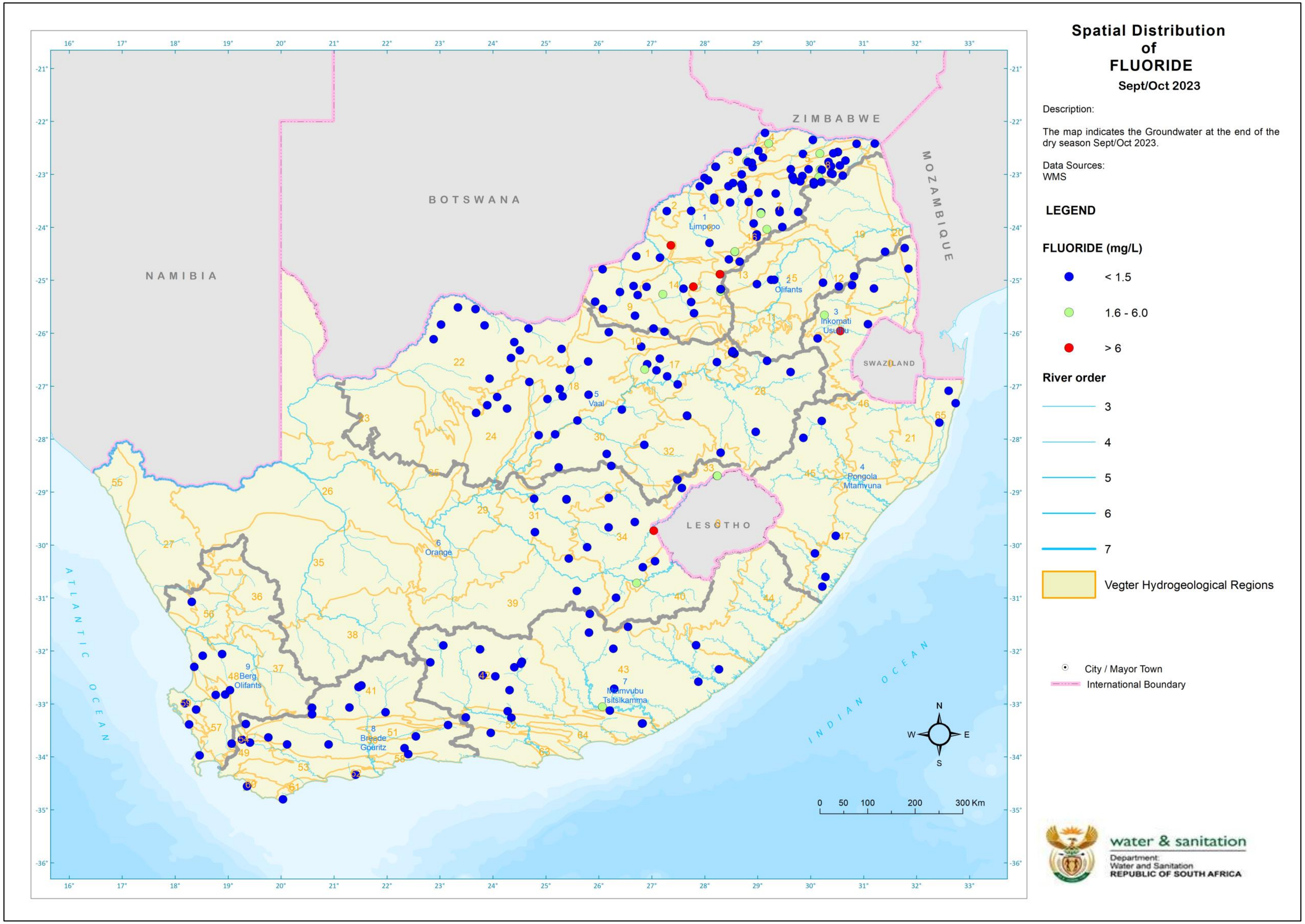


Figure 6.5: Spatial distribution of Fluoride in groundwater Sept/Oct 2022.

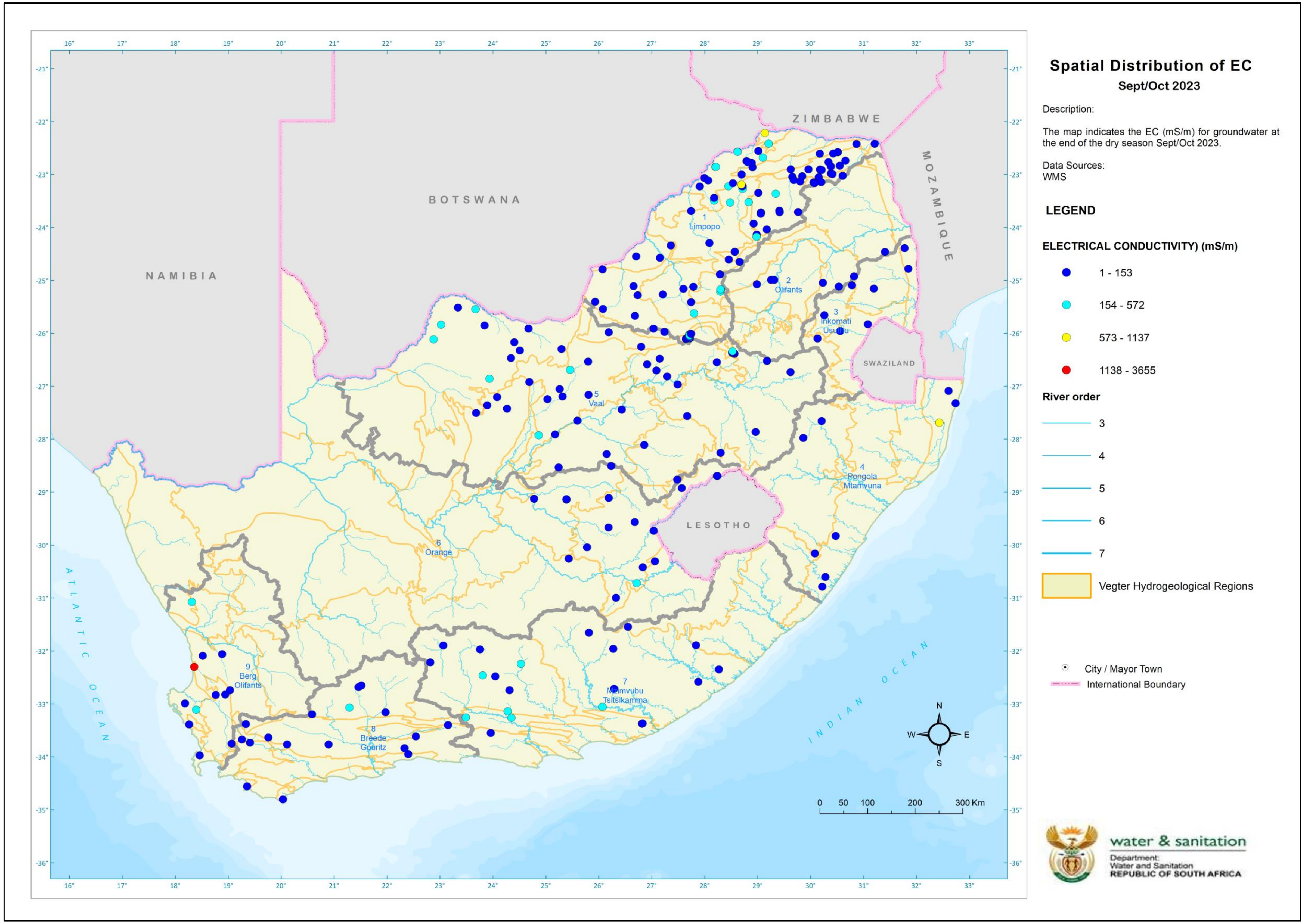


Figure 6.6: Spatial distribution of EC in groundwater Sept/Oct 2022.

6.3.1 Nitrate hotspots.

The results from the two monitoring runs continue to raise a flag on the persisting nitrate pollution status of the groundwater in Limpopo and North West Provinces. The groundwater monitoring sites with the highest nitrate concentrations in 2022/23 are listed on (Table 6-1) and the trend over time is presented in Figure 6.7. Two borehole sites ZQMGYA2 from North West and ZQMGMI1 from Limpopo anomalously crossed the 110 mg/L levels for the first time since monitoring started. Other monitoring sites that had anomalous record high include, ZQMMGE1, ZQMKHK2, ZQMBGG1, and ZQMSWW1, ZQMPPI1. These new record high levels of nitrate maybe indicative of impacts of land use activities polluting groundwater at a fast rate.

The Department is compelled to react to these new record-high figures, more research is required to study these anomalies plus, more innovative groundwater protection and remediation options need to be explored. Currently available, easy efficient methods for the reduction of nitrate ions in groundwater to the acceptable levels, is blending polluted water with pollution-free surface water. The other reduction methods such as electrodialysis, ion exchange or biological processes are costly and not always efficient (Bohdziewicz et al., 1999).

Authorities need to raise awareness and help mothers protect their bottle-fed infants from nitrate-polluted water. Education about the dangers of excessively boiling nitrate-polluted water for bottle-fed babies should be a priority during prenatal, and postnatal classes at the local clinics.

Table 6-1: Monitoring sites with the highest nitrate concentrations 2022/23

Monitoring Site	2022 mg/L	2023 mg/L	Province, Village	Comment
ZQMGYA2	109	**130**	NW, Ganyesa	Record high
ZQMGMI1	103	**125**	LP, Ga- Musi	Record high
ZQMMGE1	**93**	86	LP, Darling	Record high
ZQMKHK2	65	**92**	LP, Kramhoek	Highest Sept-2000
ZQMBGG1	**90**	n/a	LP, Bangalong	Record high
ZQMSWW1	23	**86**	LP, Dassenberg	Record high
ZQMPPI1	**78**	n/a	LP, Papegaai	Highest Sept-2017
ZQMBLT3	18	**76**	LP, Baltimore	Record high
ZQMBLT2	**73**	16	LP, Baltimore	Record high
ZQMSMA1	12	**69**	LP, Semenya	Record high
ZQMKLH1	13	**67**	NW, Radnor	Record high

Bold: highest value.

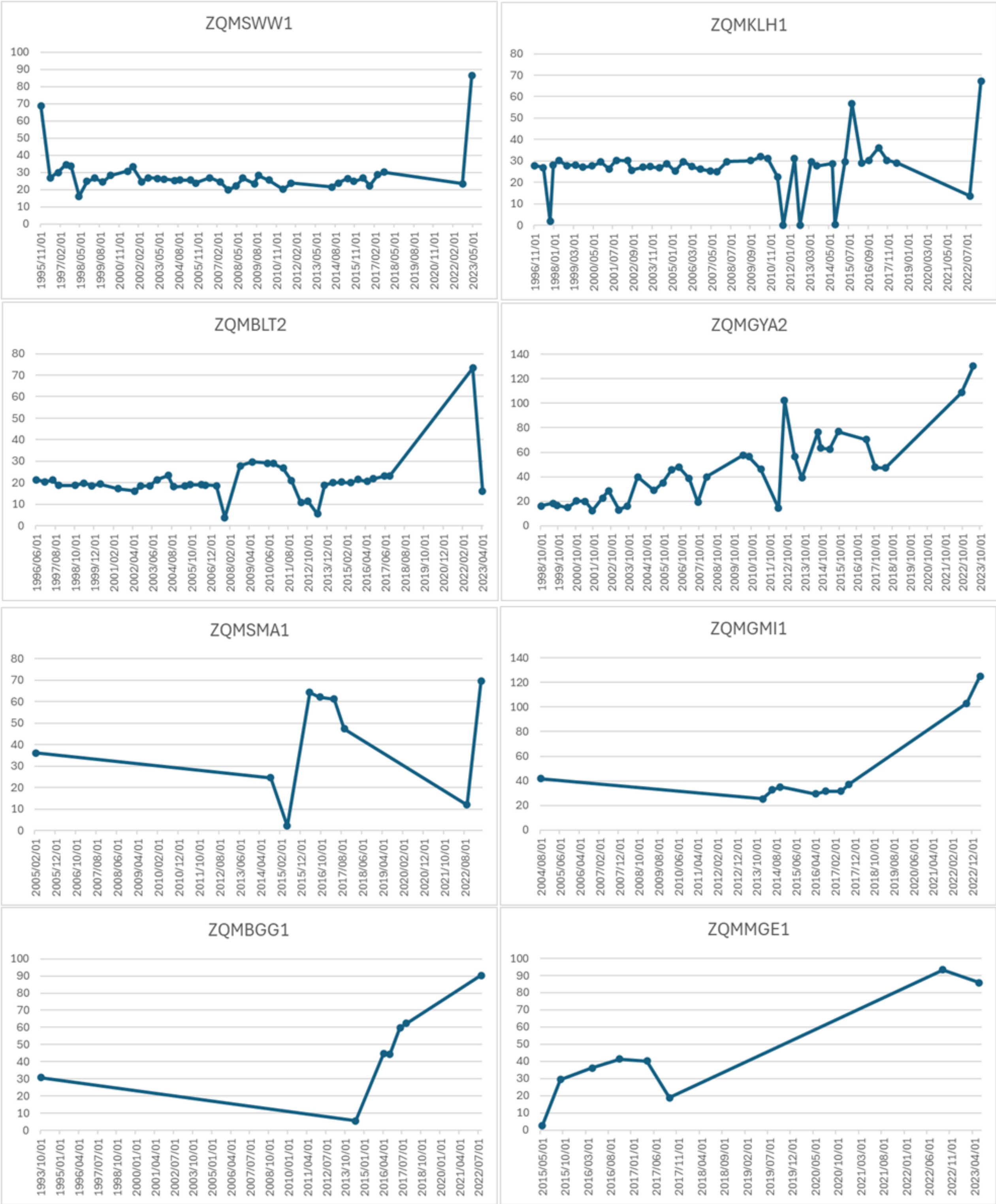


Figure 6.7: Nitrate concentrations of flagged monitoring sites.

6.4 Groundwater Use Per Economic Sector

Water Use Authorisation and Registration Management System (WARMS) data shows over 3 232 million m^3 groundwater is abstracted per annum. Figure 6.8 is a percentage pie chart illustrating national groundwater use per economic sector for 2023. Three sectors dominate groundwater use volumes, with over 55% (1 788 Mm^3/a) of the abstracted groundwater goes to irrigation, while 21% (677 Mm^3/a) goes to mining and 11% (340 Mm^3/a) goes to water supply. The balance 13% (424 Mm^3/a) goes to other minor users such as aquiculture, livestock, schedule 1, industry, urban, power generation and recreation.

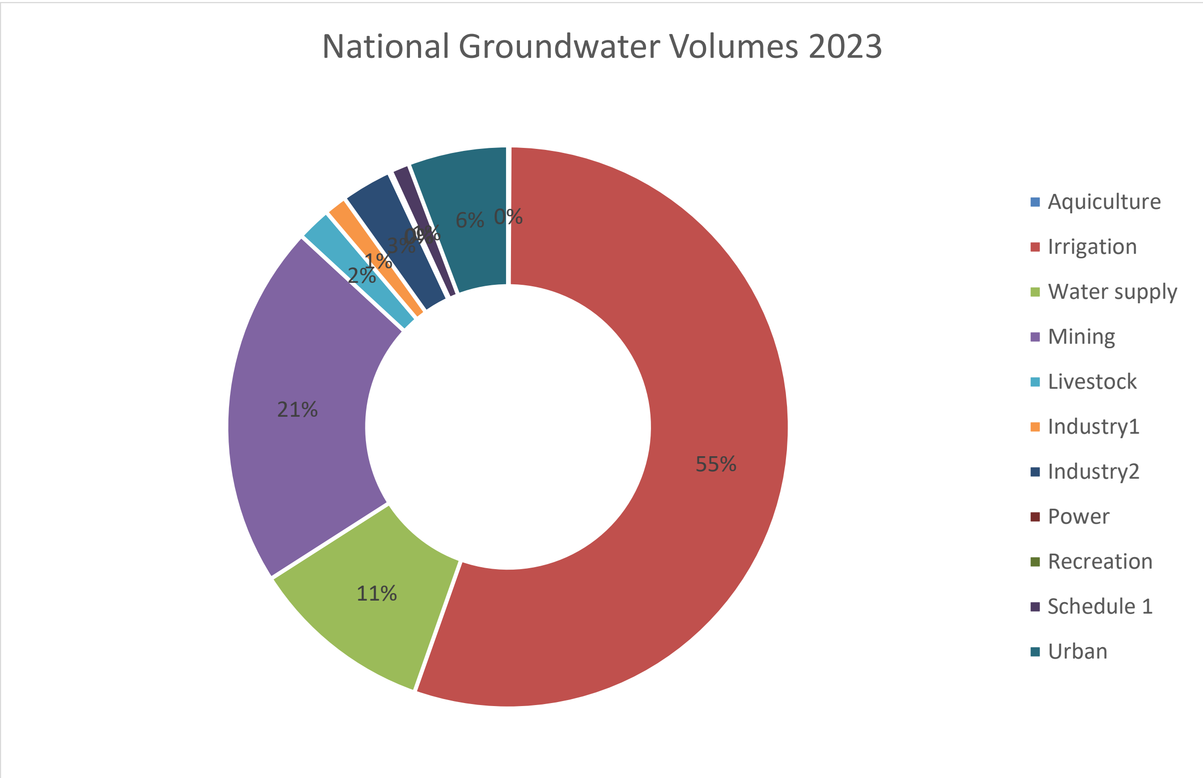


Figure 6.8: Groundwater use per economic sector 2023.

There are two WMAs dominating the irrigation groundwater use volumes, with over 51%, are Limpopo (30%) and Vaal (21%) (Figure 6.9). Groundwater plays a significant role in food security and water supply in rural communities of Limpopo and Eastern Cape. For the mining sector, groundwater mainly goes to three WMAs, Olifants (41%), Vaal (36%) and Limpopo (19%) (Figure 6.10). The Olifants WMA covers a significant part of Mpumalanga where there are mainly coal and platinum mines in operation. The Vaal WMA covers mining operations located in Free State, Gauteng, North West and Northern Cape. The Limpopo WMA covers platinum mining operations mainly located in the North West.

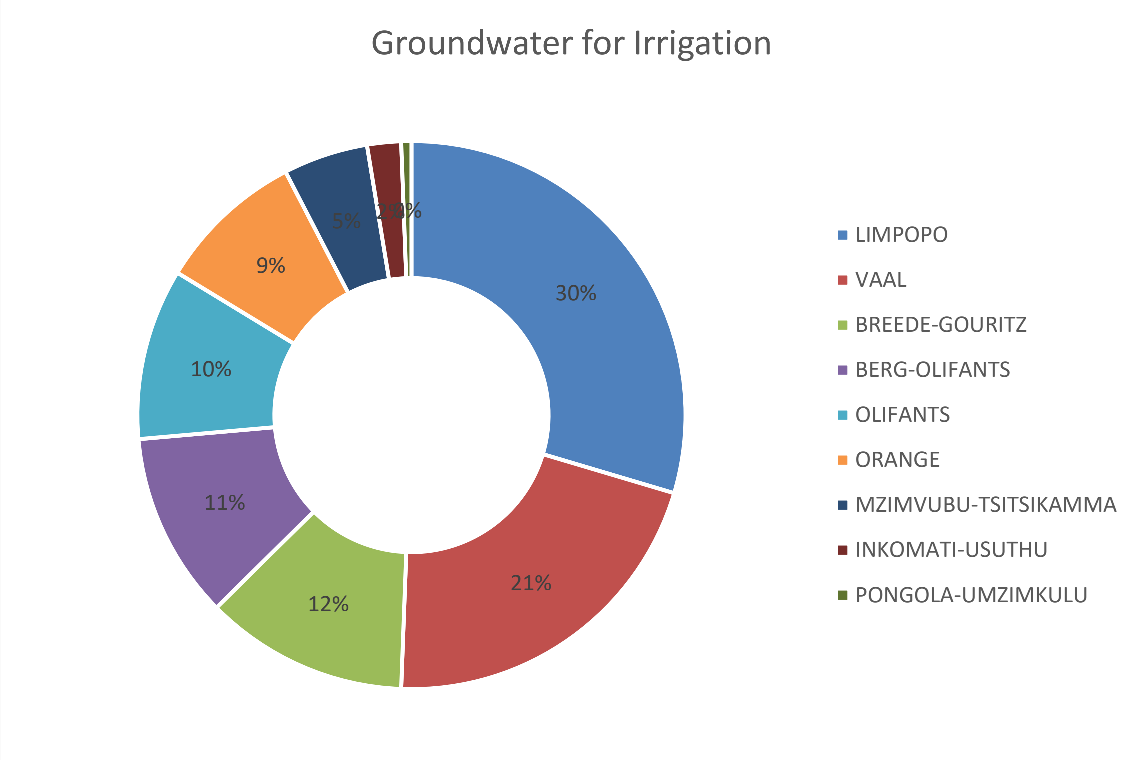


Figure 6.9: Groundwater for irrigation, per Water Management Area.

Figure 6.10: Groundwater for Mining, per Water Management Area.

7

WATER SECURITY

7 WATER SECURITY

7.1 Water Use Efficiency

In the water sector, the term 'water use efficiency' is generally understood to be a dimensionless ratio between water use and water withdrawal. Water Use Efficiency is about using water without waste. In the DWS Water Use Efficiency goes hand in hand with Water Conservation and Water Demand Management (WC/WDM). Within WC/WDM, there are several technical aspects such as non-revenue water, among others.

Non-revenue water (NRW) in South Africa is a big problem. Approximately 41% of municipal water does not generate revenue. While figures vary between service providers, average physical losses in municipal systems are estimated to be around 35%, against a global best practice of about 15%. As a result, municipalities are losing around R 9.9 billion each year.

7.1.1 Legislation and Policy

Water is at the core of human survival, peace and prosperity. The highest legislative mandate for efficient and effective distribution of water resources comes from the Constitution of the Republic of South Africa Act (No. 108 of 1996), Section 27 (1)(b) which states that everyone has a right to access sufficient food and water. The National Water Act, 36 of 1998 (NWA), provides the legal framework for the promotion of efficient, equitable and sustainable management of the country's water resources.

The Water Services Act (No. 108 of 1997) provides the additional legal framework for the provision of water supply and sanitation services to end users such as households, businesses, and industries, within municipalities, promoting water conservation in the provision of water services. It requires Water Service Authorities (WSAs) to outline measures to conserve water resources and places the duty to conserve water on water services institutions. The Water Services Act and its Regulations enable the implementation of Water Conservation and Water Demand Management (WC/WDM) specifically for the municipal sector by encouraging the sector to develop By-Laws, WC/WDM plans, Water Services Development Plans (WSDP), etc.

The Regulations relating to Compulsory National Standards and Measures to Conserve Water under the Water Services Act (No. 108 of 1997) provide for the protection of consumers and WSAs, and for ensuring the application of sound management principles. The National Water and Sanitation Master Plan (DWS, 2018) states that South Africa is facing a water crisis caused by insufficient water infrastructure maintenance and investment, recurrent droughts driven by climatic variation, inequities in access to water and sanitation, environmental degradation and resource pollution, and a lack of skilled water engineers. This crisis is already having significant impacts on economic growth and the well-being of everyone in South Africa.

The National Water Resources Strategy 3 (NWRS-3, 2023) outlines the importance of Water Conservation and Water Demand Management (WC/WDM) and Non-Revenue Water (NRW) management. The WC/WDM and NRW management are priority programmes for reaching the 15 % water demand reduction target. The National Water and Sanitation Master Plan (2018) recognises that building a water-secure future will require proactive water infrastructure management, effective water infrastructure operations and maintenance, and an overall reduction in future water demand while considering infrastructure development and augmentation, where necessary. The DWS Strategic Plan for the 2020/21 to 2024/25 (Vote 41) sets out a performance target approach to WC/WDM, highlighting its importance as one of the priority implementation areas for the DWS.

7.1.2 History of Benchmarking Studies

South Africa has a 20-year benchmarking history, starting with the adaptation of the International Water Association's methodology for calculating and understanding NRW and water losses in 2002, in the development of a pragmatic approach to benchmark water losses in potable water distribution systems in South Africa. The first comprehensive national benchmark study was published in 2012 in The State of Non-Revenue Water in South Africa (2012). Since 2012, several detailed assessments and updates have been undertaken, including the No Drop Assessment in 2015. The last national water loss benchmarking study was based on 2021/22 data, published in the No Drop Watch Report 2023.

7.1.3 Data Submission Statistics

There has been a noticeable improvement in the quality of data for Provinces that have active data collection and collation programmes combined with regular engagements. Municipalities in these Provinces are requested to report regularly at structured forums and reconciliation strategy progress meetings.
To differentiate the useability of data, data were categorised into one of three groups:

- **High confidence level:** Data sets are submitted on a regular basis, show trends, and are credible.
- **Medium confidence level:** One or more data sets were submitted in the past three years and seem credible, with few gaps and/or inaccuracies.
- **Low confidence level:** None or one data set was submitted in the past three years, and the data sets submitted are questionable, with considerable gaps and/or inaccuracies.

A total of 88 datasets (61%) were received from WSAs, which is the highest to date. Less than 50% of WSAswere able to submit water balance data in previous surveys (*Table 7-1*). The confidence level of the data submitted varies between provinces and municipal categories. The confidence levels exclude those for the WSAs that did not submit data, that is when water balances were calculated, extrapolated, or estimated.

Category A - Metropolitan municipalities continue to report consistently and most can provide a water balance monthly. This is encouraging, considering that metropolitan municipalities represent 53.3% of the total water use and 47.3% of the population.

Categories B1 and B2 - Most secondary cities and large municipalities can provide a water balance regularly, although there is considerable room for improvement in some Provinces. The secondary city and large municipalities represent 21.4% of the total water use and 20.8% of the population. These municipalities are of economic significance and should have the necessary budgets and resources to implement WC/WDM.

Categories C2, B3 and B4 - 53% of the small and rural municipalities can provide an accurate water balance regularly. Reasons for this include lack of budget, limited skills and capacity, difficulty measuring the supply due to the large number of boreholes, and large indigent consumer bases. These municipalities represent approximately 25.3% of the total water use and 31.9% of the population.

Table 7-1: Summary of data submissions and confidence levels

Province/ Category	WSA	Submissions	%	High	Medium	Low	% of SIV	% of Population
EC	14	7	50%	2	1	4	7.3%	8.8%
FS	19	10	53%	0	2	8	5.6%	5.8%
GT	9	8	89%	6	2	0	35.8%	29.3%
KZN	14	12	86%	11	0	1	19.5%	18.5%
LP	10	3	30%	1	2	0	7.0%	7.6%
MP	17	8	47%	2	2	4	6.5%	7.6%
NC	26	9	35%	5	3	1	2.4%	2.2%
NW	10	6	60%	0	2	4	5.5%	7.0%
WC	25	25	100%	21	2	2	10.4%	13.3%
Total	**144**	**88**	**61%**	**48**	**16**	**24**	**100.0%**	**100.0%**
A	8	8	100%	7	1	0	53.3%	47.3%
B1	19	17	89%	11	2	4	17.1%	16.3%
B2	17	10	59%	8	1	1	4.3%	4.6%
B3	71	37	52%	14	10	13	6.6%	8.3%
B4	8	5	63%	0	2	3	2.8%	4.0%
C2	21	11	52%	8	0	3	15.9%	19.6%
Total	**144**	**88**	**61%**	**48**	**16**	**24**	**100.0%**	**100.0%**
%				**33%**	**11%**	**17%**		

Estimated Water Balance

Prior to the 2017 benchmark report, all reports calculated the national water balance based on extrapolation. The national water balance is highly influenced by and dependent on the metro and secondary city data that have high confidence levels, while data for Category C2, B3 and B4 municipalities have low confidence levels and are poorly represented in the sample. The extrapolated results provided NRW figures between 35% to 40%, depending on the extrapolation methodology followed. To improve understanding of NRW and water losses in South Africa, the extrapolation method was substituted with a bottom-up approach, estimating a water balance for each municipality that could not provide information.

National NRW and water loss trends show a steady increase in NRW over the past 10 years and System Input Volume (SIV) projections with WC/WDM have been exceeded. The figures are dominated by Category A, B1 and B2 municipalities, some of whom have made significant strides in improving NRW management, reducing water losses, and managing the demand in line with reconciliation strategy targets. There is significant scope for improvement of NRW and all municipalities would benefit from targeted demand management programmes, including community education and awareness, leak repair, infrastructure refurbishment, pressure management, and installation of bulk meters, amongst other measures.

7.1.4 National Water Balance

The National Water Balance indicates a SIV of 4.39 billion m^3/a, water losses of 1.79 billion m^3/a (40.8%) and NRW of 2.08 billion m^3/a (47.4%) (Figure). NRW and water losses have increased by a notable 5.9% and 4.3% respectively from June 2016. The fluctuation between 2016 and 2019 was generally less than 1%. The greatest increase was in the past two years, attributed to the increased demands and the impact of the COVID-19 pandemic.

There has been a noticeable increase in billed unmetered consumption because of incorporating Free Basic Water (FBW) supply in the estimated water balances, especially for rural municipalities. Unbilled unmetered consumption remains lower than expected, considering the high number of unbilled properties in South Africa. Municipalities must correct their water balance calculations and show any water use after an accepted connection as authorised consumption, and not as water loss.

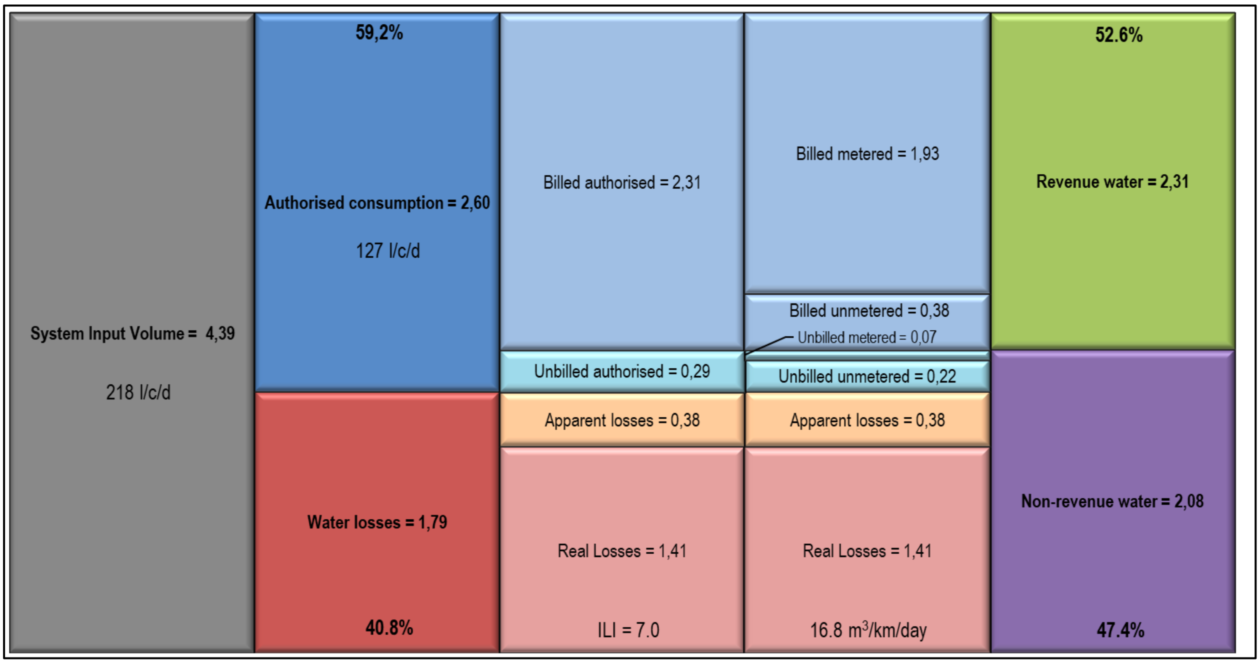


Figure 7.1: National Water Balance June 2023.

The metropolitan municipalities (Category A) are the biggest water users in South Africa, followed by Category B1, B2 and B3 municipalities, respectively (Figure 7.2Figure). The results are comparable to previous assessments. The rural B4 and C2 municipalities' estimated water use is higher than previous assessments. Category A, B1 and B2 municipalities represent 74% of the total water use while the Gauteng, Western Cape, and KwaZulu-Natal Provinces make up 66% of the total estimated use (Figure 7.3).

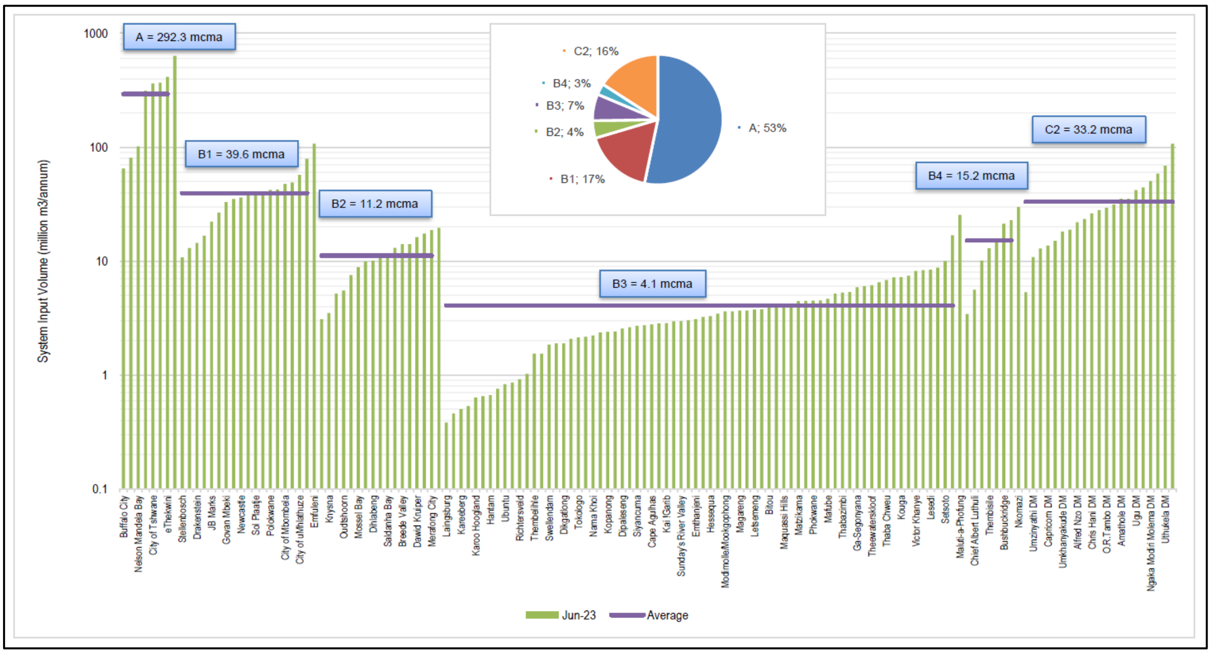


Figure 7.2: SIV distribution per municipal category.

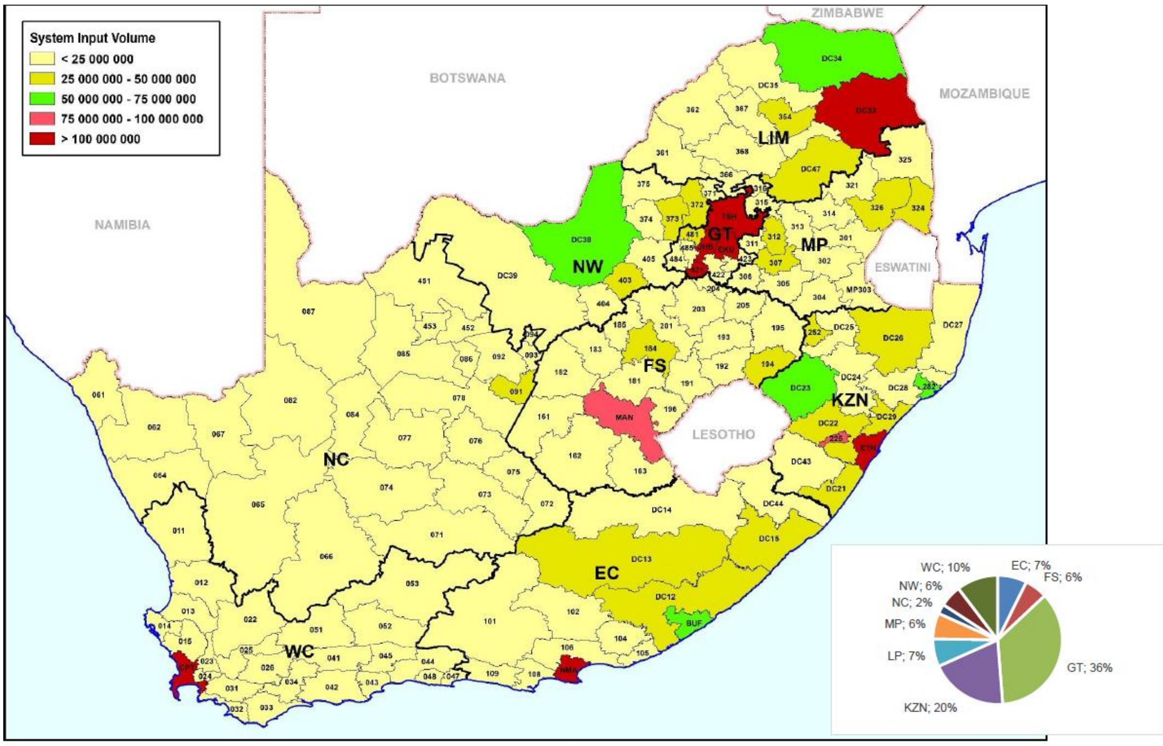


Figure 48: SIV distribution per WSA

Figure 7.3: SIV distribution per WSA.

The volume NRW in the Categories A, B1 and B2 municipalities, account for almost 75% of the national NRW and should be a focus area of the national WC/WDM programme (Figure 7.4). The Gauteng (667 million m^3/a) and KwaZulu-Natal (486 million m^3/a) Provinces account for over half of the national volume NRW (Figure 7.5).

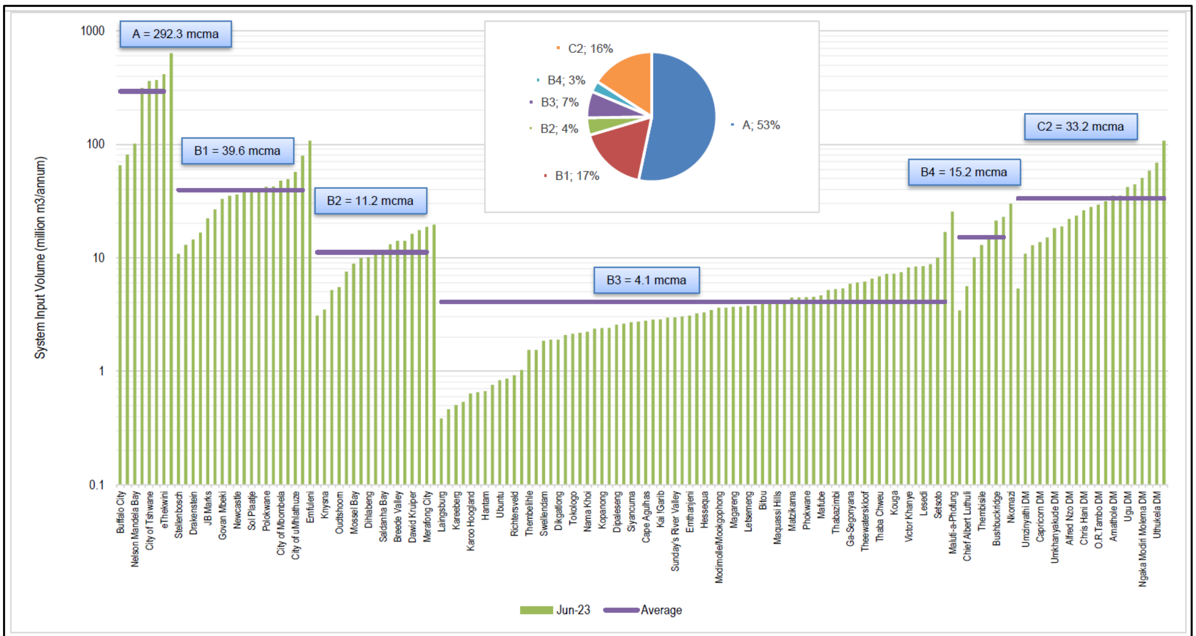


Figure 7.4: Volume NRW distribution per municipal category

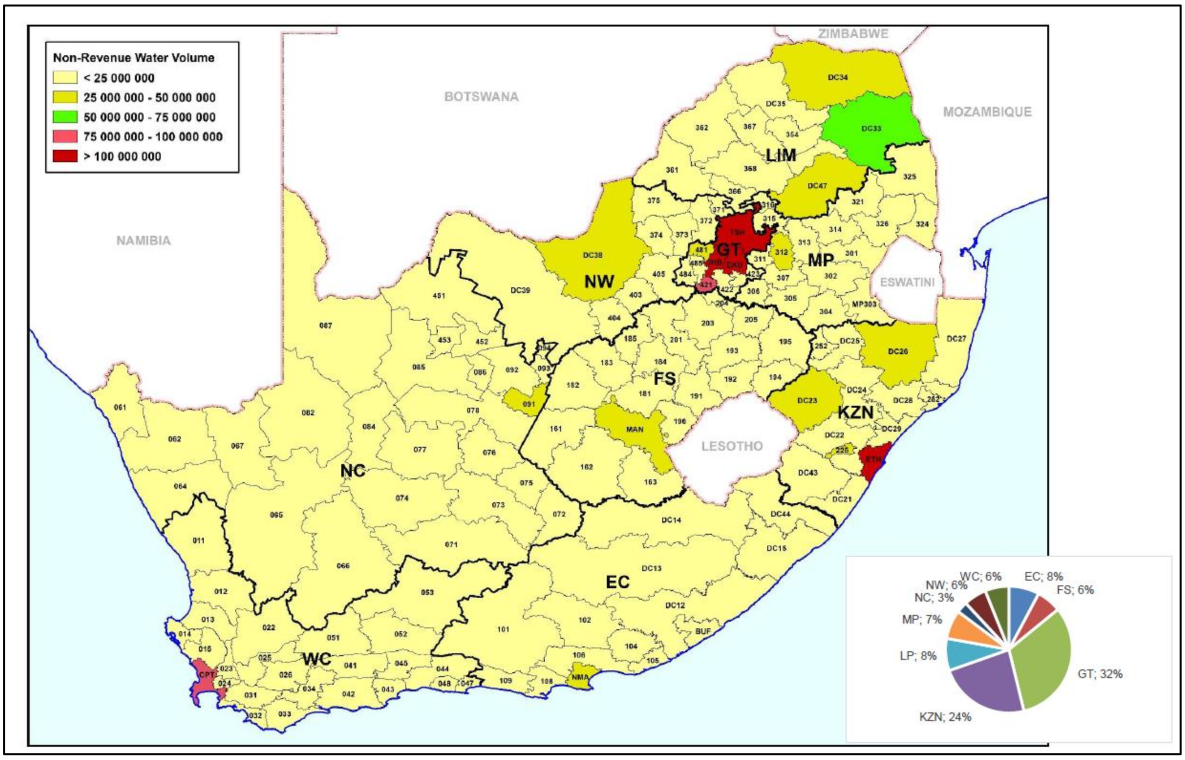


Figure 7.5: Volume NRW distribution per WSA.

In all municipal categories, the performance varies from very poor to very good (Figure 7.6). Category A and B2 municipalities are performing better, and it is assumed that they have sufficient budgets and resources to implement effective WC/WDM programmes. Category B1, B3 and rural municipalities face significant budget, cost recovery, and resource challenges, and have higher NRW. The national average of 49.1% is higher than the weighted average of 45.1% because it is not influenced by the size of the metropolitan municipalities which have lower NRW (Figure 7.7).

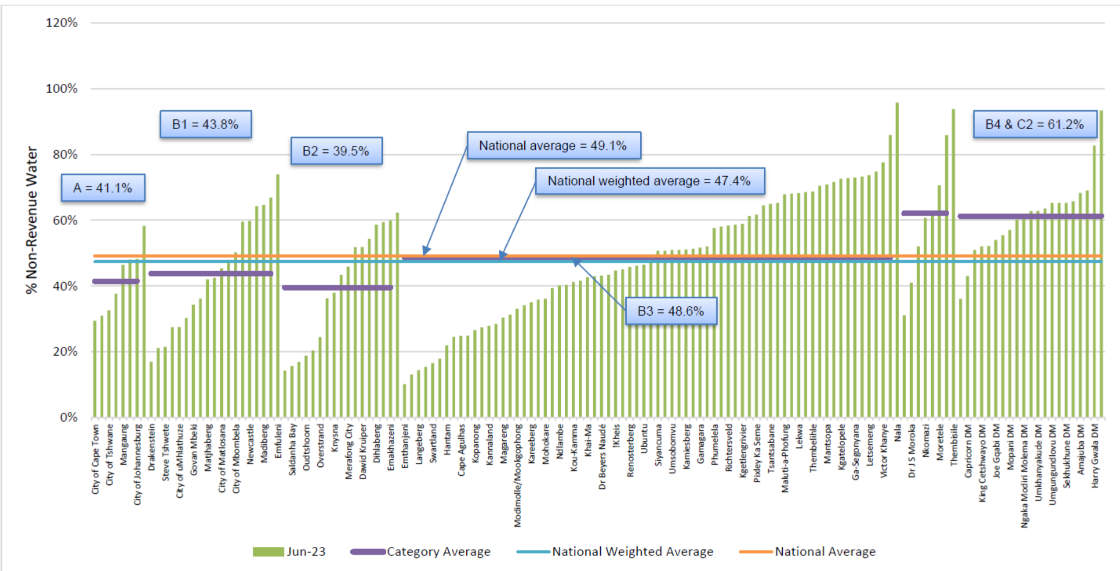


Figure 7.6: Percentage NRW distribution per municipal category.

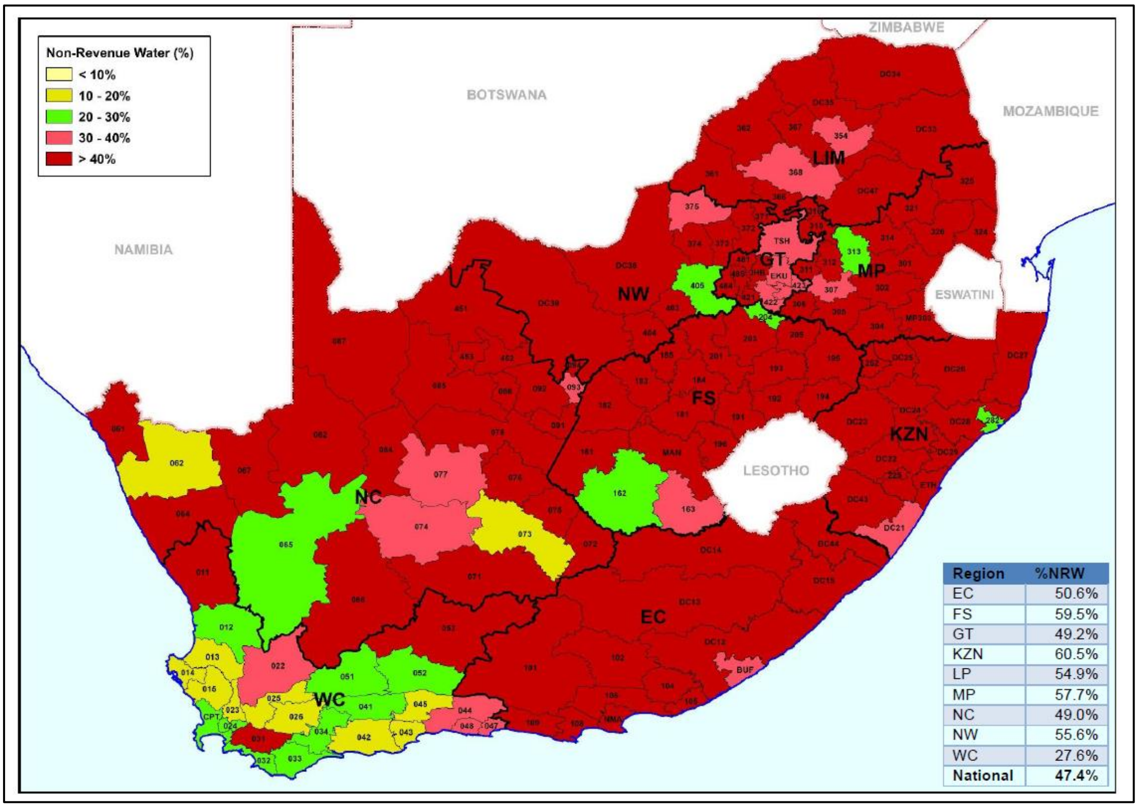


Figure 7.7: Percentage NRW distribution per WSA.

Zooming into the provincial NRW figures, we see Western Cape (25.5%) and Gauteng (34.7%) presenting excellent to good NRW respectively (Figure 7.8). The Western Cape Province has historically had an excellent NRW data reporting programme in place. Most WSAs submitted NRW data in the high confidence category. This trend is encouraged as this level of credible data coming from the Western Cape Province helps to create a realistic understanding of the nature and extent of NRW in South Africa.

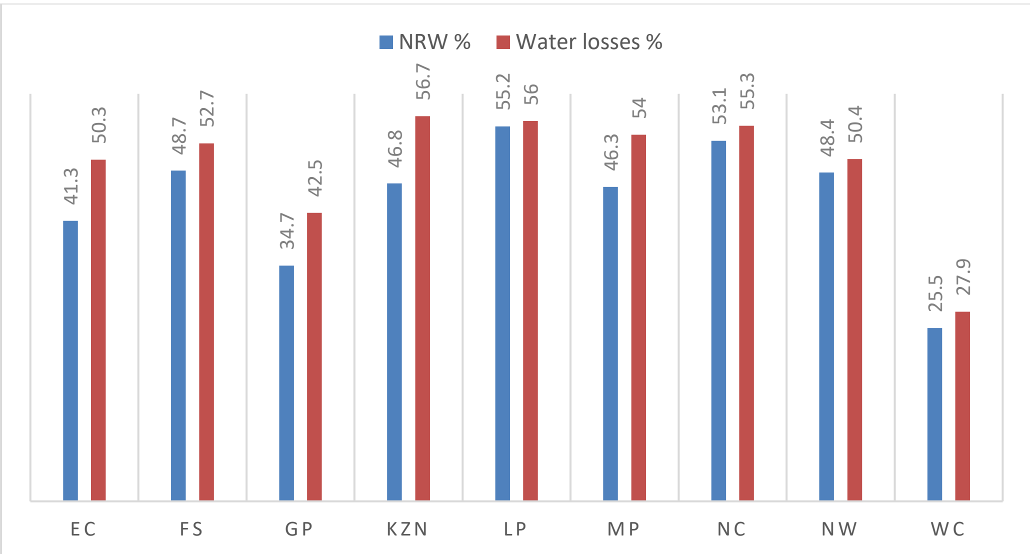


Figure 7.8: NRW vs Water losses per province.

The Gauteng Province has maintained its record of good reporting practices and sound data management. All but one WSA submitted data for the study and regularly provided reports to the Provincial Office, enabling adequate trend analysis. The Provincial Office has a coherent and coordinated reporting system in place and has continued its commendable efforts to maintain a sound relationship with the municipalities and monitoring activities. The efforts of the Gauteng Office are strongly supported by Rand Water which also provides and requires regular feedback through its Project 1600 programme.

The two worse-performing provinces are Limpopo (55.2%) and Northern Cape (53.1%). Limpopo Province, currently displaying 55.2% NRW, has historically had significant challenges with data collection and reporting on NRW. However, improvement is noted, with the water balance for the province based on a 30% submission rate. Data quality remains a concern, with only one WSA in the high confidence data category. The next step for the province would be to promote the submission of the most basic water balance and improve data quality, to ensure that results are based on credible data that reflect the true state of NRW, particularly with the proportionately larger number of rural municipalities. This would facilitate an understanding of the true nature and extent of NRW in rural environments, which constitute a critical part of the NRW management picture in South Africa, and the water management and distribution discourse overall. The Northern Cape Province shows significant variance in data quality across WSAs. Less than half of the municipalities (35%) submitted data, which is a significant decline from previous studies. The province could benefit from improved data reporting efforts and a coherent system of monitoring and verification. A closer working relationship between the Provincial Office and the municipalities is required to improve data generation and reporting practices.

National NRW and water loss trends show a steady increase in NRW over the past 10 years and SIV projections with WC/WDM have been exceeded (Figure 7.9). The figures are dominated by Category A, B1 and B2 municipalities, some of whom have made significant strides in improving NRW management, reducing water losses, and managing the demand in line with reconciliation strategy targets. There is significant scope for improvement of NRW and all municipalities would benefit from targeted demand management programmes, including community education and awareness, leak repair, infrastructure refurbishment, pressure management, and installation of bulk meters, amongst other measures.

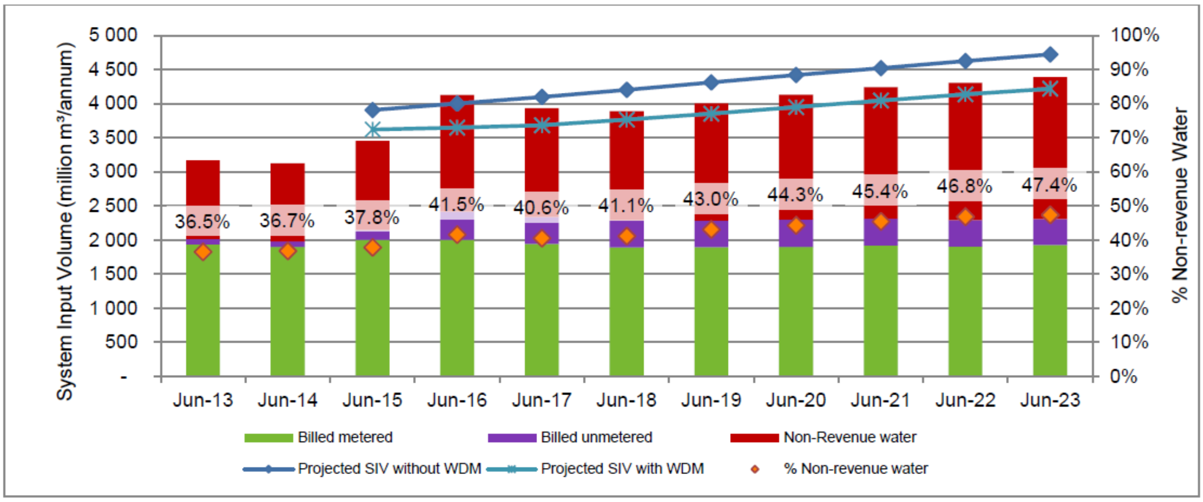


Figure 7.9: National NRW and water loss trends.

7.1.5 Consumption Trends

National trends indicate that the per capita water consumption has remained constant (218-220 l/c/d) over the past 7 years, which is commendable. However, WC/WDM efforts must be elevated considering the level and reliability of service and inefficiencies, and that South Africa is one of the 30 driest countries in the world. The per capita consumption has significantly declined after peaking at 237 l/c/d national average in June 2016 because of the prevailing droughts in parts of South Africa, deteriorating infrastructure and service delivery (Figure 7.10). The enforced water restrictions and WC/WDM interventions had a significant impact on the SIV, especially in the Western Cape.

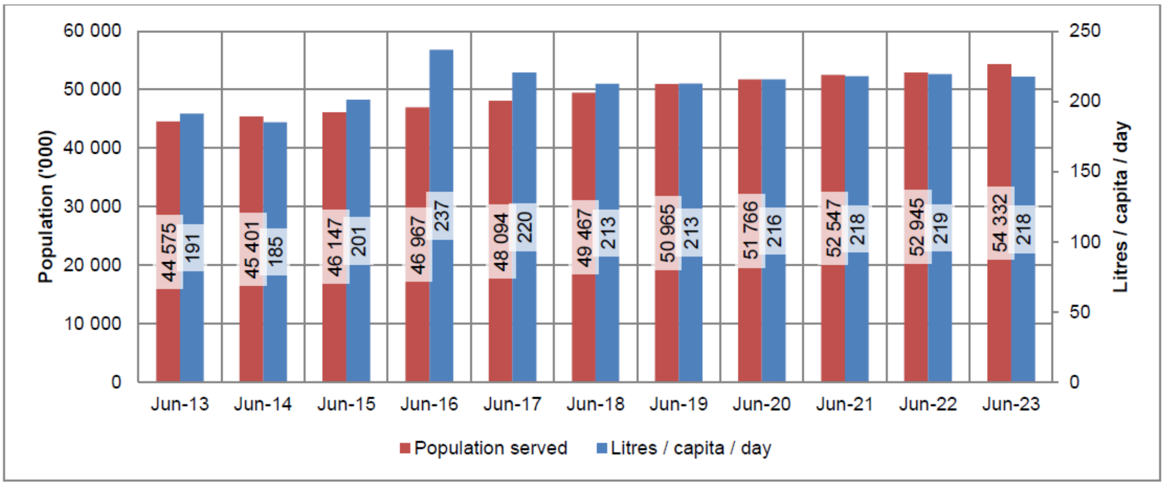


Figure 7.10: National water consumption trends.

The Infrastructure Leakage Index (ILI) deteriorated drastically from 2016 to date, showing signs of improvement in 2017 and 2018 (Figure 7.11). The COVID-19 pandemic escalated the deterioration from 2020. The ILI of 6.9 and 7.0 for 2022 and

2023 respectively indicates poorly managed physical losses, this trend is expected to improve once municipalities have returned to normal, eliminated the leak repair backlogs, and improved revenue collection.

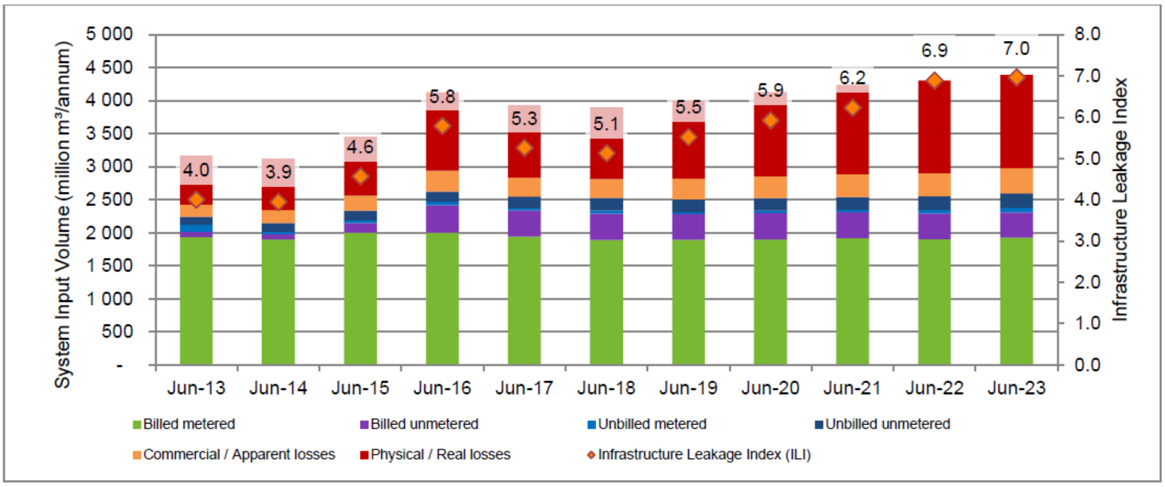


Figure 7.11: The Infrastructure Leakage Index

The results indicate increased NRW, water losses, and ILI, but a significant decrease in the national per capita consumption. Given the increases in three key NRW metrics, WC/WDM must be implemented as a matter of urgency in all Provinces, especially considering that several Provinces have NRW and water losses above 50%. There is significant scope for improvement in reporting levels, data accuracy and a reduction in SIV, NRW, water losses and improved efficiency across South Africa. Only continuous monitoring and analyses will provide a credible benchmark against which progress made with the implementation of WC/WDM can bemeasured. Continuous monitoring should also influence interventions required to manage demand, water losses, and NRW.

Litres Per Capita Per Day

The metropolitan (A) municipalities have the highest per capita consumption and the highest number of wet industries (Figure 7.12). Category B1 and B2 municipalities have slightly lower consumption figures, which are above the national average of 189 l/c/d. The national weighted average of 218 l/c/d is dominated by the Category A and B1 municipalities (Figure 7.13). The l/c/d in some municipalities is extremely high and needs further investigation to ensure the population served figures are accurate.

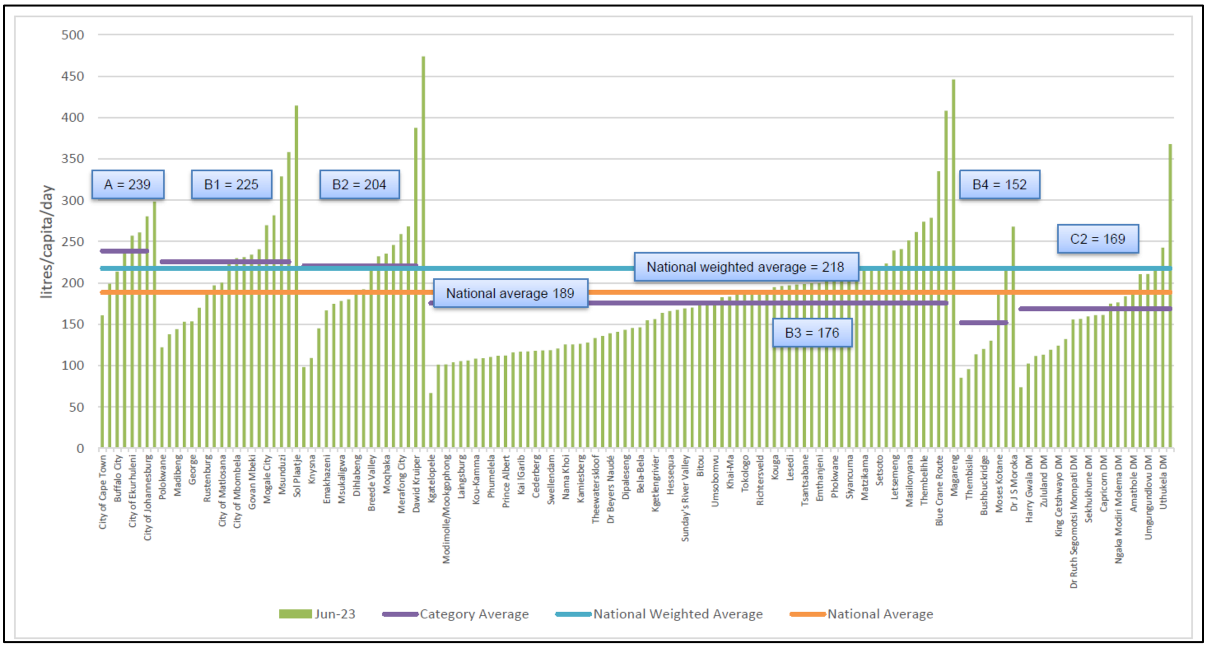
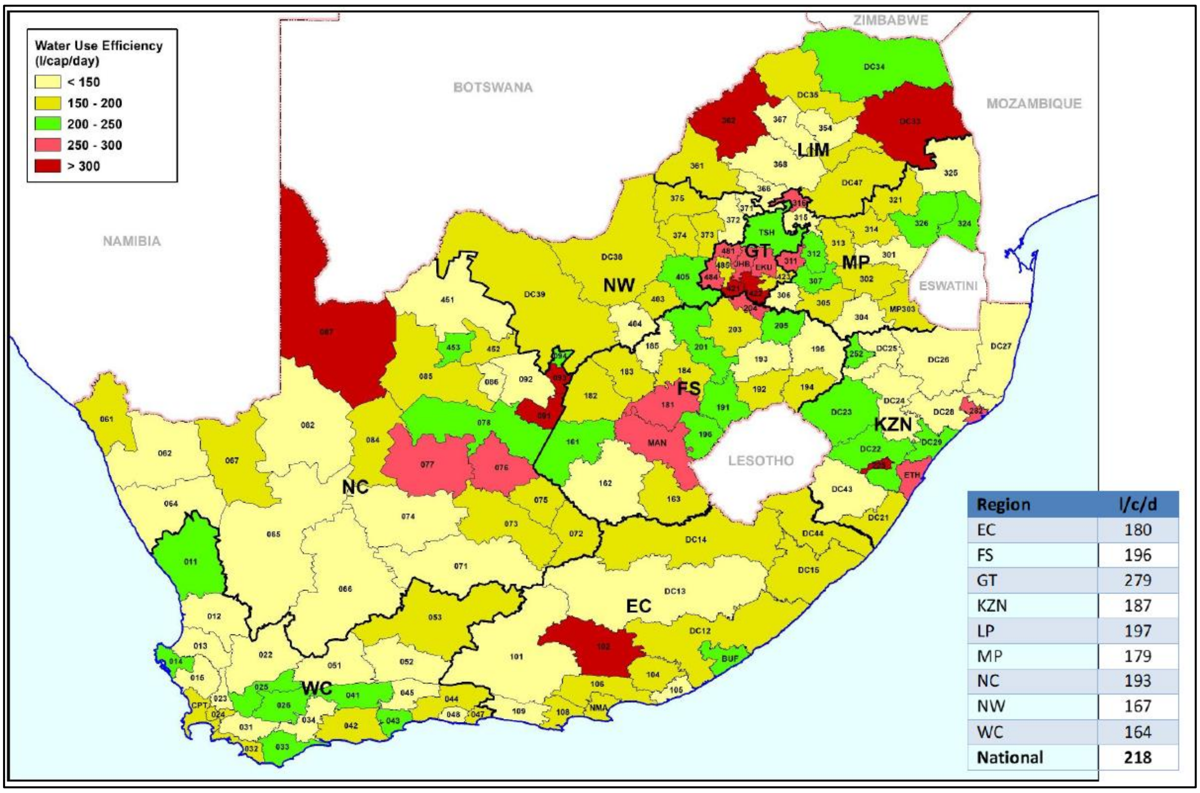


Figure 7.12: Litres per capita per day distribution per municipal category.



Region	l/c/d
EC	180
FS	196
GT	279
KZN	187
LP	197
MP	179
NC	193
NW	167
WC	164
National	**218**

Figure 7.13: Litres per capita per day per WSA.

7.1.6 Financial Analysis

In The State of Non-Revenue Water in South Africa (WRC, 2012), the value of NRW is estimated at R 7.2 billion per annum using production tariffs of between R 3.00/kl for Category B4 and R 5.00/kl for Category A municipalities. The DWS First Order Assessment of the status of water loss, water use efficiency and NRW in municipalities (2014) used R 6.00/kl to calculate the potential savings. The R 6.00/kl was based on the Water Services Tariffs Report for 2012/13 (DWA, 2013). The results from these studies gave a high-level understanding of the potential financial benefit of implementing WC/WDM in the municipal environment.

The Medium-Term Revenue and Expenditure Framework (MTREF) submitted by municipalities on an annual basis provides valuable information on the revenue and expenditure for the current year, past three years, and projected three years. This financial analysis is an attempt to align the actual water revenue and expenditure with the International Water Association (IWA) water balance to assess water cost and potential revenue.

7.1.7 Conclusions

- The 2022/23 national water balance indicates an SIV of 4.39 billion m^3/a, NRW of 2.08 billion m^3/a (47.4%) and water losses of 1.79 billion m^3/a (40.8%). NRW and water losses have increased by a notable 5.8% and 4.3%, respectively, from 2016. However, the greatest increase was in the past three years and attributed to the COVID-19 pandemic. The fluctuation between 2016 and 2019 was generally less than 1%.
- There has been a noticeable increase in billed unmetered consumption because of incorporating FBW supply in the estimated water balances, especially for rural municipalities. Unbilled unmetered consumption remains lower than expected, considering the high number of unbilled properties in South Africa. Municipalities must correct their water balance calculations and show any water use after an accepted connection as authorised consumption and not as water loss.
- National trends suggest that the per capita consumption of 218 l/c/d has remained constant over the past 8 years, which is commendable. However, WC/WDM efforts must be elevated, considering the level of service and inefficiencies, and that South Africa is one of the 30 driest countries in the world.
- The results indicate increased NRW, water losses and ILI, but a significant decrease in the national per capita consumption. Given the increases on three key NRW metrics, WC/WDM must be implemented as a matter of urgency in all Provinces, especially considering that several Provinces have NRW and water losses above 50%. There is significant scope for improvement in reporting levels, data accuracy, and reduction of SIV, NRW, water losses and improved efficiency across South Africa. Only continuous monitoring and analyses will provide a credible benchmark against which the progress made with the implementation of WC/WDM can be measured.
- All municipalities would benefit from targeted demand management programmes, including community education and awareness, leak repair, infrastructure refurbishment, pressure management, and installation of bulk meters, amongst other measures.
- Based on the functional expenditure and SIV of 127 WSAs, the average cost of supplying water is R 13.07/kl. This ranges from R 17.32/kl for metropolitan municipalities to R 12.06/kl for Category B3 municipalities. The cost of supplying rural municipalities (Categories B4 and C2) is the highest, ranging from R 14.26/kl to R 17.64/kl. This is a meaningful change from previous assessments that suggested that the cost of supplying water in rural schemes is less than in large municipalities. The higher cost is justified, considering that these schemes often consist of many small systems with boreholes, which are expensive to operate.
- Using the national average and category average tariffs, the estimated cost to supply water in South Africa is between R 60 and R 70 billion per annum and revenue of between R 42 and R 44 billion is generated from water sales. The value of NRW is between R 28 and R 33 billion at R 13.07/kl which is higher than previous estimates. The increase is due to above inflation water tariff increases from water boards, and the under estimation of water supply costs to rural municipalities.
- The results show that approximately R 1 billion per annum could be saved if the SIV is reduced by 2%, and municipalities would generate nearly R 1 billion per annum for every 2% increase in revenue. The net benefit could be R 10 billion per annum if revenue is increased by 10% and the SIV is reduced by 10%. Reducing the SIV by 10% and increasing the revenue by 10% would reduce the national NRW figure to 35.7%, and the per capita consumption to 195 l/c/d.
- The estimated water balances increase the national percentage NRW by approximately 5.5% and reduces the l/c/d by approximately 23 l/c/d. The estimated water balances increase the national figures, and it is highly unlikely that the NRW in reporting municipalities would be lower than in non- reporting municipalities.

7.1.8 Recommendations

The following recommendations are made to build on the progress made with reporting and the implementation of WC/WDM in the municipal environment:

- All Provincial Offices should establish reporting templates, schedule meetings with municipalities to confirm targets, analyse the water balance information, and provide feedback. The reporting structures in well-performing Provinces are now well-established and managed by the provinces, and most municipalities are reporting quarterly. The initiative was supported by Regulations and sending directives to municipalities that did not respond. A similar approach could be followed for all Provinces to improve communication and water balance reporting.
- One of the key challenges with gathering the information is the poor communication channels with municipalities, which include staff turnover and the common use of private e-mails. Often municipalities are unwilling to provide the information as it reflects badly on them, or they feel that the information has already been submitted through the WSDP and various questionnaires. Government should reconsider effective communication channels with municipalities. Communication should be more formal, avoid duplication, and target senior management in the organisation. Currently, the circulars from the National Treasury provide clear guidelines to municipalities and communications are only with the mayor, municipal manager, and CFO.
- Monitoring and reporting on water balances by municipalities could become more self-regulatory if a policy is implemented that no new infrastructure projects will be funded unless the municipality can provide actual consumption figures and proof that their water losses are under control. The IWA water balance should become the backbone of all water related management and decision support systems, especially grant application and awarding processes.
- Maintenance of the reconciliation strategies must continue and should be used to monitor the progress made with the implementation of WC/WDM. Too many local municipalities are not aware of the reconciliation strategies or expect DWS to provide the necessary funding to implement these strategies. Municipalities must be reminded of their responsibilities in terms of the Water Services Act and actively participate, budget through the Integrated Development Planning process, and implement the results from the reconciliation strategies.
- Ongoing monitoring and reporting of municipal NRW and water loss performance by DWS against determined targets and baselines are critical. DWS Provincial Offices / Catchment Management Agencies / Water Boards must increase their skills and capacity to provide WC/WDM support to municipalities, for monitoring and reporting.
- Budgets are allocated towards new infrastructure projects through Water Service Infrastructure Grant (WSIG), Regional Bulk Infrastructure Grant (RBIG), Municipal Infrastructure Grant (MIG), and other funding programmes, but the management of these funds is fragmented, with emphasis on new infrastructure and insufficient focus on WC/WDM.
- The No Drop incentive-based regulation programme should be rolled-out as planned, alongside the other Drop programmes, to elevate WC/WDM regulation in the municipal environment. DWS should also enforce its regulatory mandate to penalise municipalities that do not comply.
- DWS should consider a policy whereby water services institutions are compelled to either measure and control or fix leaks on private properties, as government cannot continue to fund new infrastructure projects to supplement leakage. DWS is already encouraging the fixing of leaks through various programmes.
- Municipalities should encourage consumers to appreciate the value of water and enforce the user pays principle, through on-going awareness programmes.
- The recommendations of the National Water and Sanitation Master Plan concerning WC/WDM, should be implemented as a matter of urgency.

- Municipalities should increase their efforts to reduce NRW and the negative impact it has on their ability to generate income and operate a viable water service.
- Municipalities should resolve metering and billing issues to increase payment levels, encourage consumer fixing of leaks, prosecute illegal water connections, and reduce theft of water.
- Municipalities should resolve intermittent supply as it is a prerequisite for an effective WC/WDM programme. Intermittent supply is ineffective (consumers adapt), corrupts meter readings and billing data, expensive to operate, damage pipe seals with subsequent increased leakage and is disruptive.
- The recommendations of the Second Edition of the National Water Resource Strategy (DWA, June 2013) must be implemented, including the call for greater emphasis on meeting specific targets to reduce water loss. WC/WDM measures will have multiple benefits in terms of the postponement of infrastructure augmentation, mitigation against climate change, support for economic growth, and ensuring that adequate water is available for equitable allocation.
- Closer involvement and collaboration with National Treasury are critical to ensure issues related to funding of WC/WDM programmes, and metering, reading and billing are resolved with municipal finance departments.
- Greater involvement of the private sector through public-private partnership, stewardship, and performance-based contracts should be encouraged to improve service delivery and expedite the implementation of WC/WDM interventions. National Treasury should review the procurement of these contracts to eliminate bottlenecks and attract private investment.
- On-going provision of mentorship to municipalities through the DWS Provincial Offices, Department of Cooperative Governance and Traditional Affairs (CoGTA), the South African Local Government Association (SALGA) and other institutions is critical.
- Closer involvement and collaboration with CoGTA and SALGA are critical to ensure issues related to human resources skills and capacity in municipalities, payment for services, and unauthorised water use are resolved.
- Closer collaboration is required with other national, provincial, and local government departments that are big water users. These include Departments of Education, Correctional Services, Health, Public Works, and Housing, to ensure leakages and wastage are brought under control.
- Human right to food and water comes with a responsibility and every citizen must use water sparingly, pay for water services, fix household leaks, report municipal leaks, and promote water use efficiency at home, work, and public facilities.

7.2 Water Resources Development

Water resource development mainly addresses issues such as socio-economic uplifting and development, ensuring the availability of safe water supplies to communities, and meeting the water requirements for industries and other sectors critical for economic growth. The Department has been involved in the development of water resources infrastructure to augment the water supply and safeguard future water security. Estimated funding of at least R126 billion is required to finance key water resource development projects in the next ten years**.**

Furthermore, the list of prioritised water resource development per water supply system is given in Table 7-2.

Table 7-2 Current Prioritised Water Resource Development

Water Resource (WR) System	**Current Prioritized Water Resource Development Option and Estimated Date of Water Delivery**		
	2020 – 2030	2031 - 2040	2041 – 2050
Integrated Vaal River System	Phase 2 of Lesotho Highlands Water Project by 2025 (R32.6 billion)	Use of Acid Mine Drainage	Thukela Water Project (Jana & Millietuin Dams)
Orange River System	Gariep Pipeline by 2024 (R8 billion), Vioolsdrift Dam in the Lower Orange (R6 billion)	Dam at Verbeeldingskraal in the Upper Orange River	
Crocodile West River System	Mokolo Crocoldile (West) Water Augmentation Project (MCWAP) by 2024 (R15 billion)	Re-Use of Effluent	Re-Use of Effluent
Olifants River System	Olifants River Water Resource Development Project (ORWRDP) Phases 2B (R6.6 billion), 2D (R1.8 Billion), 2E (R0.5 Billion) & 2F (R2.3 billion) Exploitation of the Malmani Dolomitic Groundwater Aquifer	Re-Use of Effluent	Olifants Dam (Possibly Rooipoort Dam)
Mgeni Water Supply System	Phase 1 of uMkhomazi Water Project by 2026 (Dam at Smithfield, 33km transfer tunnel and Associated Works) (R18.5 billion)	Re-Use of Effluent	Phase 2 of uMkhomazi Dam (Dam at Impendle and Associated Works)
Algoa Water Supply System	Lower Coerny Balancing Dam Ground Water Development Scheme	Re-Use of Effluent	Kouga Dam Augmentation Scheme
Western Cape Water Supply System	Berg River – Voelvlei Augmentation Scheme (BRVAS) by 2021 (R0.9 billion) Table Mountain Group Aquifer Scheme	Breede-Berg River Augmentation Scheme (Mitchell's Pass Diversion & Raising of Voelvlei Dam)	Raising of Lower Steenbras Dam Desalination of Sea Water
Eastern Cape Water Schemes	Mzimvubu Water Project (R17.9 billion), Koonap River Development Project (Foxwood Dam) (R3 billion), Lusikisiki Water Project (Zalu Dam) (R2 billion)	Groundwater Development	Phase 2 of Mzimvubu Water Project
Letaba Water Supply System	Groot Letaba Water Augmentation Project (GLeWAP) (Nwamitwa Dam (R1.7 billion) & Raising of Tzaneen Dam wall)	Groundwater Development	Water Re-Use
Olifants-Doorn Water Scheme	Clanwilliam Dam Raising (R 3.3 billion) Phase of Conveyance System from the Raised Clanwilliam Dam (R6 billion)	Phase of Conveyance System from the Raised Clanwilliam Dam	Groundwater Development

7.2.1 Augmentation Projects

Water infrastructure is ageing and becoming dysfunctional. Aged infrastructure results in huge water losses and water supply backlogs. Infrastructure renewal lies in the responsibility of the Infrastructure Management Branch within the Department, which is also responsible for the management of Government Water Schemes (GWSs). Table 7-3 reports the progress made on augmentation projects that the Chief Directorate is implementing: Infrastructure Development for the period up to the end of September 2022.

Table 7-3 Progress of augmentation projects across the country

Province	Project Description	Projects status	Other
Limpopo	Nandoni Dam	Giyani water services project, including the pipeline from Nandoni Dam on progress.	Nandoni water purification upgrade, including possible waste-water treatment plant
	Phase 2 of the Olifants River Water Resources Development Project (ORWRDP – 2) involves the development of additional water resource infrastructure consisting of the De Hoop Dam on the Steelpoort River	The amended fence and security drawings were presented at the second security technical meeting with further amendments required before finalisation.	
Western Cape	The project for the Raising of Clanwilliam Dam is aimed to provide additional water to improve the assurance of supply for agriculture, provide for water allocations to resource-poor farmers and to address dam safety aspects. The scope of the work includes the raising of the existing dam wall by 13 metres, the relocation of a section of the N7 directly affected by the raised dam wall and the raising of the secondary provincial roads affected by the Full Supply Level	The civil design is complete. Most of the construction drawings are complete and have been formally issued to the Contractor. Construction progress is at 12% completion. The procurement process for the appointment of the PSP and APP was finalised, the PSP is rendering engineering services as of September 2023.	Upgrade of Greater Brandvlei Dam Scheme
Gauteng	Lesotho Highlands Phase 2	Lesotho Highlands Phase 2 is in progress.	
KZN	uMkhomazi Water Project	To date, 73 anchors have been installed and stressed.	

	Raising of Hazelmere Dam. The project for the Raising of Hazelmere Dam is aimed to augment the water supply to the KZN North Coast by raising the dam wall by 7 metres to increase the yield of the dam for medium-term supply. The scope of the work includes the construction of a piano key weir on the spillway, the installation of rock anchors, foundation grouting and other minor works	Progress on the dam wall construction is at 97% completion. Work on the intake tower and the left and right flank training wall is complete, and work on the NOC screed and training wall is in progress. The appointment of a private contractor for the construction of the permanent houses is in progress.	
Eastern Cape	Ncwabeni off-channel storage dam The project involves the construction of a new concrete faced zoned rockfill dam on the Ncwabeni River, with a multi-level intake tower, an abstraction weir on the Umzimkhulu River and a pump station and pipeline to pump water into the off-channel storage dam	Civil and mechanical designs independent of geotechnical investigations and surveys are continuing. The preliminary design is 85% complete, the detailed design is 25% complete, and tender documentation is 8% complete. The procurement of environmental engineering, geotechnical engineering and surveying services required to advance the design work is being hindered by the lack of funding for the project.	

7.3 Wetlands Rehabilitation

The protection and rehabilitation of wetlands are vital in addressing water security in the country. Wetlands are natural assets and natural infrastructure that can provide a variety of free products, functions, and services. Despite being valuable ecosystems, wetlands make up only 2.4% of the country's area (DFFE, 2021). However, studies have found that wetlands are among the most threatened ecosystems in South Africa and are currently in poor ecological condition. According to the 2011 National Biodiversity Assessment, 65% of wetland types were threatened (48% critically endangered, 12% endangered, and 5% vulnerable). Only 11% of wetland ecosystem types were found to be well protected, with the remaining 71% unprotected (SANBI, 2011).

In the 1970s, governments around the world, including South Africa, offered farmers incentives to convert their wetlands to agriculture. Over the years, these activities have had a significant impact on and altered the landscapes of South Africa. According to SANBI (2011), between 35% and 60% of South Africa's wetlands have already been lost or severely degraded. Figure 7.14 shows the South African Wetlands Map (SANBI, 2020).

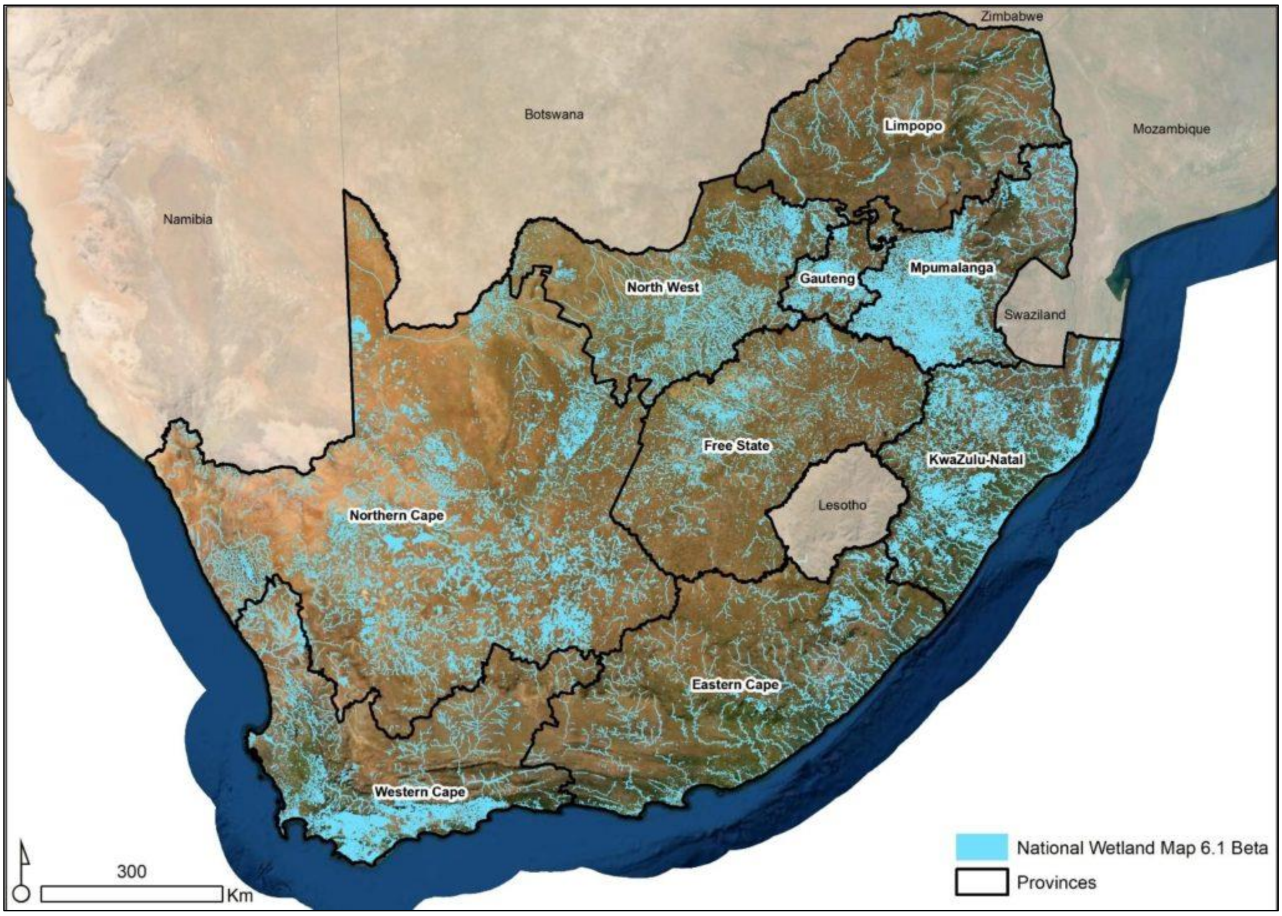


Figure 7.14: SA Wetlands Map (Source: SANBI, 2020).

7.3.1 Legislative background on wetlands protection

The South African government policy reflects the recognition that, in order to be truly effective, wetland conservation strategies must include both proactive measures for maintaining healthy wetlands and actions to reverse past degradation. The latter aspect is central to a government-led wetlands program. The protection of wetlands in South Africa is promoted by the following policies:

- Section 24 of the South African Constitution states that "everyone has the right to an environment that is not harmful to their health or well-being; and the right to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic growth."

- The 1984 Conservation of Agricultural Resources Act became the first substantial legal instrument for protecting wetlands and remains in force to this day.
- The National Environmental Management Act (NEMA, Act No. 107 of 1998) and the National Water Act (NWA, Act No. 36 of 1998) and the environmental provisions of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA) ensure that urban and commercial developments do not affect or alter the natural state of wetlands.
- Principles such as the ‘duty of care’, enshrined in Section 28 of the NEMA, require that landowners take reasonable measures to prevent, minimise and rectify environmental degradation on their properties.

7.3.2 Benefits of Wetlands Rehabilitation

According to the 2018 National Biodiversity Assessment, rivers, wetlands, and catchment areas are critical ecological infrastructure for water security, often supplementing built infrastructure; however, the benefits of some of these ecosystems are currently jeopardized due to their poor ecological condition, (SANBI, 2018). Water security can be enhanced through integrated natural resource management in Strategic Water Source Areas (SWSAs) and other critical catchments. SWSAs account for only 10% of South Africa's land area but supply 50% of all surface water, supporting half of the country's population and nearly two-thirds of its economy.

Moreover, with climate change expected to alter rainfall patterns, wetlands will play a greater role in mitigating the effects of floods and droughts. All rehabilitation interventions aim to improve the condition and functioning of wetland ecosystems, addressing both causes and effects of degradation.

7.3.3 Ecological Infrastructure Rehabilitation and Restoration Projects

Several wetlands in South Africa have been rehabilitated and restored by different institutions such as the Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), and the Working for Wetlands programme. DWS, in collaboration with the City of Ekurhuleni, the Gauteng Department of Agriculture, Rural Development, and Environment (GDARDE), is currently working to rehabilitate a wetland along the Blesbokspruit River, which, once completed, will contribute to cleaner and better-managed water for the Vaal Water Management Area (VWMA). The project is detailed in the case study below.

CASE STUDY: BLESBOKSPRUIT RAMSAR SITE REHABILITATION PROJECT

Background

The Blesbokspruit wetland is located along the Blesbokspruit River, a large tributary of the Vaal River. It is one of 26 RAMSAR sites in South Africa, and forms part of the Convention on Wetlands of International Importance. The wetland covers 1858 ha, and habitats more than 250+ bird species including species listed in the South African (SA) Red Data Book of Birds.

The surface water quality of the Blesbokspruit wetland deteriorated over the past ten years due to impacts from municipalities, industries, mining, lack of reed management, and the invasion of the water hyacinth. The challenges with the reed management make the wetland impenetrable and cause anoxic conditions in some parts of the wetland. The few open bodies of water that are present have become overgrown with the invasive alien species water hyacinth (Eichhornia crassipes). The thick decks of water hyacinth decrease the habitat for water fowl and cause more anoxic conditions in some parts of the wetland.

Project Progress:

The following has been achieved thus far:

- Spraying and removal of reeds and water hyacinths.
- Setting up biocontrol successfully at the side. Insects are used to slow down the growth of the water hyacinth together with DEFF and Rhodes University.
- Training of women of the local community to craft sustainable products out of the water hyacinth that has been removed.
- Setting up a project management structure with water quality, economic development, Ecological restoration, Compliance and Mining commissions.

Project Partners

DWS Gauteng, GDRARD and the City of Ekurhuleni. Stakeholders include DEFF, Rhodes University, Grootvaly Blesbokspruit Conservation Trust, the Blesbokspruit forum and NGO Thegka.

8

WATER-ENERGY-FOOD NEXUS

8 WATER-ENERGY-FOOD NEXUS

8.1 Background

The connectedness of current challenges (climate change, environmental degradation, population growth, migration, and the emergence of novel infectious diseases) requires circular and transformative approaches that holistically address these cross-cutting challenges. Managing the intricate relationships between distinct but interconnected sectors through nexus planning has provided decision-support tools to formulate coherent strategies that drive resilience and sustainability. As a result, the Water-Energy-Food (WEF) nexus has gained increasing attention in the research and decision-making communities in recent years as a prominent approach for integrated resources management. The systematic thinking embedded in the WEF nexus is priceless as it considers the synergies and trade-offs in resource planning, utilisation, and management. The developments in one of the three WEF sectors should always consider the impacts on the other two to avoid transferring problems from one sector to the other.

Over the past decade, the WEF Nexus has emerged as a useful concept to systematically reduce trade-offs and increase synergies in promoting water, energy, and food security goals. This, in turn, supports the attainment of several Sustainable Development Goals (SDGs), particularly SDGs 2, 6 and 7, with interlinked positive effects on several other SDGs. The nexus is driven by a holistic vision of sustainability that seeks to strike a balance among key resources (water, energy, and food), the different goals, interests, and needs of people and the environment in a region faced with population growth, urbanisation, industrialisation, resource depletion and degrading ecosystem services. The nexus builds understanding around interlinked resources and can be applied to achieve resource security and sustainable development. Focusing on addressing challenges in any one of these sectors only promotes optimal efficiencies in that one sector at the expense of the other two, as the same challenges will manifest in the other neglected but equally important sectors.

Furthermore, the three resources are the most climate-sensitive sectors, a cross-sectoral challenge needing cross-sectoral and holistic interventions. The WEF concept is, therefore, promoted as a governance solution to complex resource management challenges. The intricate interlinkages between the three WEF sectors manifest as food production needs water and energy, water management (extraction, treatment, and redistribution) requires energy; and energy production requires water. Despite these interlinkages and the fact that decisions taken in one sector can spill over and affect the other sectors, traditional and sector-based research approaches have fallen short in addressing the linkages between WEF resources. Moreover, existing WEF insecurities are exacerbated by climate change, increasing uncertainty for future development plans.

8.2 Overview of the WEF Resources

South Africa is currently grappling with the poverty-inequality-unemployment challenges, with unemployment over 34% (StatsSA, 2021). Most government initiatives are driven by the urgent need to address this problem and deliver the promise of a better life for all. In these efforts, water, energy, and food are critical to delivering socio-economic reforms, sustainable economic development, and achieving national and international goals. South Africa is slowly adopting the WEF nexus as a transformative approach that drives the transformational agenda at the national level (Liphadzi et al., 2021; Mabhaudhi et al., 2021; WRC, 2018). A working group of the country's WEF Community of Practice (WEF-COP) was formed to support the development and implementation of a 5-year country WEF programme. The working group is meant to harmonise policy documents and reduce sector-based management of resources that are still fragmented, sitting in distinct departments. Through its WEF nexus Lighthouse, the Water Research Commission (WRC) has been leading work and discussions as well as pilot projects that highlight the benefits of the WEF nexus approach. However, despite these efforts, South Africa still lacks a guiding WEF policy document to guide the implementation, monitoring, and evaluation of the nexus (WRC, 2018).

South Africa faces water, energy, and food insecurity (Figure 8.1). While the country is food secure at a national level, over 50% of households still face food insecurity, 98% of the country's water resources are already allocated, and the country currently faces instability in the energy sector (StatsSA, 2019). The recurrence and increasing droughts, coupled with sectoral resource management and climate change, compound the challenges of resource insecurity (Mpandeli et al., 2019; Nhemachena et al., 2020). Given these cross-cutting and interlinked challenges (Figure 8.1), there is an urgent need for South Africa to speed up the implementation of the WEF nexus approach to enhance resource security in an integrated and sustainable manner.

Ensuring water, energy and food security is a priority in South Africa, centred on improving livelihoods, building resilience, employment creation, and economic development (Nhamo et al., 2020; Von Bormann and Gulati, 2014). The current cross-cutting challenges require adopting transformative approaches such as the WEF nexus at the national level, a platform for stakeholder engagement, as evidenced by forming a community of practice at the national level. Importantly for South Africa, the WEF nexus has been recognised as a framework to guide integrated resource management and drive the country towards resource use efficiency, poverty reduction, employment creation, and achieving SDGs (Mabhaudhi et al., 2021; StatsSA, 2019, 2021). This is also motivated by the need to produce more food and energy to meet the demands of a growing population.

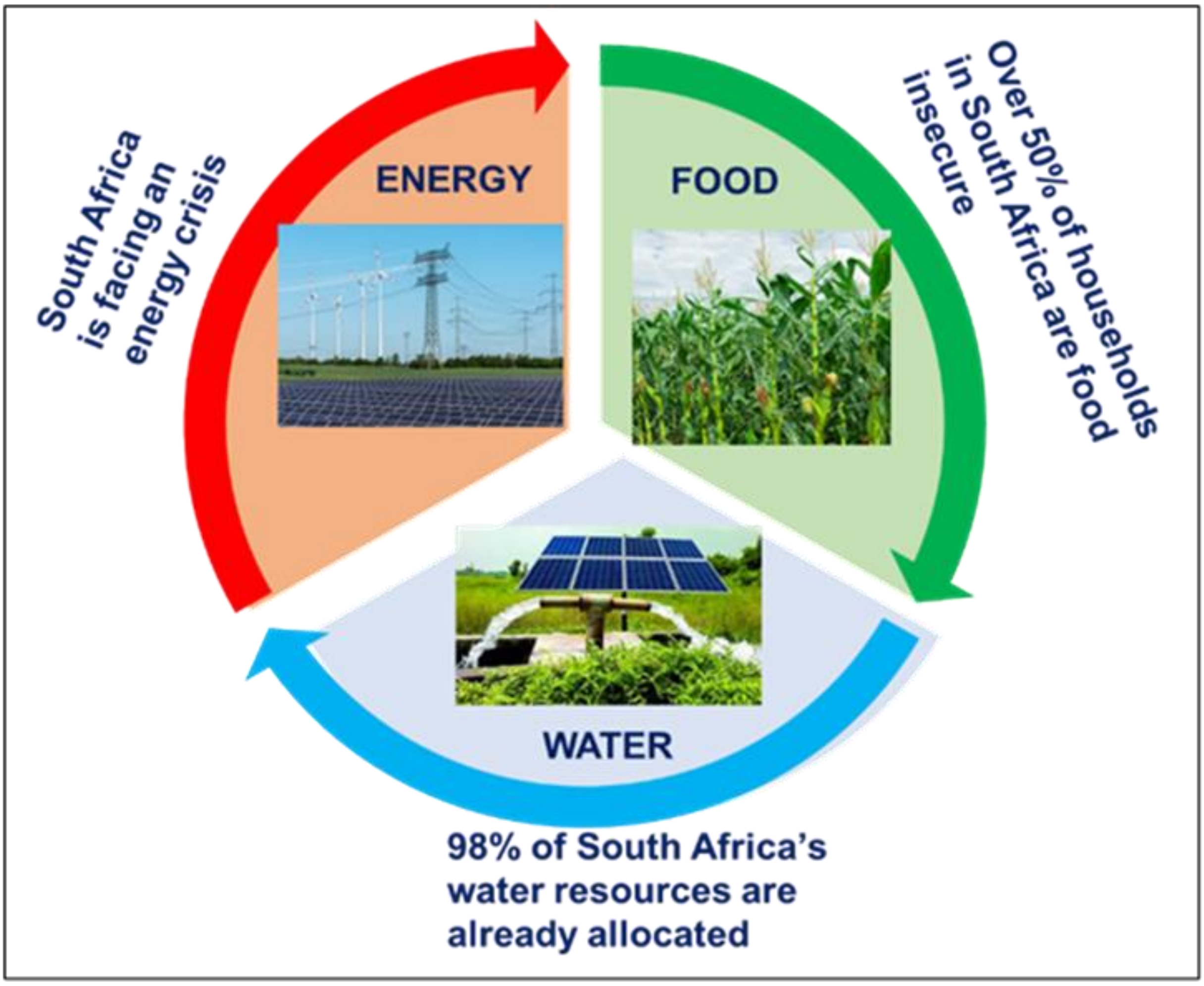


Figure 8.1: The WEF nexus sectoral challenges (Source: WRC).

8.2.1 Water Resources

South Africa is a water-scarce country (StatsSA, 2017). Water insecurity has become severe as almost 98% of the available freshwater resources are already allocated, and over 60% is used for crop production (StatsSA, 2017). Water availability is highly variable, determined by rainfall variability in the national territory (Figure 8.2).

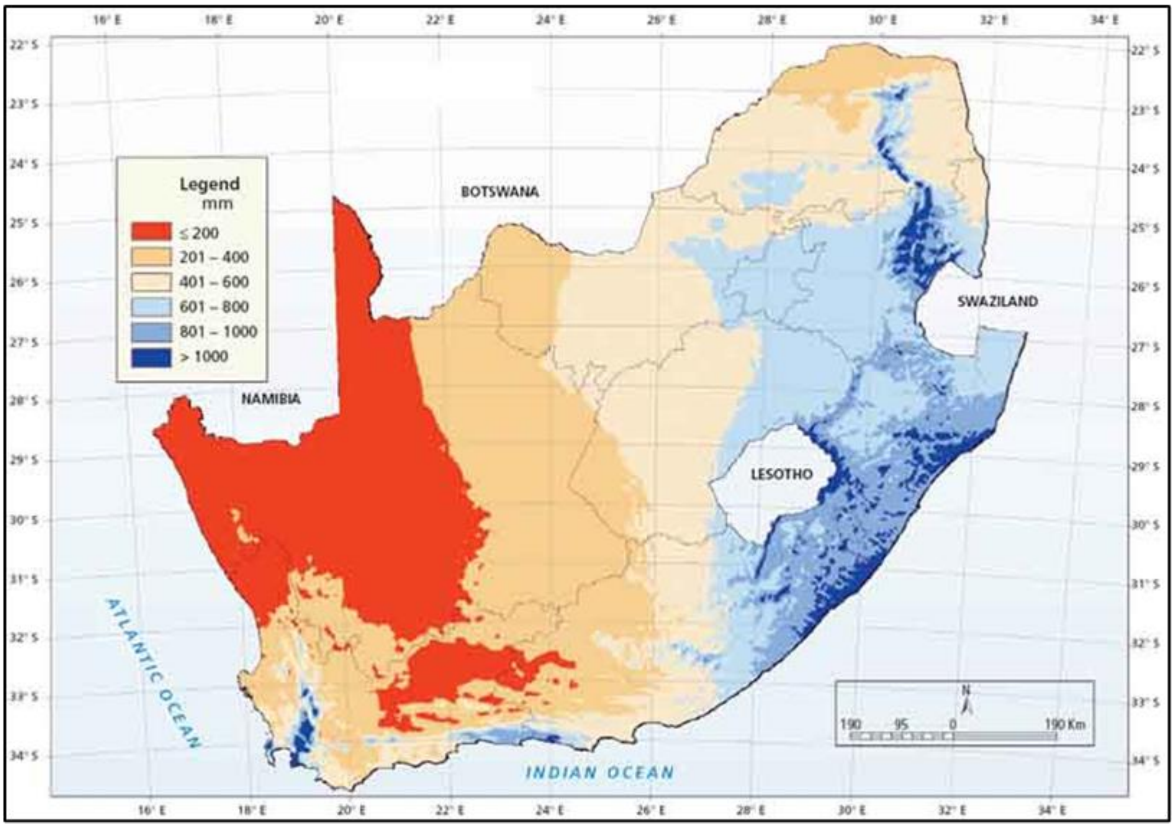


Figure 8.2: Average annual rainfall across South Africa (Source: ARC-ISCW, 2004).

Rainfall varies from less than 50 mm in the northwest to more than 3,000 mm in the mountains of the southwestern Cape. Thus, the eastern parts of the country receive considerably more rain than the dry western parts. However, the country has a well-developed water infrastructure (Pitman, 2011). South Africa has the highest level of artificial water storage per capita in Africa, at around 700 m^3 per capita per annum (StatsSA, 2010). The well-developed water infrastructure has enabled the country to manage long periods of drought. Still, the recurrence and intensity of drought in recent years have resulted in the depletion of reservoirs, causing an increased use of groundwater resources (GreenCape, 2017).

Although groundwater resources availability in South Africa is still unknown, 13% of the country's freshwater resources come from groundwater, of which 59% is used in irrigation, 13% in water supply, 13% in mining, 6% in livestock, and 9% for other uses (Figure 8.3). South Africa has 1,000 m^3 of renewable water available per capita per annum, which is too high for a water-scarce country (StatsSA, 2017). The country has a dependency ratio of 13%, meaning that 13% of its freshwater water resources are generated from other countries (GreenCape, 2017). At the same time, 170 million m^3/yr of water resources generated in South Africa are transferred to Botswana, Mozambique, Swaziland, and Namibia (Kumwenda et al., 2015). South Africa has formed Water Management Areas (WMAs), and in almost all of them, there are currently water deficits as demand outstrips supply (GreenCape, 2017; StatsSA, 2010). This is projected to worsen as the population grows and water demand increases (GreenCape, 2017). Estimates indicate that by 2030, South Africa will face a 17% demand-supply gap (GreenCape, 2017).

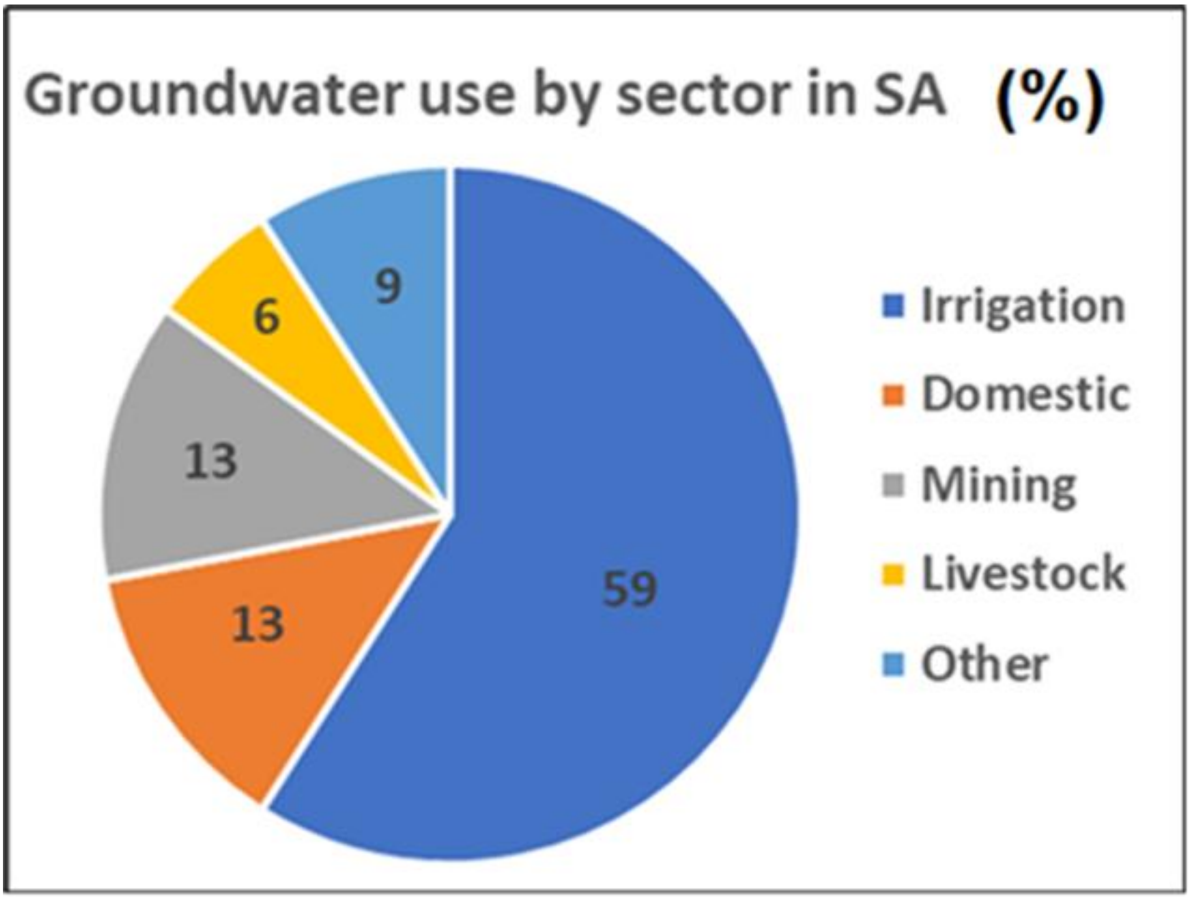


Figure 8.3: Sectoral groundwater in percentage (Source: GreenCape, 2017).

Agriculture alone uses approximately 9.7 km^3 (about 63%) of total annual water withdrawals in South Africa (Donnenfeld et al., 2018) (Figure 8.4). There is an urgent need to enhance water-use efficiency, promote sustainable food systems through circular models, and improve water productivity, particularly in agriculture. Agriculture is the largest consumer of water in South Africa; therefore, adopting agricultural water management technologies and innovations is critical for the country to enhance water use efficiency in the agriculture sector. The situation is worsened by the low average annual rainfall of about 450 mm, well below the world average of 860 mm (Davis and Vincent, 2017).

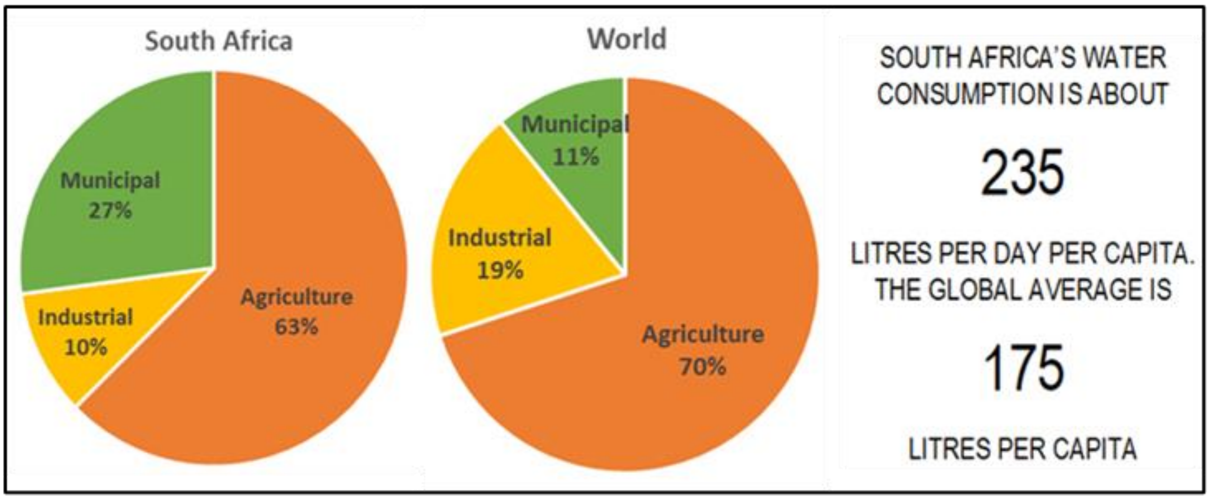


Figure 8.4: Total water withdrawals in South Africa versus the world by sector (Source: World Bank Indicators, 2020).

As already alluded to, agriculture accounts for about 63% of water use in South Africa, followed by domestic (24%) (Figure 8.4) (GreenCape, 2017; Von Bormann and Gulati, 2014). As a mitigatory measure to the challenge of water scarcity, South Africa and Lesotho initiated the Lesotho Highlands Water Project, where Lesotho transfers some of its abundant water resources to the Gauteng region (Nhemachena et al., 2020). In return, Lesotho uses the revenues from the project to develop its hydropower capacity and improve water distribution within the country (Matchaya et al., 2019). There is a need to build on such transboundary transfers to address water scarcity at the regional level.

8.2.2 Energy Resources

Energy is a key economic driver, especially in an emerging economy such as South Africa. Strategies to increase levels of industrialisation, mining output, growth in manufacturing, and associated activities are all key contributors to increasing demand for energy. In addition, the growing middle class, rural-urban migration, and focus on developing rural economies also add to the increasing demand for energy. The International Energy Agency (IEA) forecasts that demand for energy in South Africa is set to increase by more than 30% between 2010 and 2035 (IEA, 2016). Over the same period, climate change predictions indicate increased frequency and intensity of extreme weather events in the country (particularly drought and floods) (Nhamo et al., 2019). The increased demand for energy and the increased water scarcity highlights a challenge that requires transformational approaches such as nexus planning, circular economy, and scenario planning that enhance resource use efficiency (Mabhaudhi et al., 2021). For example, water and energy availability have become topical issues in recent years. Most parts of the country have been experiencing water supply shortages due to a lack of power and cable theft. The main water purification systems are not getting enough energy. The lack of power supply and water unavailability is due, in part, to a lack of recognition of the relationships between the water and energy sectors or slow implementation of the nexus approach.

About 4% of South Africa's water is used for power generation (Figure 8.5), a low figure compared to that used in agriculture. However, this figure only considers water used for hydroelectric power and cooling coal and nuclear plants. It does not take into consideration water that is used in biofuel feedstock production, nor does it take into consideration the entire water footprint in power generation. However, energy is used for services by municipalities in South Africa. Drinking and wastewater use 45% and 55% of energy in urban areas respectively (Figure 8.5).

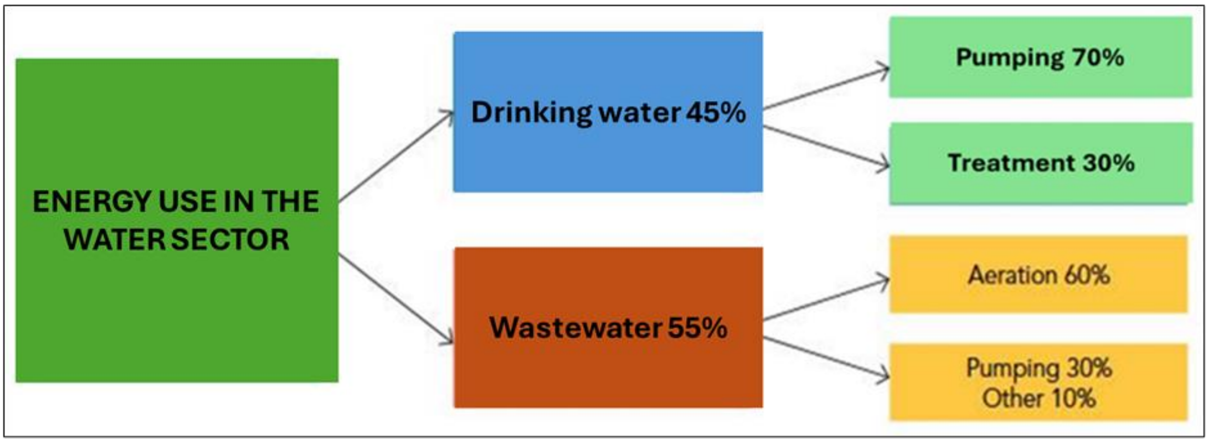


Figure 8.5: Average energy use in the water sector in South Africa (Source: GreenCape, 2017).

8.2.3 Land and Agriculture

South Africa is food secure at the national level; however, it is faced with extreme poverty and high-income inequality, in that approximately 56% of the population lives in poverty (StatsSA, 2019). Many households face food insecurity daily (Chakona and Shackleton, 2019). Most people facing food and nutritional insecurity live in rural areas and informal settlements. Statistics South Africa (StatsSA, 2019) reports that approximately 25.2 % of the population lived below the poverty line of R14.70 per person per day. Rainfed agriculture is the third-most important means of livelihood, after remittances and government grants, but it contributes only 10% to household survival (StatsSA, 2019). Given the political and human rights challenges of hunger and unemployment that the Covid-19 pandemic has exacerbated, there is an urgency to provide practical, cost-effective support to smallholder farmers that can be implemented at different agroecological zones.

Figure 8.6 is a map of South Africa showing the agricultural area by the system (rainfed and irrigated) and the percentage of each system by province. Over 23 million ha of land in South Africa is under cultivation, of which 18 million ha is rainfed and only 5 million ha is irrigated. The Western Cape, Northern Cape, Limpopo, and KwaZulu-

Natal provinces have the highest proportion of agricultural land under irrigation. The rest of the provinces have irrigated areas of less than 15%, and they are the provinces that show extreme dry conditions. The most rainfed area is under smallholder farmers. As smallholder farmers produce most of the food crops and yet are the most vulnerable to the impacts of climate change, intervention should, therefore, target the smallholder farming system. Dependence on rainfall for agriculture implies that once there is a climate shock in the system, such as drought or flood, there would be total crop failure that season.

Eighty percent of South Africa's agricultural land is suitable for animal production. Cereals and grains occupy about 42% of cultivated land (StatsSA, 2017). Although South Africa is defined as a food-secure country, producing enough staple food or having the capacity to import food, if needed, to meet the basic nutritional requirements of its population, (Chakona and Shackleton, 2019), 20% of the population remains food insecure, and 50% do not have enough food (StatsSA, 2019). On average, South Africa has been self-sufficient in agricultural production and a net food exporter. The impact of extreme weather events has been impacting on food security of the country, as evidenced by the 2015/16 drought that saw the country importing the staple maize crop for the first time (Nhamo et al., 2019). Agriculture contributes about 3% to South Africa's gross domestic product (GDP) and about 7% to formal employment (StatsSA, 2019).

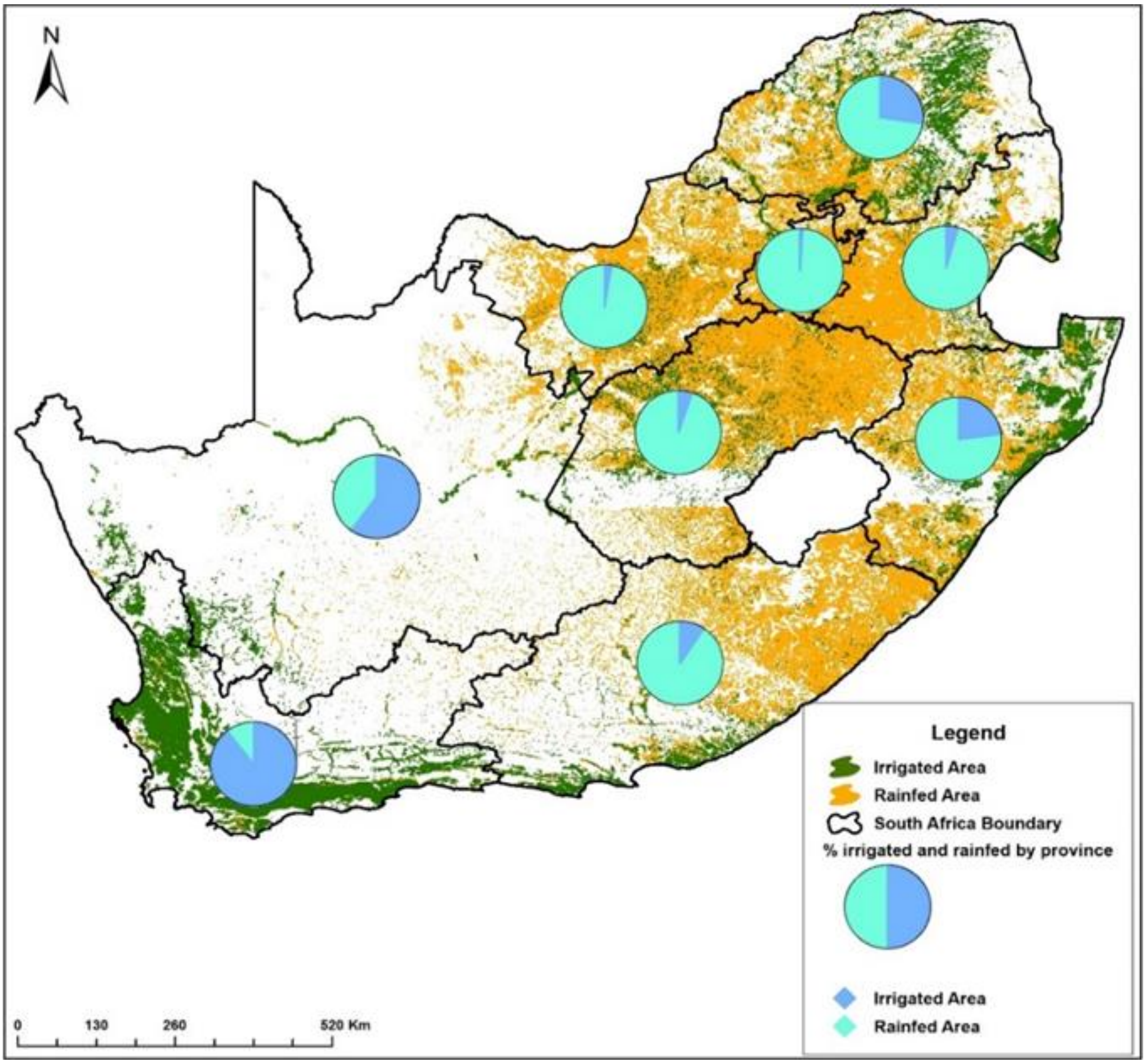


Figure 8.6: Irrigated and rainfed areas and the proportions by province (Source: Siddiqui et al., 2016).

8.3 Importance of Nexus Approaches

The insecurity of the WEF resources in South Africa is compounded by climate change, resource depletion, and degradation, migration, the emergence of novel pests and diseases, poverty and inequality, and unsustainable food systems, among others, a situation that has triggered the need for transformational change. Apart from the challenges within the three WEF sectors that are also causing negative environmental changes, there are also spill-overs into other sectors, such as health and the environment. For example, the disruptions caused by the COVID-19 pandemic caused immense disruptions in all sectors of the economy while policy and decision-makers were proving reactive measures, focusing on the health sector. The COVID-19 experience has demonstrated that focusing on a single sector during a crisis only exacerbates the stressors in other sectors as decision-makers have often viewed the world from a linear perspective, with the thought that a click of a button would get the economy and society back on track (Nhamo and Ndlela, 2021).

South Africa has developed a natural resources atlas that provides access to a comprehensive set of data and a framework for strategic planning at national and provincial levels for implementing programmes focusing on biodiversity, climate change, and land assessment for long-term sustainability. The atlas provides access to 63 national spatial layers of information on soil, climate, vegetation, terrain, land capability, and high-resolution satellite data. These are being implemented with other national departments, provinces, and municipalities. The LandCare programme was established to promote productivity through the sustainable use of natural resources, improve food security, and create employment, encouraging South Africans to use sustainable methods of cultivation, livestock grazing, and harvesting of natural resources to limit land degradation.

8.4 Establishing the Context and Case for Supporting WEF Nexus Investments

South Africa's natural resources and the location of economic development nodes are unevenly distributed; this amplifies management constraints and inequality of access to these resources. A delicate scenario South Africa faces is water, energy, and food insecurity, yet the security of these resources forms the basis of a resilient economy. Apart from being a water-scarce country, the country has limited arable land (StatsSA, 2019) and is highly dependent on fossil fuels for energy generation (86% of the country's electricity is generated from coal); the country also depends on oil imports. Estimates show that by 2030, 65% of South Africa's electricity will still be generated from coal. The population will have increased to 60 million, and as early as 2025, the country will face a water deficit of 1.7% (Von Bormann and Gulati, 2014). At the same time, the National Development Plan (NDP) targets an increase of more than 50% of land under irrigation (NDP, 2013). Indications are that the country's resources will be stretched to the limit soon, and this calls for urgent adoption of an integrated approach to resource utilisation and management through the WEF nexus.

The challenges posed by resource constraints in South Africa indicate a looming crisis in providing clean water, electricity, and nutritious and affordable food, which are at the heart of national security and welfare. The WEF nexus is central to the sustainability of South Africa's future. The situation requires enhanced information, coordinated planning, wider technology use, adaptation, and greater governance through policy to guide the WEF sectors.

8.5 Institutional and Legal Frameworks at the National Level

8.5.1 Existing Institutional Arrangements Governing WEF Resources

The Constitution of the Republic of South Africa (RSA, 1996) is the overarching document that guides all other legislative and policy instruments adopted by the government. The water right is enshrined in the Constitution and implemented by the work of ordinary statutes. The Constitution states that everybody has the right to access sufficient water, food, and energy. The Bill of Rights informs the development and implementation of the National Water Act, Energy Act, and The White Paper on Agriculture, among others. It is important to note that domestic legislation is also influenced by international agreements. An example of this is the United Nations Framework Convention on Climate Change. Also, South Africa is governed by regional frameworks like those of the Southern African Development Community and the African Union. Given this, the country is making policy and regulatory shifts in line with international law. South Africa has good legislative and policy instruments that direct the management of WEF sectors (Figure 8.7), and the country still has started initiatives to integrate these resources through the WEF nexus. The nexus is an opportunity to distribute the WEF components equitably.

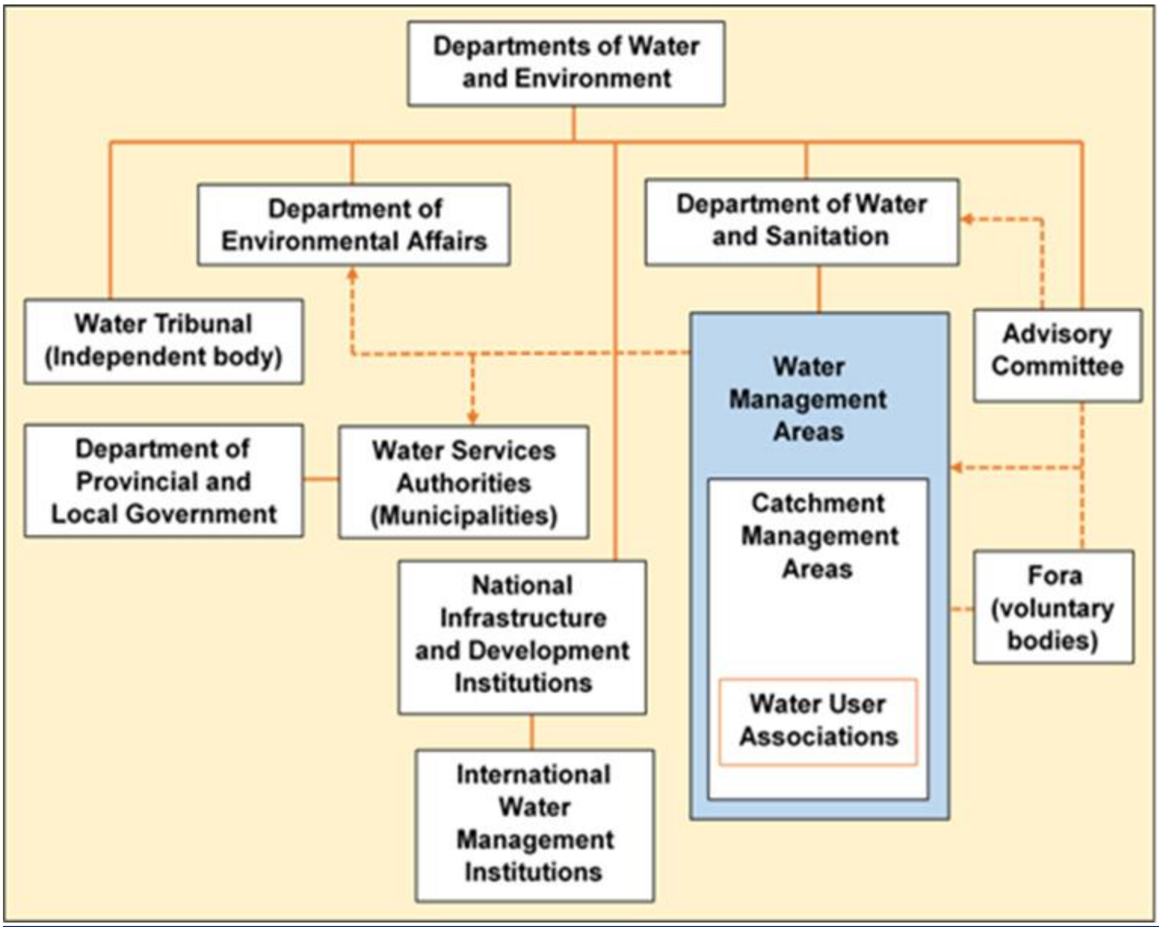


Figure 8.7: National water institutional arrangements (Source: DWS, 2009).

8.5.2 Challenges to Current Policy Frameworks Set Up in South Africa

Water, energy, and food resources remain at the core of human well-being, poverty reduction, and sustainable development (FAO, 2014). These tenets are enshrined in South Africa's Constitution. Pressure on these resources is set to increase owing to population growth, migration and urbanisation, economic development, international trade, improved standards of living, and climate change. This will increase competition for resources and prioritisation between the water, energy, and food sectors, negatively impacting the country's socio-economic security.

Various factors affect water, energy, and food security differently (Figure 8.8). Hence, while it is important to understand the interlinkages in the nexus, it is also important to realise that an overall approach to resolving the challenges must be underlined by specific cases of solving national and regional problems. The absence of a WEF nexus policy results in conflicts among sectors. There is, therefore, a need to harmonise current sector-based policy frameworks. The National Development Plan has made commendable attempts to encourage integrated planning across government departments. There is a need for a framework that facilitates proper coordination and identifies synergies and trade-offs across sectors to avoid duplication of activities, create opportunities for harmonising government priorities, and allocate resources effectively and efficiently. This should enable the government to meet its targets, including the SDGs and the National Development Plan. A mismatch in planning objectives by different factors can inadvertently limit the capacity to deliver what may otherwise be good policies.

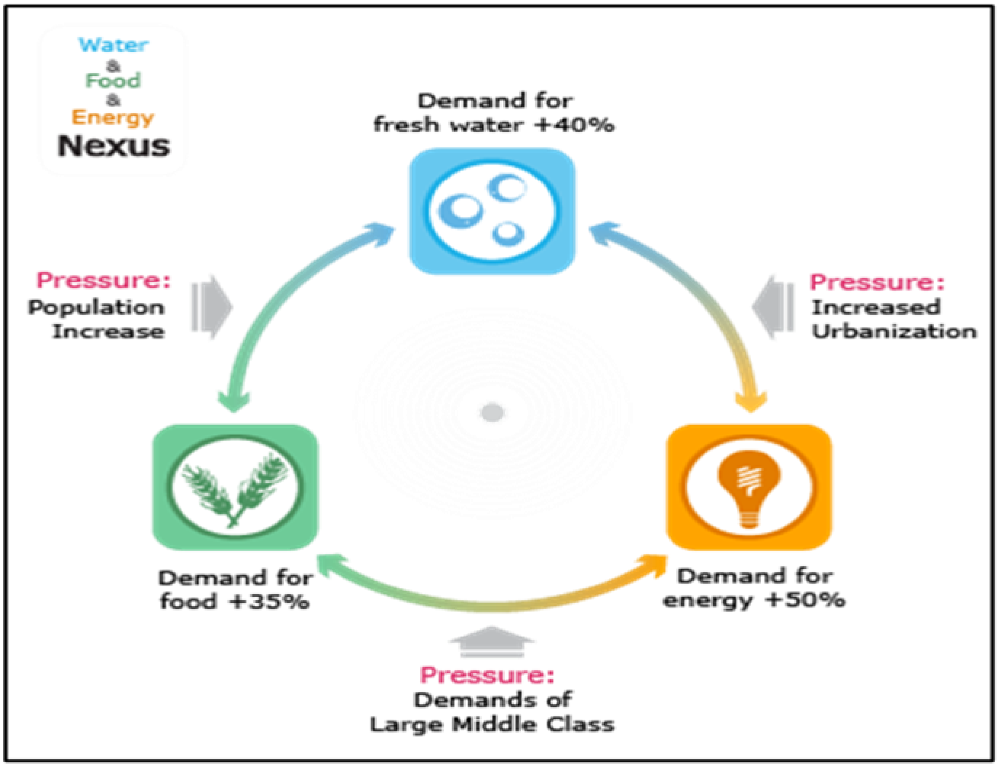


Figure 8.8: Factors affecting the WEF nexus (Source: FAO, 2014).

8.6 Recommendations for Enhancing WEF Nexus Investments

The cross-cutting challenges affecting WEF resources, coupled with climate change, require a framework that facilitates proper coordination and identification of synergies and trade-offs across sectors to avoid duplication of activities, create opportunities for harmonising government priorities, create employment, and allocate resources in effective and efficient ways. The WEF nexus offers opportunities for the government to meet its targets, including the SDGs and the National Development Plan. There is a need to advance integrated planning, policy, and management and raise inter-ministerial awareness about the WEF nexus. Efforts should highlight the fact that all key factors within the nexus need to ensure that there is increased sectoral coordination. We recommend the following:

- At the level of legislation, it is necessary to ensure that horizontal linkages exist during the design and implementation phases. It is also important that legislation regarding water, energy, agriculture, land, climate and other related matters be harmonised to efficiently use all resources concerned. In turn, this legislation should influence the vertical development of relevant strategies/policies which are horizontally synergistic. Similarly, national water, energy, and agriculture plans/programmes should emanate from national strategies/policies. These plans should also be comprehensively aligned. There is a need to capture elements of resource use efficiency at all policy levels.

- The review of South Africa's water sector legislative and policy framework highlights that South Africa is a physically water-scarce country. This scarcity is mainly regarding the limited water resources that the country has coupled with low mean annual rainfall, which is unevenly distributed thus rendering huge swathes of the country arid and semi-arid. This has dictated much of the water policy, emphasising managing the country's limited water resources. Secondary to that is the need to ensure access to water for the country's population, a right enshrined in the Constitution. Except for the Water for Growth and Development Framework, existing water policies neither explicitly nor adequately highlight linkages between the water, energy, and agricultural sectors. This is even though agriculture, on its own, accounts for the bulk of water use and the strong linkages between water and energy. Adopting the WEF nexus thus promotes coordinated development, improves people's livelihoods, and improves resilience-building initiatives.

- Energy insecurity in South Africa has previously contributed to the country's credit status being downgraded. The 'crises' in the energy sector have also led to the signing of nuclear power deals with Russia and China and an 'explosion' of new coal mines with new prospecting licenses issued in areas like Mpumalanga. This has raised renewed fears of acid mine drainage in the Vaal River; the mushrooming of new mines is set to clash with water and agriculture sectors as mining pollutes water and competes for land with agriculture. While energy might receive more attention as an important economic driver, it must be noted that many of the pressures that drive energy demand also apply to water and agriculture. In addition, water, energy, and food security are all central to South Africa's independence vision of delivering a better quality of life to its citizens. This highlights the need for better convergence of policy amongst the three sectors and a movement from the 'silo' approach.

- As an initiative to start the WEF nexus discussions, there is a need for an inter-ministerial and other stakeholders' dialogue (WRC, Non-Governmental Organisations, and academia) at a national level to discuss how the WEF nexus can be implemented and monitored. Table 3 provides potential WEF nexus stakeholders.
- The government should promote WEF nexus research, development, and innovation and formulate nexus guidelines and indicators in the same form as the SDG indicators.
- As the three WEF sectors are inextricably linked, current uncoordinated management creates imbalances in resource allocation with the effect of threatening to reduce the economic gains made in the past. Thus, the WEF nexus provides an opportunity to stabilise competing demands in an environment of scarce resources by ensuring that the development of one of the sectors has minimum impacts on the other. Thus, there should be a review of past and ongoing projects to identify opportunities for embedding WEF nexus thinking; this will contribute towards the overall sustainability of these initiatives.

As already alluded, the three WEF components are dealt with in silos. To achieve the country's goals, South Africa needs to adopt the WEF nexus as it is a more balanced approach based on the interlinked management of resources and capable of improving national management of the links between water, energy, and food and increase the resilience of the economy from the risks of climate change and economic volatility. The adoption should be practical; for example, existing government departments with cross-cutting mandates, such as the Department of Science and Technology and the Department of Planning and Monitoring, could be tasked with driving the WEF nexus and ensuring that it is embedded in new policies and strategies across government.

9

WATER RESOURCE PROTECTION

9 WATER RESOURCE PROTECTION

The National Water Act (No. 36 of 1998) is the primary statute that provides the legal basis for realising South Africa's water quality management. The Act stipulates that the South African water resource is a national asset for which the national government must act as a public trustee. South African water resources are facing ever-increasing pressures from climate change, population growth, over-utilisation, poor land use and management practices, and subsequent pollution.

The limited knowledge and neglect of the requirements for freshwater ecosystems have serious environmental, social and economic consequences for societies and further result in the destruction and degradation of important water-related ecosystems. The ecosystem degradation may lead to a reduction in ecosystem services, such as the reduced capacity to generate water and loss of food production. The protection of water-related ecosystems is mainly to ensure that ecosystem services continue to be available to society.

Land-based activities such as alien vegetation; developments along the water resource, sand mining, etc are a threat to aquatic habitats and associated biodiversity. The threat to aquatic biodiversity is not only the unsustainable use of water resources but the decreasing freshwater availability and widespread ecosystem degradation. The clearing of natural vegetation without consideration of biodiversity may undermine sustainable development, impact all biomes and cause a decline in some bird species. The urban and rural communities are the most affected and vulnerable since they rely heavily on the natural environment for their livelihood.

The DWS's objective is to improve the protection and ensure the sustainable use of water resources. Water quality management strategies as well as the associated operational policies and strategies as reflected in the National Water Quality Management Framework Policy of 2002, DWS Integrated Water Quality Management (2nd edition) of 2017 and the National Water Resource Strategy (NWRS) have outlined policies and strategic actions required to address the water quality leading to long-term sustainable water use. Furthermore, Chapter 3 of the National Water Act (No. 36 of 1998) prescribes two Integrated Water Resource Management (IWRM) approaches i.e., Resource Directed Measures (RDMs) and Source Directed Controls (SDCs), which aim to achieve a balance between protecting the water resources and utilising the water resources for social and economic benefits.

9.1 Resource Directed Measures (RDMs)

The role of RDMs is to provide a framework to ensure the sustainable utilisation of water resources to meet ecological, social, and economic objectives and to audit the state of South Africa's water resources against these objectives. South African water resources are unevenly distributed, which implies that different water resources require different levels of protection. RDMs are applied on a catchment basis within Water Management Areas (WMAs) and implemented through a three-staged set of processes outlined in Figure 9.1, which, when taken together, determine the actions that must be taken to protect the water resource to the desired level. The linkages between the three processes are shown in Figure 9.2.

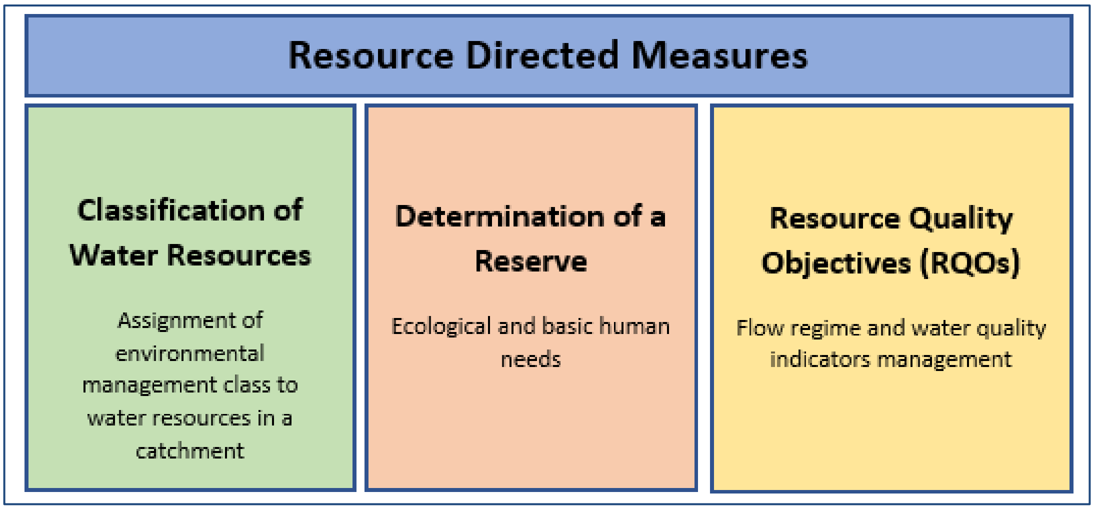


Figure 9.1: Three-stage processes of RDMs.

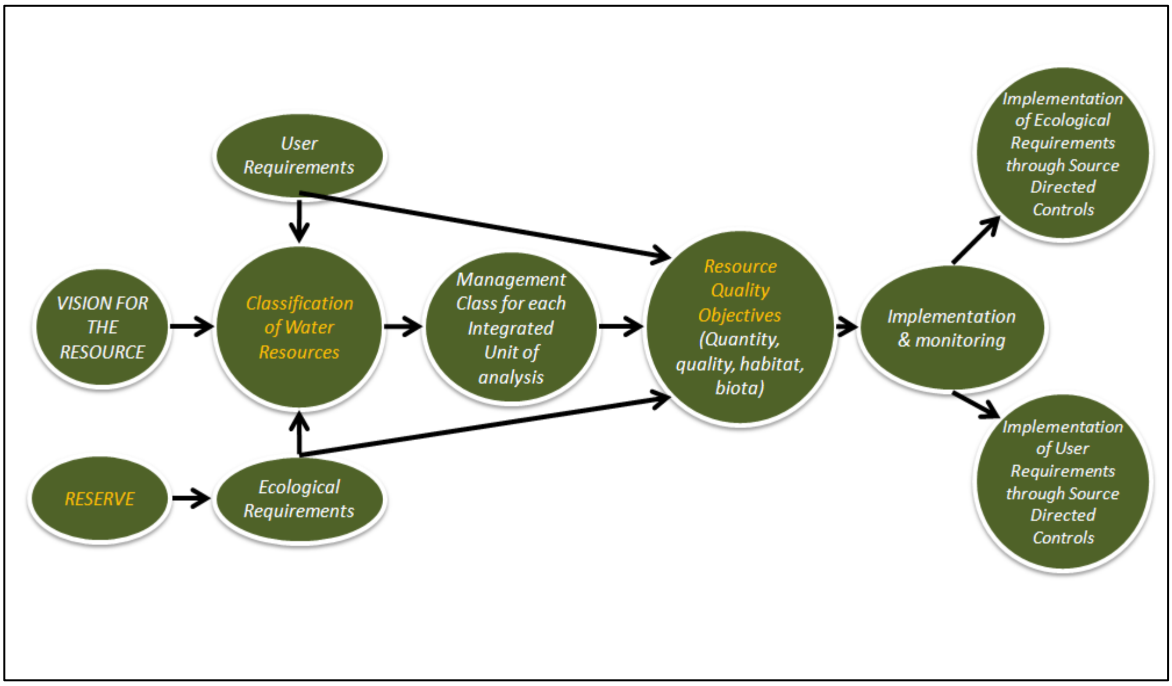


Figure 9.2: The Linkages between the RDMs processes.

9.1.1 Classification of Water Resources

The Water Resource Classification System (WRCS) was formally prescribed through Regulation 810, which was published in the Government Gazette (GG 33541 of 17 September 2010). 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. This system prescribes processes to be followed for determining RDMs and categorises water resources according to specific water resource classes that represent a management vision of a particular catchment.

The Water Resource Classification process considers a catchment's social, economic, ecological, and environmental landscape to assess the costs and benefits associated with using versus protecting the water resource. The classification process defines three water resource classes based on the extent of use and the alteration of ecological conditions of water resources from the pre-development state. The Water Resource Classes (WRCs) shown in Table 9-1, which range from minimally used (Class I) to heavily used (Class III) are ultimately used to describe the desired condition of the resource and the degree to which it can be utilised.

Table 9-1: Water Resource Classes.

Classes	Description of use	Ecological Category*	Description of water resource
Class I	Minimally used	A-B	Minimally altered
Class II	Moderately used	C	Moderately altered
Class III	Heavily used	D	Heavily altered

**Ecological Category (EC) - the assigned ecological condition of a water resource in terms of the deviation of its biophysical components from a pre-development condition*

***Integrated Units of Analyses** are finer-scale units aligned to watershed boundaries, in which socio-economic activities are likely to be similar. These homogenous units provide a useful indication of similar impacts in different areas of the catchment, which should be considered in the determination of RQOs. The IUAs are delineated during the water resource classification process.*

9.1.2 Resource Quality Objectives

The Act states that the purpose of Resource Quality Objectives (RQOs) is to establish clear goals relating to the quality of the relevant water resources. It also stipulates that in determining RQOs, a balance must be sought between the need to protect and sustain water resources and the need to use them. RQOs are numerical and/or narrative descriptors of conditions that need to be met to achieve the required management scenario as provided during the water resource classification. Such descriptors relate to the:

(a) Water quantity, pattern, timing, water level, and assurance of instream flow;
(b) Water quality, including the physical, chemical, and biological characteristics of the water;
(c) Character and condition of the instream and riparian habitat; and
(d) Characteristics, conditions, and distribution of the aquatic biota.

In 2011, the Department developed a procedure for the determination of RQOs, which involves the delineation and prioritisation of Resource Units (RUs) for the different water resource components (e.g., rivers, dams, wetlands, and groundwater). RQOs are determined at the RU level.

*A **Resource Unit** (RU) is a stretch of river that is sufficiently ecologically distinct to warrant its own specification of Ecological Water Requirements (EWR). Resource Units are nested within IUAs and in the RQO process, are aligned to IUA boundaries. There are normally several RUs within a single IUA*.

9.1.2.1 DWS Progress on WRCS and Determination of RQOs

The Department is continuously classifying the resource and determining the associated RQOs in all WMAs. The studies have been completed in some catchments while the work is either in progress or outstanding in other study areas. The update on the RDM studies is detailed below:

(i) Finalised WRCs and RQOs studies

The Department has completed and gazetted the Water Resources Classes (WRCs) and the determination of associated RQOs in several WMAs, with uThukela, recently finalised in March 2023. The final WRCs and RQOs have been implemented in some catchments, including Inkomati and Olifants-Doorn, and are currently being monitored through surface water resource monitoring programs. Figure 9.3 and Table 9-2 shows an overview status of WRC and RQO determination progress post-2010 to September 2023 and a synopsis of study areas with finalised WRCs and RQOs, respectively.

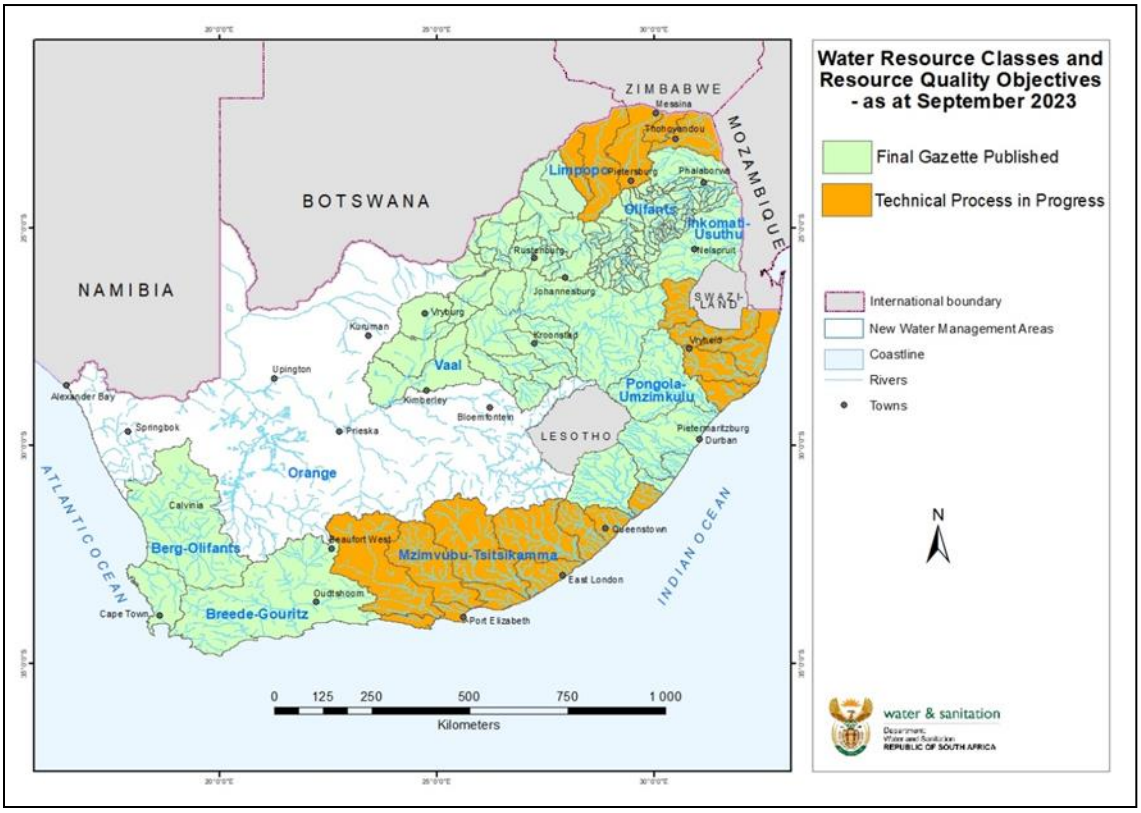


Figure 9.3: Overview status of WRC and RQO determination progress post-2010 to September 2023.

Table 9-2: Overview of study areas with finalised WRCs and RQOs.

Study Areas	Status	Government Gazette No.
Olifants-Doorn, Olifants, Upper Vaal, Middle Vaal and Lower Vaal	WRCs and associated RQOs have been finalised and gazetted.	GG 39943 of 22 April 2016
Letaba and Inkomati	WRCs and associated RQOs have been finalised and gazetted.	GG 40531 of 30 December 2016
Mvoti to Mzimkulu	WRCs and associated RQOs have been finalised and gazetted.	GG 41306 of 08 December 2017
Crocodile (West) Marico, Mokolo and Matlabas	WRCs and associated RQOs have been finalised and gazetted.	GG 42775 of 18 October 2019
Breede-Gouritz	WRCs and associated RQOs have been finalised and gazetted.	GG 43726 of 18 September 2020
Mzimvubu	WRCs and associated RQOs have been finalised and gazetted.	GG 43015 of 14 February 2020

Study Areas	Status	Government Gazette No.
Berg	WRCs and associated RQOs have been finalised and gazetted.	GG 43872 of 06 November 2020
uThukela	WRCs and associated RQOs have been finalised and gazetted.	GG 48187 of 10 March 2023

(ii) WRCs and RQOs Determination in Progress

The process of determining WRCs and RQOs is still ongoing in some study areas, while other study areas are nearing completion of the technical processes (*Table 9-3*). It should be noted that once the technical processes in a particular river system have been completed, a legal notice for the proposed water resource classes and the accompanying proposed RQOs is published in the Government Gazette for a 60-day public comment period.

The public comments received are taken into account when finalising the WRCs and associated RQOs. The final WRCs and associated RQOs for the individual river systems are published in the Government Gazette upon approval by the Minister of Water and Sanitation, after which they become binding on all institutions and authorities.

Table 9-3: Overview of WRCs and RQOs determination processes as of September 2023.

Study Areas	Status	Government Gazette No.
Fish to Tsitsikamma	The technical process for the determination of WRCs and associated RQOs commenced in **September 2021** and is scheduled to be completed in **March 2025.**	Not yet gazetted
Luvuvhu	The technical process for the determination of WRCs and associated RQOs commenced in **October 2021** and is scheduled to be completed in **September 2025**.	Not yet gazetted
Usuthu to uMhlathuze	The technical process for the determination of WRCs and associated RQOs commenced in **December 2021** and is scheduled to be completed in **August 2024.**	Not yet gazetted

(iii) Outstanding Water Resource Classifications and RQOs studies

The Department is, as of September 2023, only left with the Orange River System (Upper and Lower Orange), which has outstanding WRCs and RQO determination studies, as shown in Figure 9.4. The technical process for the determination of WRCs and the associated RQOs in the Upper and Lower Orange study areas commenced in September 2023 and is scheduled to be completed in October 2026.

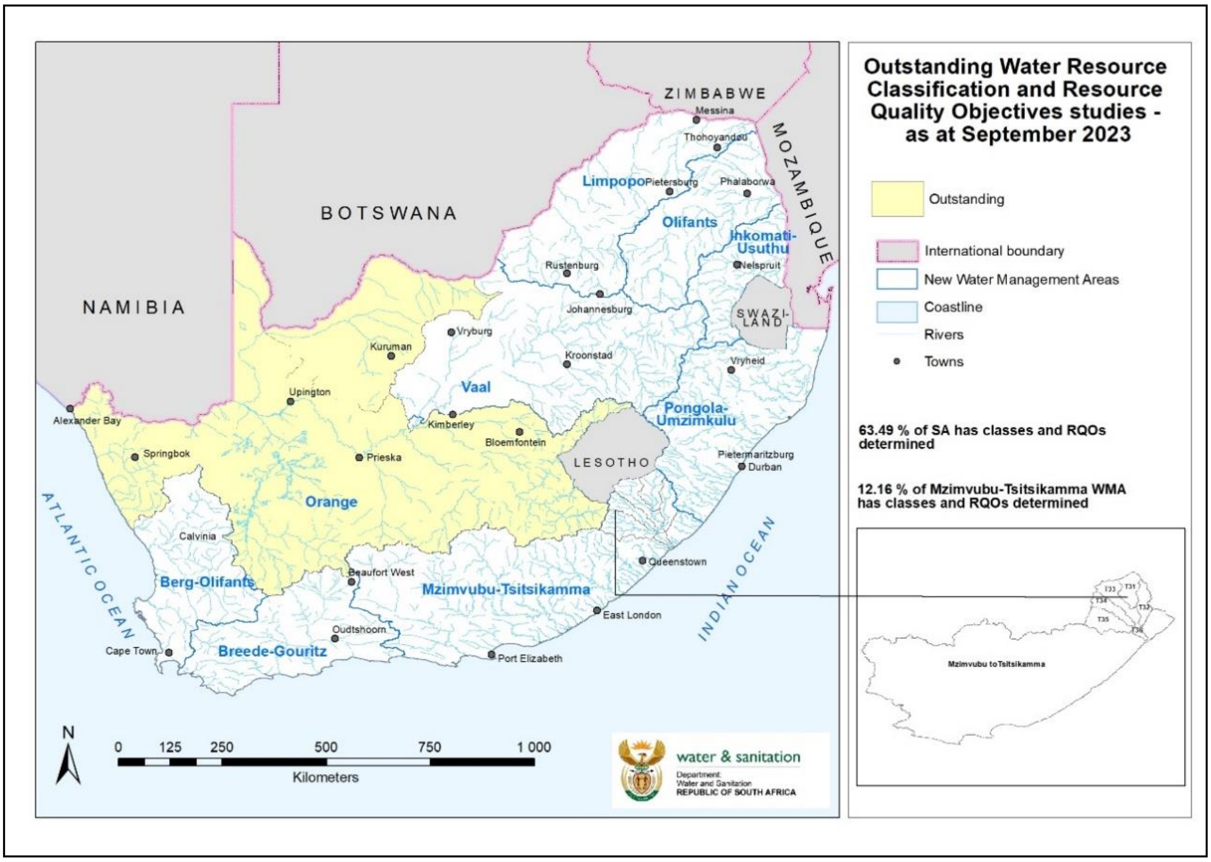


Figure 9.4: Outstanding Water Resource Classification and RQOs studies as of September 2023.

9.1.3 Present Ecological State, Ecological Importance & Sensitivity Database, 2013

The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) have initially been determined for all main stem rivers in the 1 946 Quaternary catchments in South Africa (Kleynhans, 1999). The 2011 PES/EIS update included the PES and EIS for main stem rivers and their tributaries, as well as important wetlands. Both the 1999, 2007 and 2014 PES/EIS databases are based on amongst others the high confidence Reserve information that has been extrapolated in areas where there was no sufficient data.

The Directorate: Reserve Determination, (D: RD) initiated a study to review the 2014 PES/EIS. The main objectives will focus on the update of the current PES/EIS 2014 database as reported in the previous State of Rivers report. The new study will follow the same principles, procedures, concepts, and assessment methods as implemented previously, to allow for compatibility and comparison of data and sites. The study will focus on the assessment of instream and riparian components of rivers and instream wetlands such as floodplains and instream valley bottom wetlands, per sub quaternary reach (SQR).

The PES and its Ecological Importance (EI) and Ecological Sensitivity (ES) for the identified water resource reaches within the 147 Secondary Catchments in South Africa will be assessed at a desktop level, using all data that has become available since 2011. The finest resolution is the SQRs, developed by DWS, RQIS at a 1:500 000 scale. As stated above the information will be extracted from RDM studies as completed under the mandate of Chapter 3 of the National Water Act (Act 36 of 1998). This includes the Classification, Reserve Determination/EWRs and RQOs determined. Of importance is the specified ecological resource monitoring that is identified for all EWR sites that are part of the National monitoring program, the River Eco-Status Monitoring Programme (REMP). The PES/EIS 2014, the 2007 PES/EIS and as far back as the first PES/EIS assessment in 1999 were used amongst others to contribute to the National Biodiversity assessments and the Biodiversity Accounting process of the Department of Forestry, Fisheries and Environment (DFFE) and will be used to contribute to Sustainable Development Goal reporting (SDG 6.6).

For the 2023/2024 PES/EIS update, the assessment of wetlands and estuaries will again be included and will follow a similar approach as during the 2014 PES/EIS assessment, however for the update a spreadsheet to capture wetland and estuary information will be included in more detail than before. This additional information will capture the essence of the decision-making by the experts to derive a particular category for the water resources in the form of Information sheets. These sheets are crucial for future studies to understand the way of thinking of the specialist and to provide criteria and principles that were used.

The template of the estuary data will be completed using available information from e.g., recent catchment and estuarine Reserve, Classification and RQOs studies and the 2018 National Biodiversity Assessment. As stated above, while river-linked wetlands will be incorporated in the river assessment spreadsheets, important non-river linked wetlands, will be geo-referenced and information pertaining to these wetlands will be captured in a similar spreadsheet (currently being developed) as for the estuaries.

Since 2014, there has been a considerable increase in the information sources and tools used to evaluate water resources in South Africa. There has also been an increase in the understanding of the functioning of South African natural water resources, the integration and the importance of evaluating water resources management/protection from source to sea.

Water resources cannot only be protected at one point. Rivers for instance are used as important migratory corridors for all sorts of aquatic and other fauna and flora that use these natural aquatic systems to survive and complete their natural ecosystem functioning/cycles. Unfortunately, the impacts of various anthropogenic modifications and impacts on the ecological conditions are increasing, the demand for water is growing and if not managed sustainably, it could have a devastating impact on the ecological infrastructure of the natural aquatic ecosystems.

9.1.4 The Determination of the Reserve

The Department has made notable progress in the determination of the Reserve for significant water resources at various levels of confidence ranging from desktop to comprehensive, depending on the type of impact, the magnitude of the impact on water resources, and the quantity and quality of data available to run the models. Reserves for surface water resources (i.e., rivers, wetlands, and estuaries) have been determined at a desktop, rapid, intermediate, and comprehensive level.

Similarly, the Reserve for groundwater resources (aquifers) has also been determined at a desktop, rapid, intermediate, and comprehensive level. The Reserve studies for both surface and groundwater conducted thus far have been plotted spatially, and Reserve maps have been developed for South Africa (Figure 9.5 and Figure). These maps have been made available to the regional offices to assist in the decision-making process for processing Water Use Authorisation applications.

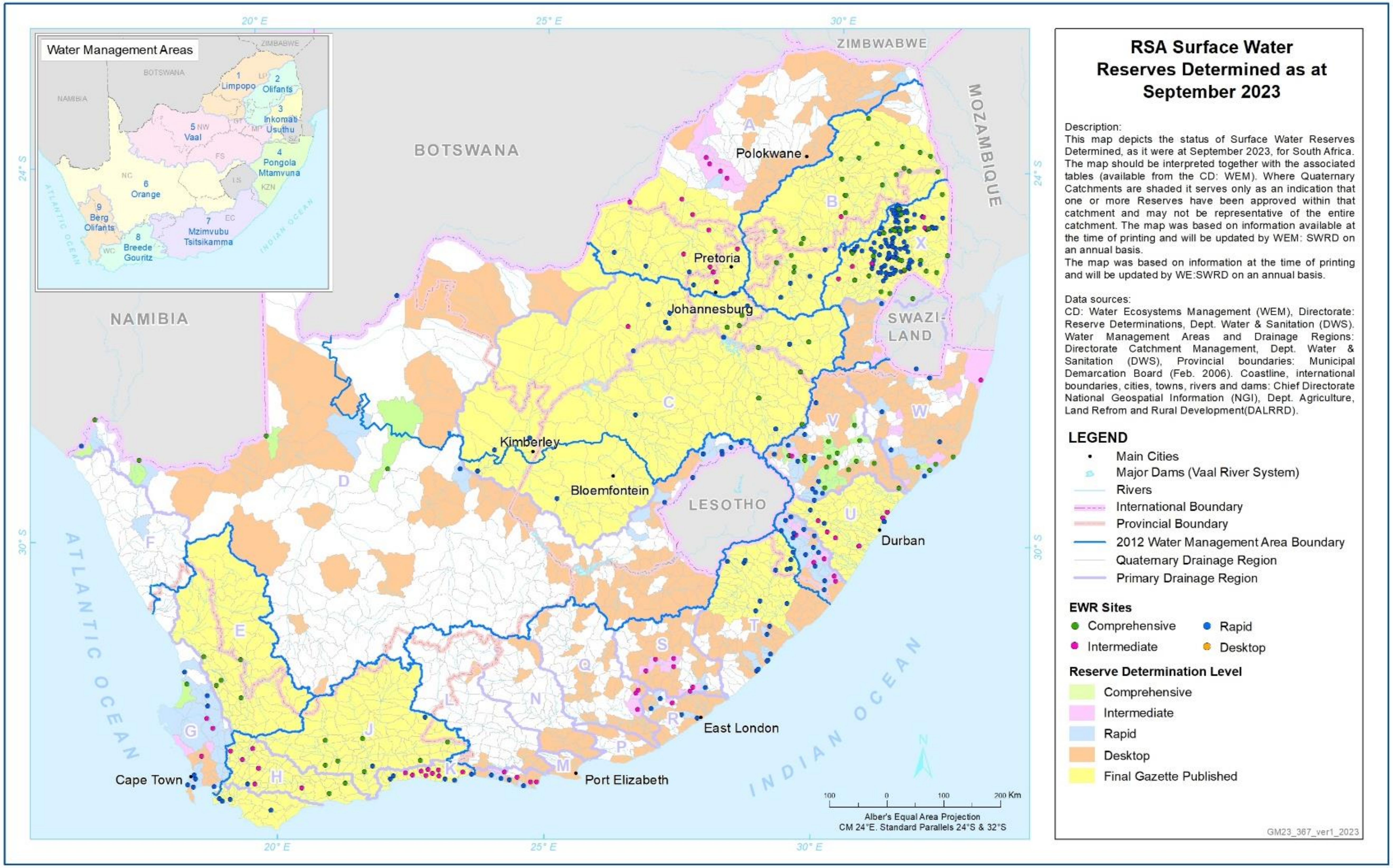


Figure 9.5: Surface Water Reserves determined as of 30 September 2023.

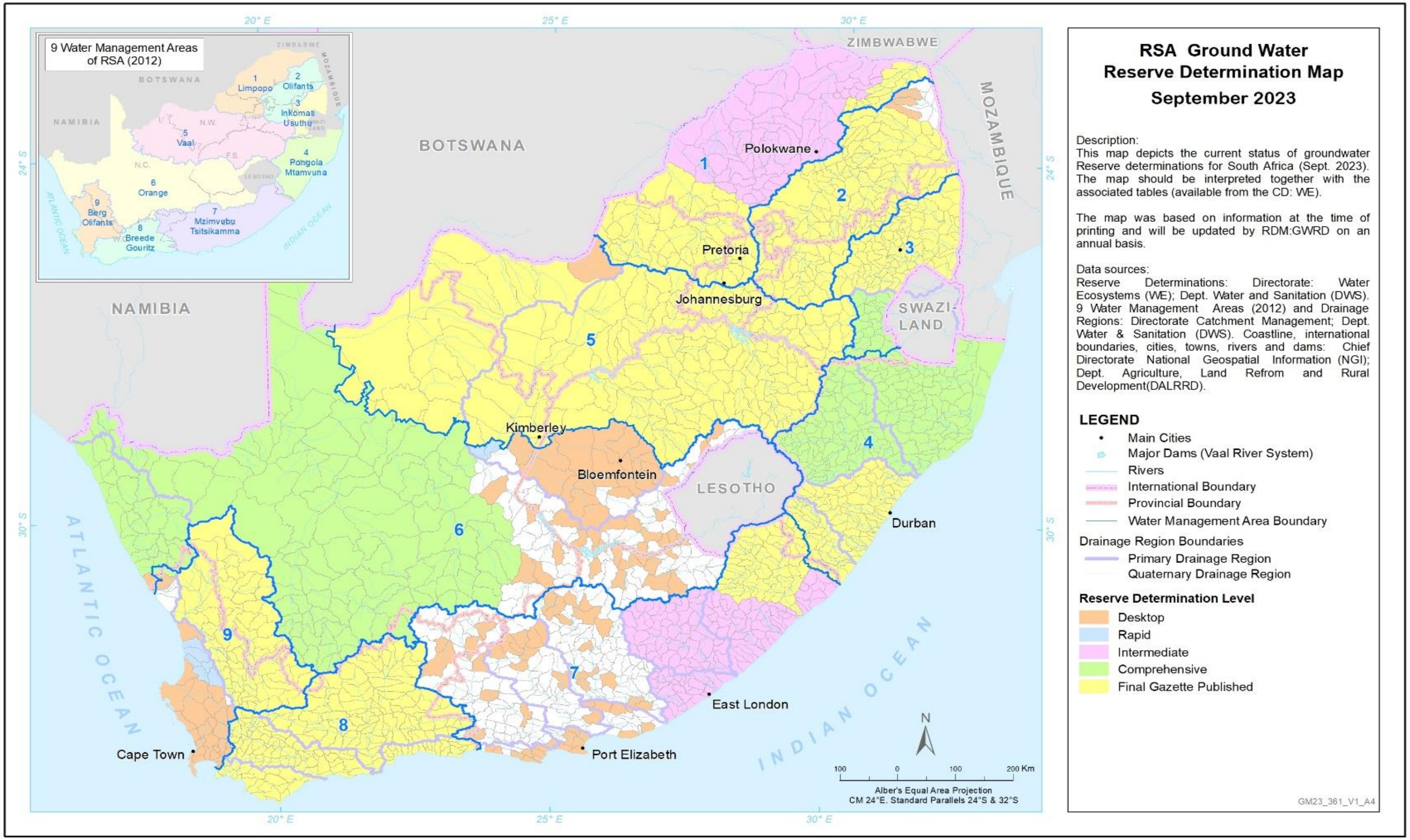


Figure 9.6: Groundwater Reserves determined as of 30 September 2023.

(i) Progress on Reserve Determination

A total of 19 surface water reserves were completed between October 2022 and September 2023. *Table 9-4* indicates the number and level of Surface Reserves determined/approved per Water Management Area (WMA).

Table 9-4: Summary of Surface Water Reserves per WMA completed between October 2022 and September 2023.

Water Management Area	Desktop	Rapid	Intermediate	Comprehensive	Total
Limpopo	0	0	0	0	0
Olifants	0	0	0	0	0
Inkomati- Usuthu	0	0	0	0	0
Pongola-uMzimkulu	0	0	0	0	0
Vaal	7	0	0	0	7
Orange	2	0	0	0	2
uMzimvubu-Tsitsikama	9	0	0	0	9
Breede- Gouritz	1	0	0	0	1
Berg- Olifants	0	0	0	0	0
TOTAL	**19**	**0**	**0**	**0**	**20**

A total of 4 desktop Groundwater Reserves were determined and completed between October 2022 to September 2023. Table 9-5 indicates the number and level of Groundwater Reserves determined per Water Management Area (WMA).

Table 9-5: Summary of groundwater Reserves completed between October 2022 and September 2023 per WMA

Water Management Area	Desktop	Rapid	Intermediate	Comprehensive	Total
Limpopo	1	0	0	0	1
Olifants	0	0	0	0	0
Inkomati-Usuthu	0	0	0	0	0
Pongola-uMzimkulu	0	0	0	0	0
Vaal	0	0	0	0	0
Orange	1	0	0	0	1
uMzimvubu-Tsitsikama	1	0	0	0	1
Breede-Gouritz	0	0	0	0	0
Berg-Olifants	1	0	0	0	1
TOTAL	**4**	**0**	**0**	**0**	**4**

(ii) Gazetting of the Reserve

Section 16(1) of the National Water Act (Act No. 36 of 1998) states that *"As soon as reasonably practicable after the class of all or part of a water resource has been determined, the Minister must, by notice in the Gazette, determine the Reserve for all or part of that water resource."* The Chief Directorate: Water Ecosystems Management has completed the gazetting of the Reserve in the Catchments/WMAs summarised in *Table 9-6*.

Table 9-6: List of WMAs/Catchments where the Reserve has been gazetted

Water Management Area/Catchments	Government Gazette Number
Olifants/Doring (excluding F60 and G30 tertiary catchments)	41473
Vaal	43734
Mvoti-uMzimkulu	41970
Inkomati	42584
Olifants/Letaba (excluding B9 Shingwedzi secondary drainage region)	41887
Breede-Gouritz	46798
uMzimvubu Catchment (tertiary drainage T1-T36)	47526
Croc-West and Marico	45568

9.2 Source Directed Controls (SDCs)

The role of SDCs is to ensure that the cumulative impacts of water use, with respect to quantity and quality, are not exceeding the limits appropriate to the class of the resource. SDCs are imposed on water use to protect, conserve, utilise and develop the water resource. The standards to regulate the quality of waste discharge, hazardous substance elimination, cleaner production, cleaner technology, and continual improvement are all considered in the formulation and setting of SDCs.

Potential polluters must demonstrate that waste minimisation, reuse and recycling before disposal have been considered and employed (DWAF, 2002). The aim, therefore, is towards cleaner technology and not only to improve methods of disposal of waste. SDCs are implemented as water use licenses are issued and contribute to the achievement of the objectives for the protection and use of a resource in terms of its class (DWAF, 2002). The National Water Quality Management Framework Policy (2002) categorised the SDCs as follows.

- Best management practice measures relate to measures that apply to water use nationally
- Special measures which relate to source-related requirements dictated by and/or derived from catchment management strategies and/or plans; and
- Site-specific measures which relate to measures stemming from the water use authorisation process, taking cognisance, among other things, of general authorisations stipulated at national or regional levels and/or considerations specific to the water use being considered.

9.2.1 Current SDCs Projects

The Directorate: Sources Directed Studies under the Chief Directorate: Water Ecosystems Management (CD: WEM), has initiated in-house projects for the **improvement of water quality** in South African Water Resources. These projects are in line with the Departmental policies and strategies for effective water resource management and sustainable development.

i. EUTROPHICATION MANAGEMENT STRATEGIES FOR SOUTH AFRICA

The Eutrophication Management Strategy for South Africa (EMSSA) was developed to provide direction concerning the management of eutrophication, particularly the control of anthropogenic sources of excessive nutrient enrichment, from a strategic country perspective. The Eutrophication Management Policy contains fourteen policy statements, which are technical, and five supporting policy statements which are general and cross-cutting in nature, that altogether are regarded as the most pertinent to eutrophication management in South Africa. These policy statements define ground rules, delineate intent, and specify desired outcomes for the management of eutrophication. From policy objectives, the Eutrophication Management Strategy adopted three interrelated and mutually supporting strategies as illustrated in Figure 9.7**,** namely:

- Core strategies;
- Operational strategies; and
- Supporting strategies, for eutrophication management.

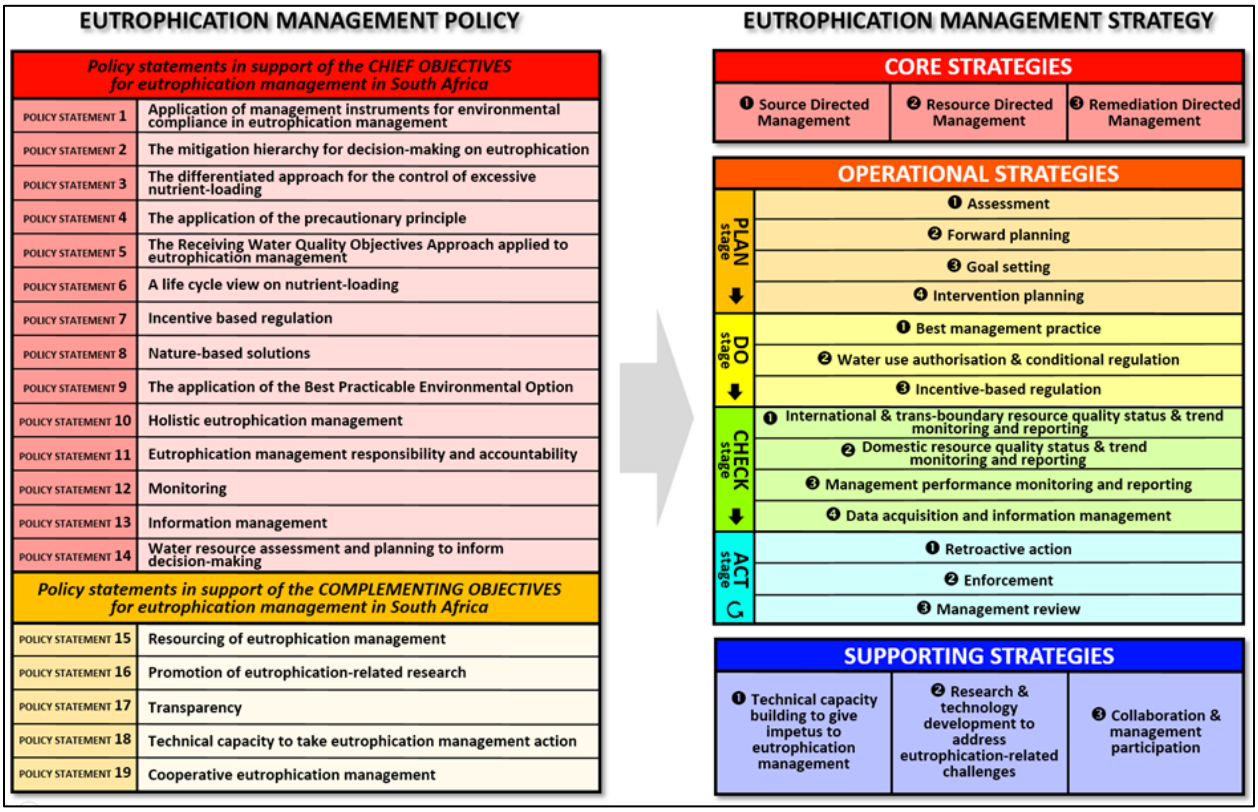


Figure 9.7: Eutrophication Management Policy and Strategy “ROADMAP”.

The final step in the development of the EMSSA was to put the Strategy into Practice. The current Eutrophication Management Strategy into Practice report, therefore, supports the EMSSA by providing a structured way to articulate how the EMSSA can be pragmatically implemented; and by arranging and translating all gaps, actions, and interventions identified in the EMSSA into measurable outcomes inclusive of roles, responsibilities, and timeframes. To date, the EMSSA (Second Edition), and Eutrophication Management Strategy into Practice (First Edition) reports have been completed. Stakeholder consultations have been undertaken through the Project Steering Committee (PSC), Catchment Management Forums, Ministerial level through the National Water and Sanitation Summit held in February 2022, and the public consultation held on 14 October 2022 to solicit inputs from wider stakeholder groups and get a buy-in from the water sector responsible with the implementation thereof.

ii. REHABILITATION MANAGEMENT GUIDELINES FOR WATER RESOURCES

Chapter 3 of the National Water Act (NWA, Act No. 36 of 1998) provides for the protection, use, conservation, management, and control of water resources in an efficient, sustainable, and equitable manner in South Africa. Sections 19 and 20 of NWA focus on *prevention* and *remedying effects of pollution* and *control of emergency incidents*, respectively. Protection of water resources is critical for ensuring healthy ecosystems and water availability for current and future use. To this end, sustainable development of water resources requires that water quality degradation be avoided, minimised and remedied where applicable.

The project aims to develop Rehabilitation Management Guidelines that address the following characteristics of watercourses: *Hydrology, Geomorphology, Water quality, Habitat and Biota.* In terms of the definition contained within the NWA, Act 36 of 1998, a watercourse means a ***river*** *or* ***spring****, a* ***natural channel*** *from which water flows regularly or intermittently, a* ***wetland, dam****, or* ***lake*** *into which, or from which, water flows, any* ***collection of water*** *which the* ***Minister*** *may, by notice in the* ***Gazette****,* ***declare*** *to be a watercourse. A* ***reference*** *to a watercourse includes, where relevant, its* ***bed*** *and* ***banks.***

Figure 9.8 emphasises a link between water resources and watercourse. The project objectives are to:

- Establish the status quo and integrate various initiatives and practices regarding rehabilitation management for water resources (rivers, wetlands, estuaries, lakes, dams, and groundwater);
- Map out the legislative framework for water resources rehabilitation practices in South Africa; and
- Develop best practice guidelines for rehabilitation management of water resources.

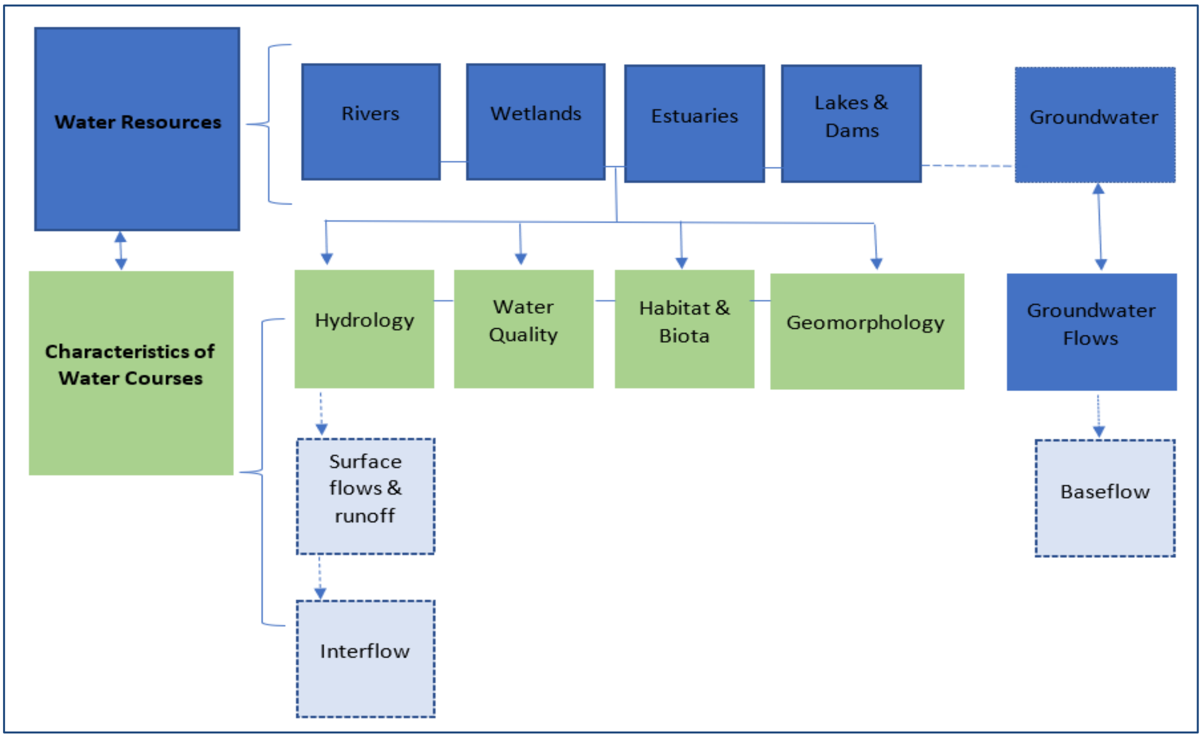


Figure 9.8: Link between Water Resources & Watercourses.

To date, five themes (Figure 9.9) have been developed for the Rehabilitation Guidelines, categorised into Rivers, Wetlands, Estuaries, Lakes and Dams and Groundwater as per the NWA.

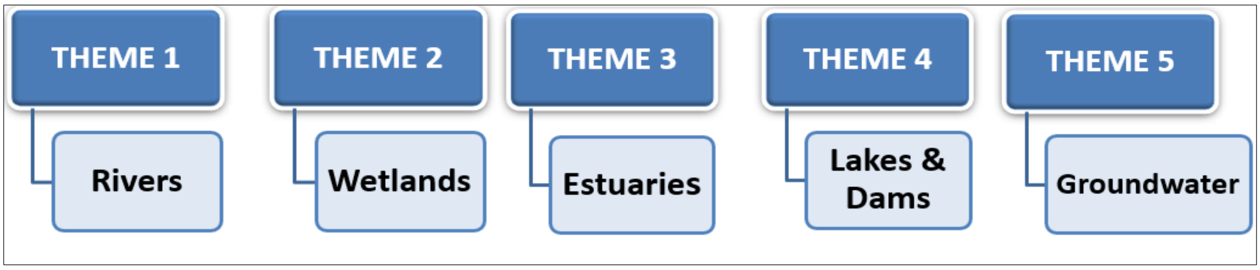


Figure 9.9 : Water Resources Themes.

The development of the **Rehabilitation Management Guidelines** for Water Resources commenced in April 2022. To date, the following draft guidelines have been completed, and information endorsed by the PSC members:

- Draft Rehabilitation Management Guidelines for Rivers Report;
- Draft Rehabilitation Management Guidelines for Wetlands Report;
- Draft Rehabilitation Management Guidelines for Lakes and Dams Report; and
- Draft Rehabilitation Management Guidelines for Groundwater Report.

iii. CLEANER TECHNOLOGY OPTIONS FOR IMPROVEMENT OF WATER QUALITY SOUTH AFRICAN WATER RESOURCES

The Project was initiated during the 2023/2024 financial year and it is envisaged to be concluded within 36 months from the date of initiation. Figure 9.10 below depicts the Scope of Work for the project. The Project will be themed into water use sectors, namely, water services, agriculture, industrial and mining.

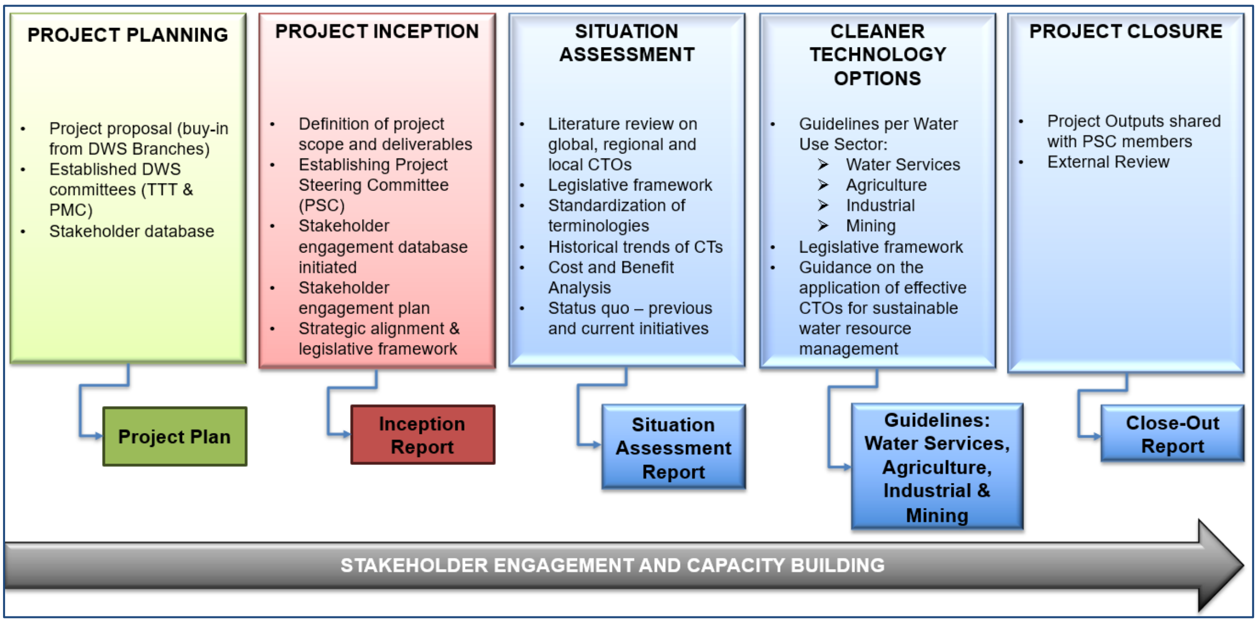


Figure 9.10: Scope of Work and Outputs.

Currently, the Inception Report has been drafted and circulated for external stakeholders through the PSC platform. The purpose of the inception phase is to define the specific project scope to ensure alignment between the project objectives and the expected final deliverables to be produced, i.e., improve water quality in water resources through waste management hierarchy strategies for cleaner technology options (Figure 9.11).

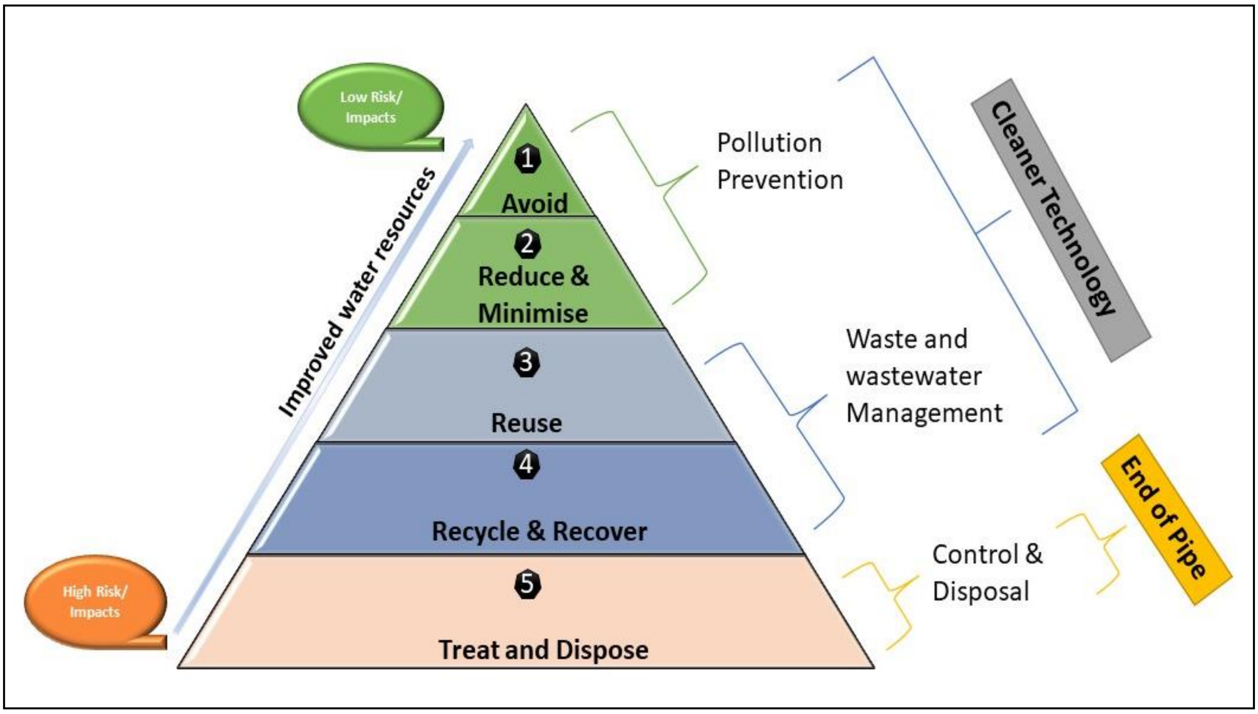


Figure 9.11: Waste Management Hierarchy for Cleaner Technology Options.

10

WATER RESOURCE REGULATION

10 WATER RESOURCE REGULATION

10.1 Compliance Monitoring and Enforcement

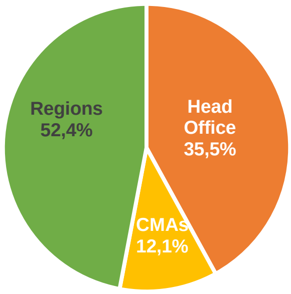
The Compliance Monitoring function promotes and monitors the status of compliance of water users to standards, with water use authorisation conditions and regulations across the full water value chain of all sectors in a way that triggers appropriate enforcement or other regulatory-enhancing action if needed. The enforcement function ensures that a set of actions (administrative, criminal, and civil) are taken against non-compliance with the provisions of the National Water Act as a Specific Environmental Management Act (SEMA) under the National Environmental Management Act (NEMA, Act no. 107 of 1998).

The Department of Water and Sanitation (DWS) constantly strives to enhance the Compliance Monitoring and Enforcement (CME) procedures, protocols and instruments for effective functioning within the Environmental Management Network. The development of the DWS CME or Environmental Management Inspector (EMI) Standard Operating Procedure (SOP) Manual has been finalised to harmonise and standardise operating procedures within the water sector that will allow the CME officials and EMIs to perform their duties in an administrative just and legal defensive manner and conform to the chain of custody process and actions at national, regional and Catchment Management Agency (CMA) levels to result in successful court cases.

In support of an enhanced compliance and enforcement capacity, there is ongoing training and designation of officials as Environmental Management Inspectors (EMIs). The current total of EMIs designated by the Minister of Water and Sanitation is one hundred and twenty-four (124) (Figure 10.1). The DWS is part of the blue sector (freshwater) and brown sector (waste) and its performance data is also reported under the Environmental Secretariat and EMI network. It needs to be noted that during this financial year, only 128 DWS and CMA CME officials are performing the CME functions and about 80 officials are within the regions and CMAs to regulate all the water sectors registered on the Water Use Authorisation and Registration Management System (WARMS) of about 55 000 water users as well as identified unlawful activities.

A significant part of the DWS CME Strategy is the commitment to training and capacity building as well as access to information relating to CME. The National Compliance Information Management System (NCIMS) and the Enforcement Case Management System (ECMS) are operational with future integration planned into one Integrated Regulatory Information System (IRIS) together with Wastewater and Drinking Water (Green Drop and Blue Drop Programmes respectively).

Executive overview of the EMI designations

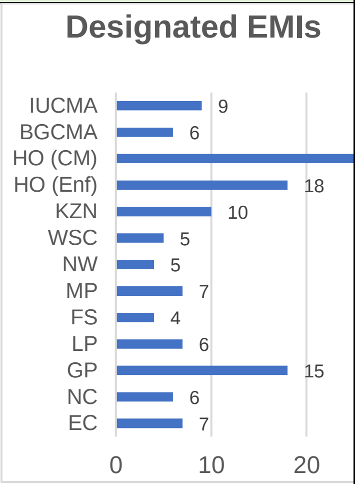


Total number of designated EMIs is 133

124 = Active
9 = Inactive (Left department/moved out of Compliance Monitoring)

National and Provincial EMIs trained per financial year.

2016/2017	**13**
2017/2018	**12**
2018/2019	**15**
2019/2020	**36**
2020/2021	**20**
2021/2022	**16**
2022/2023	**21**



Designated grades

Grade 1 = 9	**Grade 2 = 114**	**Grade 3 = 1**

Training dates	**Number of DWS and CMA / proto-CMA CME officials**	**Total officials enrolled**
May 2023	Fourteen officials trained: BGCMA (1); IUCMA (1); Mzimvubu Proto CMA (2); Head Office: Compliance Monitoring (1); Northern Cape (1); Free State (1), KwaZulu Natal (1); Mpumalanga (1); North West (1), Gauteng (1); Northern Cape (1) and Limpopo (2).	14

Figure 10.1: The Environmental Management Inspectorate – DWS and its entities component.

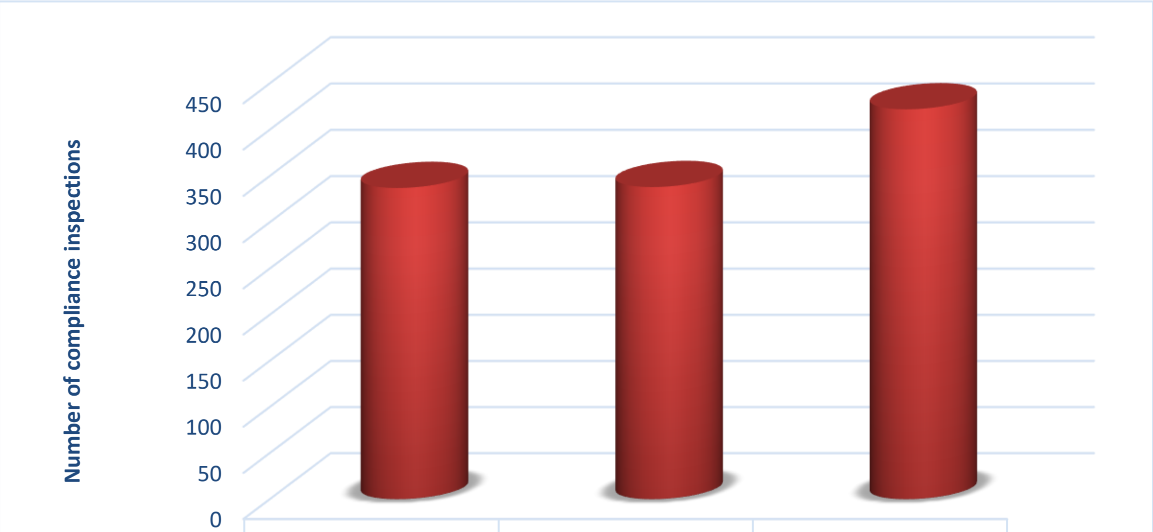
The two established CMAs, namely Breede-Gouritz CMA (BGCMA) and now re-named as Breede-Olifants CMA (BOCMA) and Inkomati-Usuthu CMA (IUCMA) are conducting CME functions in their respective WMAs, and these CME functions were also incorporated into the national Annual CME Report 2022/23 with respect to their CME Annual Performance Plan (APP) targets to give a holistic overview of the water sector performance and status of compliance in South Africa.

The Department is in the process of implementing the approved organisational structure and NWA delegations, 2023. The relocation of the CME function from Regional Offices to the CMAs necessitates a concerted effort to bolster the CME capacity as well as the criminal enforcement capacity of new officials that will be integrating into the CMAs or National Office from various units encompassed within the Department.

10.2 Compliance Monitoring

The Compliance Monitoring team set a target to monitor 379 authorised water users across the various sectors for the FY2022/23. The Compliance Monitoring team achieved 422 (including dam safety) and exceeded the target by 43 due to additional inspections conducted by the Provincial Offices as well as the Western Cape joint operation Blitz.

The number of water users monitored has been on an increase for the past three financial years since taking a sharp decline in 2020 due to the Covid-19 pandemic that forced regions to conduct desktop compliance inspections (Figure 10.2). Although there has been an improvement in the FY2022/23, the average number of water users monitored in the past three years is 365 out of 55 000 registered water users, which represents 0.6% of the registered water users that were monitored. The primary contributor to this problem is the uneven annual allocation of compliance monitoring officials in the provincial offices. From the compliance inspections conducted during the financial year FY2022/23, the mining sector received more attention, followed by the irrigation sector (Figure 10.3).



	2020/21	2021/22	2022/23
Financial year	337	338	422

Figure 10.2: Overview of Compliance Inspections from FY2020/21 - FY2022/23.

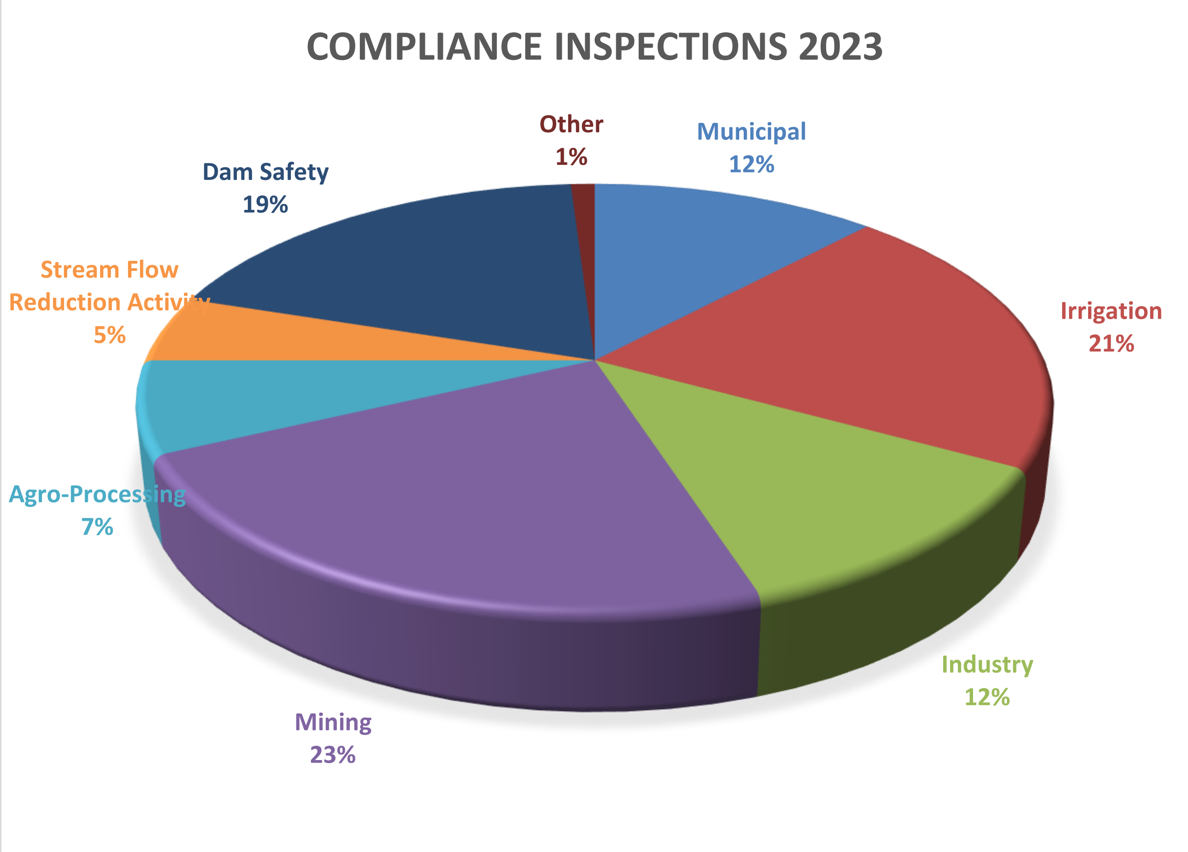


Figure 10.3: Compliance inspections conducted per water sector for the FY2022/23.

In the Medium-Term Strategic Framework (MTSF) and Outcome 10 performance agreement, an impact indicator is used to determine the level of performance of the water users and sectors. The purpose of the impact indicator is to add value to the statistics of users monitored by indicating the status of compliance against the conditions of the authorisation. A scorecard has been developed and is used to accurately and consistently measure or score performance, and forms part of the portfolio of evidence together with the inspection report.

The target set for the level of compliance with water user authorisations obligations per sector is 65%. The 422 users monitored achieved a combined average performance level of 58%, with the mining sector (49%) and landfills (45%) having the worst scores (Figure 10.4). To improve this more emphasis needs to be placed on follow-up inspections to ensure findings are implemented and to follow through with enforcement actions and consequences where required.

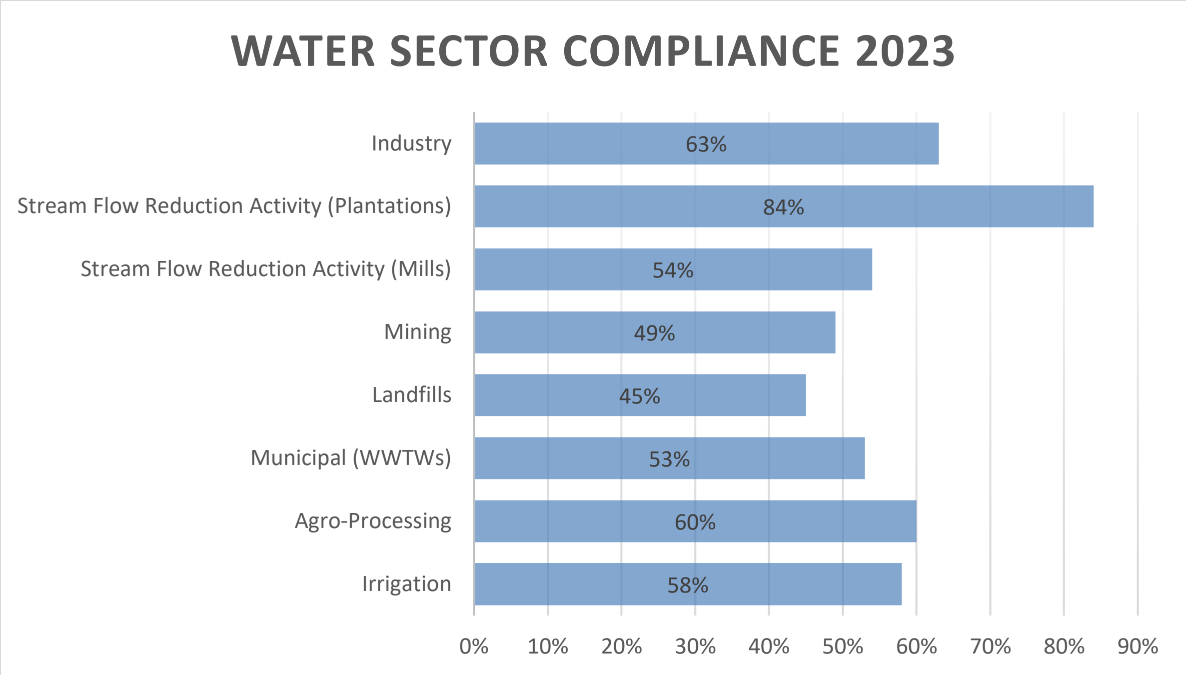


Figure 10.4: Overview of compliance performance of the water sectors for 2022/23.

10.3 Enforcement For DWS

During the FY2022/23, a total of 460 cases were reported for non-compliance. Out of these reported cases, 385 were investigated, demonstrating a commendable achievement of 84% compared to the committed target of 80% (Figure 10.5). This also represents a significant increase of 14% in the number of cases investigated when compared to the previous financial period (Table 10-1). The significant rise in the number of cases examined can be attributed to an increase in reported incidents of pollution and unlawful water uses.

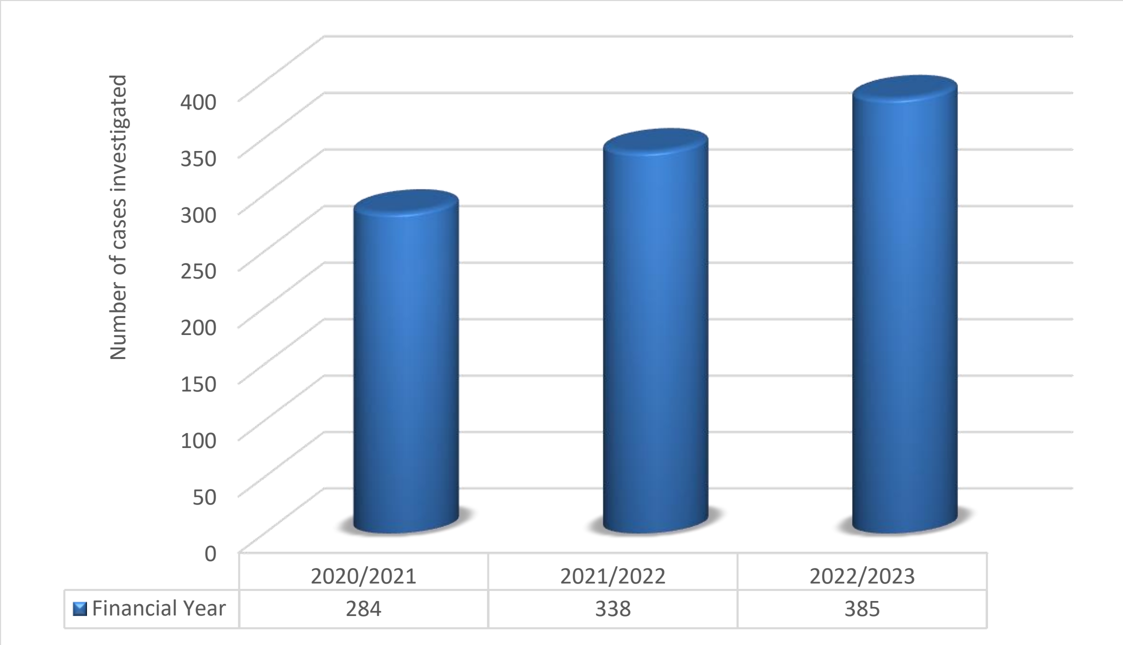


Figure 10.5: Overview of Enforcement cases investigated during from FY2020/21 - FY2022/23.

Table 10-1: Reported non-compliance cases investigated for DWS.

Sub-Programme		**Enforcement**			
Performance Programme Indicator (PPI) no	**Performance indicator**	**Planned target FY2022/23**	**Actual achievement FY2022/23**	**Deviation from planned target to actual achievement for FY2022/23**	**Comment on deviations**
5.1.6	Percentage of reported non-compliant cases investigated	80%	84% (386 out of 460)	Over by 4%	The target was exceeded as a result of high number of pollution related cases reported which required urgent investigations to be conducted.

In certain instances, findings arising from these investigations unveiled non-compliance with the water-related legislation. In response to these contraventions, the DWS invoked its authority to initiate administrative enforcement actions aimed at rectifying the identified contraventions. Furthermore, were necessary, the DWS has exercised its prerogative to initiate criminal proceedings or pursue civil actions in instances where such enforcement measures were deemed appropriate and necessary to address cases of significant non-compliance.

The DWS duly issued a total 205 notices indicating its intention to subsequently issue directives. A total of 72 directives were issued. Moreover, the DWS recorded 17 criminal cases against offenders. Six cases, which had been initiated in preceding financial years, were subsequently referred to the National Prosecuting Authority (NPA) for a decision (Table 10-2).

Several complaints have been reported regarding unlawful water uses and pollution-related cases, highlighting non-compliance in various sectors. The agriculture sector and local government municipalities account for the highest proportion of reported cases, at 28% for each, followed by mining at 21% (Figure 10.6).

Table 10-2: Enforcement actions taken against non-compliant water users and water polluters in the various provincial offices.

Region	Percentage of reported non-compliant cases investigated	*Notices Issued	*Directives Issued	*Cases Registered with SAPS	*Cases referred to NPA
Eastern Cape	34/50 = 68%	13	7	-	1
Free State	9/9 = 100%	1	5	1	-
Gauteng	58/64 = 91%	9	17	2	1
KwaZulu-Natal	55/75 = 73%	3	4	6	1
Limpopo	36/38 = 95%	9	9	2	1
Mpumalanga	82/95 = 86%	69	24	5	2
North-West	67/71 = 94%	25	1	-	-
Northern Cape	28/29 = 97%	42	3	-	-
Western Cape	16/29 = 55%	34	4	1	-
Total	**385/460 = 84%**	**205**	**74**	**17**	**6**

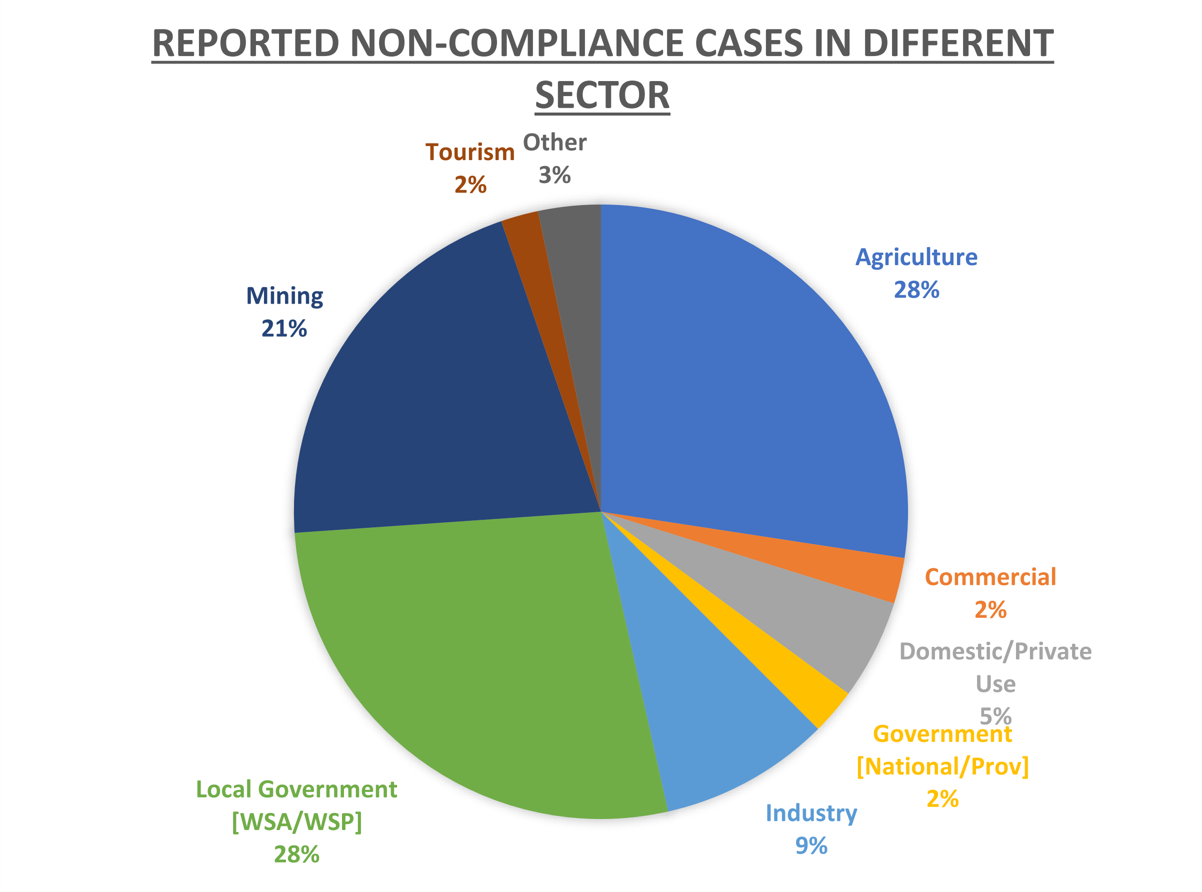


Figure 10.6: Enforcement cases per water sector for the FY2022/23.

An analysis of the cases resolved following enforcement interventions on reported non-compliance cases reveals several outcomes (Table 10.3). At least 27 cases were investigated and revealed no evidence of contravention, indicating that the alleged non-compliance claims were inadequately substantiated. In four cases, a plea sentence agreement was reached, with the responsible party admitting guilt. Additionally, remedial actions were taken for 11 cases during the investigation phase, highlighting the importance of addressing non-compliance issues promptly.

Overall, this analysis provides insights into the various resolutions achieved following enforcement interventions, emphasising the significance of enforcing compliance and taking appropriate measures to rectify non-compliance instances.

Table 10-3: Summary of resolved enforcement cases in FY2022/23.

Summary of Resolved Cases	No
Cases referred from Compliance Monitoring Unit	12
Complied with Administrative Action	23
No Contravention Detected	27
*Nolli prosequi** or declined to prosecute	0
Plea Sentence Agreement (Admission of guilt)	4
Remedial action taken at Investigation Phase	11
Total	**77**

*A decision not to prosecute will be indicated by the legal term "nolle prosequi" literally meaning "not to wish to prosecute". The certificate nolle prosequi is a certificate issued by the National Director of Public Prosecutions (DPP) of the region, to the effect that the DPP has considered the matter and declines to prosecute on behalf of the state for varying reasons.

10.3.1 Joint Compliance and Enforcement Operations

During the past three financial years, the joint operations by DWS Enforcement Units have shown fluctuating trends in the number of reported non-compliance cases. In the FY2020/21, a total of 17 joint operations were conducted to address reported non-compliance incidents. This number increased significantly in the following FY2021/22, with 30 joint operations conducted, indicating a heightened effort in enforcing compliance. However, in the current FY2022/23, there has been a slight decrease to 25 joint operations (Figure 10.7). In addition to the 25 joint operations DWS were involved with, the IUCMA dealt with one joint operation with DFFE during the reporting period that led to a criminal case and BGCMA conducted a V&V follow-up Blitz operation with DWS regional office officials where 21 facilities were inspected.

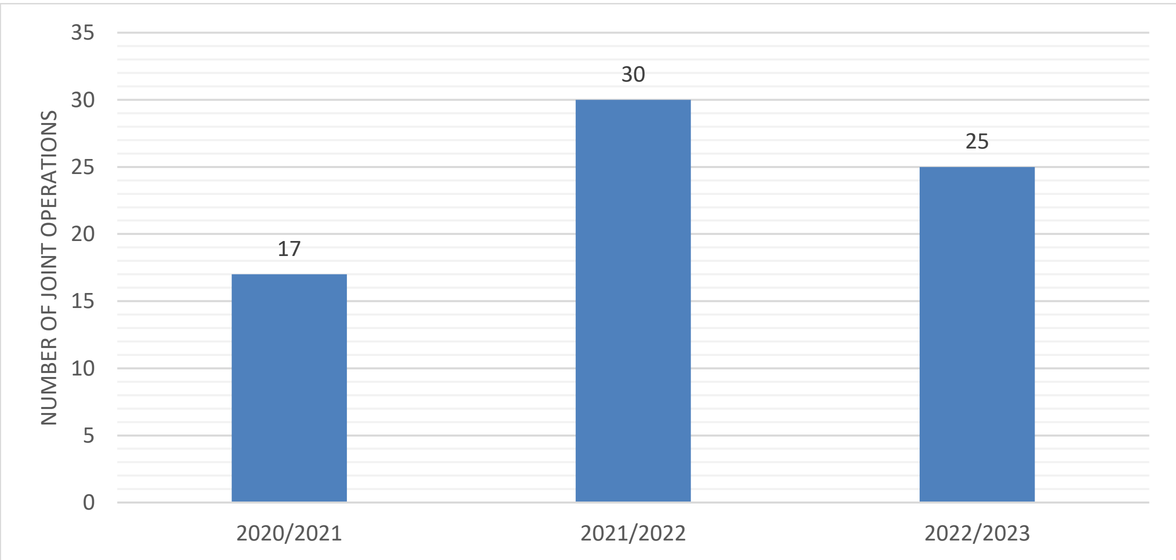


Figure 10.7: Number of DWS joint enforcement operations over the last three financial years 2020/21-2022/23.

10.3.2 Emergency Pollution Incident Enforcement

During the 2022/23 review period, a total of 460 cases of non-compliance were reported to DWS. Among these cases, 164 cases were related to the control of emergency incidents resulting in water resource pollution. In response to these incidents, the Department conducted thorough investigations and, where necessary, initiated administrative enforcement actions or filed criminal charges against those responsible. These actions were aimed at compelling individuals or entities involved to undertake corrective measures to mitigate pollution.

It is important to highlight that these incidents primarily occurred during normal operations of various activities, often involving spillages, manhole overflows and others. The affected sectors included local government, mining, industrial, and agriculture. The Department is monitoring efforts to ensure that appropriate clean-up and rehabilitation measures are implemented to protect our valuable water resources from further harm and degradation. Mpumalanga had the most emergency pollution incidents at 43 followed by North West at 35 (Figure 10.8).

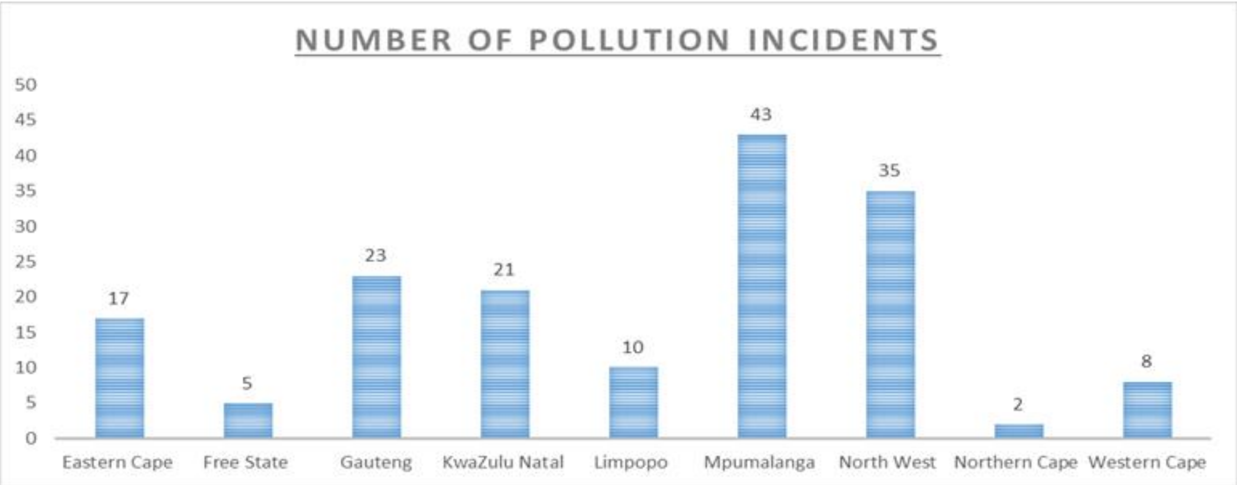


Figure 10.8: Number of emergency pollution incidents of non-compliance reported per DWS provincial offices.

The Department issued 36 notices and 18 directives, while a criminal case was initiated against a facility operator who, either intentionally or negligently, engaged in activities that resulted in the pollution or potential pollution of a water resource. Collaboratively, the Department is actively engaged with SAPS to facilitate the completion of the case docket, which will then be forwarded to the NPA for a decision. Furthermore, seven cases have been closed as facility operators have undertaken corrective measures to clean and rehabilitate the affected areas, effectively mitigating the pollution risk to our water resources.

Additionally, the IUCMA CME unit received 30 reported pollution incident-related cases for investigation. The majority of these issues were related to sewage overflow as a result of municipal infrastructure failure. At least 25 of the reported matters were resolved with a verbal directive. Only five directives were confirmed in writing within 14 days of issuing a verbal directive. Follow-up inspections were conducted, and all users issued with directives have fully complied with the satisfaction of the IUCMA.

Furthermore, the BGCMA CME unit also received 26 pollution incident-related cases for investigation. Out of the 26 cases, four notices were issued following the site investigations and the rest were resolved through verbal directives. Most of these incidents are related to sewage spillages due to the municipal infrastructure breakdown. Follow-up site inspections were conducted, and all the pollution cases were dealt with during this financial year.

10.3.3 CME Capacity Building

The DWS CME Strategy approved in March 2018 is progressively being implemented with the further training of DWS and CMA CME/EMI personnel and external stakeholders. In respect of EMI Basic Training undertaken during the FY2022/23, 21 DWS and CMA officials received training from the DFFE. All officials passed and have been designated as EMIs. Additional training was rolled out to the IUCMA and BGCMA to capacitate the officials in the CME generic concepts, processes, procedures, and IT Application tools (NCIMS and ECMS) and how to compile a Compliance Inspection Report.

10.4 Water Services Regulation

The Department of Water and Sanitation is responsible for ensuring that water is effectively managed in order to promote equitable and sustainable socio-economic development and universal access to water, as well as the provision of safe drinking water to all. As part of regulation, the Department runs the Blue Drop and Green Drop Certification Programmes, which are Incentive-based Regulation (IBR) models pioneered by the South African Water Sector in 2008. The programmes not only assist the Department in meeting its strategic objectives, but they also align with its efforts to achieve the United Nations Sustainable Development Goals for clean water and sanitation, as well as climate action. These programmes call for the country to manage drinking water and wastewater quality to the highest standards.

The Water Services Act, (Act No. 108 of 1997) prescribes the legislative duty of Water Service Authorities (WSAs) to provide drinking water to residents of all municipalities. The Act requires the Minister to establish and maintain a national information system and monitor the performance of all water services institutions. Based on this, the Department has established the Integrated Regulatory Information System (IRIS) to monitor the quality of drinking water. The IRIS is accessible to the public at http://ws.dwa.gov.za/IRIS/documents.aspx.

10.4.1 The Green Drop Certification Programme

In 2008, the Department of Water and Sanitation introduced a Green Drop Programme, which is an incentive-based, risk management approach to address the design and operating capacity of WWTWs, compliance of the effluent to agreed standards, local regulation (by-laws implementation) and infrastructure management and condition, (i.e., asset management practices). Since its inception, this programme has sought to identify and develop the core competencies that, if strengthened, would gradually and sustainably improve the standard of wastewater management in South Africa (DWS, 2023a).

Consequently, the Green Drop certification process recognies and rewards progressive improvement and excellent performance. The process measures and compares the results of the performance of Water Services Institutions (WSIs) and subsequently rewards or reprimands the institution upon evidence of their excellence or failures according to the minimum standards or requirements that have been defined.

The annual Green Drop report intends to provide WSIs with comparative analysis and diagnostics to help them focus on specific areas for improvement. Each Green Drop audit cycle is distinguished by gradual changes in the audit criteria, which are guided by the status and priorities of the wastewater sector. Therefore, the maintenance of the previous cycle's Green Drop evidence and performance does not result in the same Green Drop score for any WSI.

10.4.2 The 2023 Green Drop Assessment

The Green Drop Progress Assessment was conducted for 144 Water Services Authorities (WSAs) via an infrastructure network comprising 867 WWTWs, the Department of Public Works, Government, and some private institutions across the country. The report covered 1004 WWTWs within WSIs assessed as reported in the Green Drop Report 2022. The progress report revealed a negative national trend in risk movement over the past five (5) assessment cycles (2009-2023), with an increase in average risk rating from 70.1% to 76.5% placing the country in a **high-risk category**. Figure 10.9 shows the movement in the number of WWTWs in each risk category at a national level as summarised below:

- The overall national risk profile in 2023 leans towards WWTWs dominating the medium, high, and critical risk areas, with prominence in the high-risk category.
- The number of WWTWs in the low-risk category has reduced from 199 in 2013 to 168 in 2022, with a further reduction to 74 in 2023 indicating a negative movement with deterioration in wastewater management.
- The number of WWTWs in the medium-risk category has decreased since 2013 from 272 to 217 in 2023, noting a small decrease between 2022 and 2023.

- The number of WWTWs in the high- and critical-risk categories have both increased since 2013.
- The number of WWTWs in the high-risk category has increased from 232 in 2013 and 252 in 2022 to 298 in 2023. This indicates negative movement of WWTWs from low and medium category into the high-risk category.
- The same pattern is apparent for the number of WWTWs in the critical-risk category with a notable increase from 2013 with 278 WWTWs now residing in the critical-risk category.

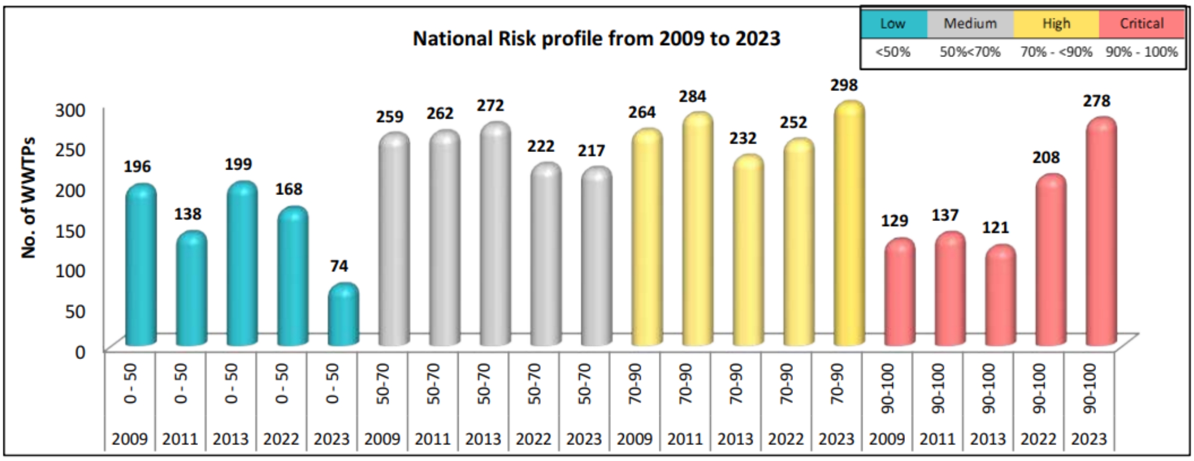


Figure 10.9: National Risk Profile Trend from 2009 to 2023.

The Department is concerned about the increase in the number of WWTWs in the high and critical-risk categories as this represents poor wastewater management at these WWTWs. The WSIs with high- and critical-risk rated WWTWs must ensure funding is secured for targeted interventions to improve the risk rating of these WWTWs.

The 2023 national risk profile and the results are summarised as follows:

- The average %CRR deviation score is 76.5% placing the country in the high-risk category;
- 9% of WWTWs are in the low-risk category;
- 25% of WWTWs are in the medium-risk category;
- 34% of WWTWs are in the high-risk category; and
- 32% of WWTWs are in the critical-risk category.

10.4.3 The Blue Drop Certification Programme

The Blue Drop certification programme is an incentive-based regulation that was introduced in 2008, where the DWS measures all aspects contributing to a sustainable Water Services Business and provision of safe water to the citizens of South Africa. This programme gives prominence to the World Health Organisation's (WHO) *Water Safety Planning* concept as the basis for a proactive, risk-based approach to drinking water quality management from catchment to consumer. Since then, DWS has been monitoring the risk of each water supply system based on the performance against

Blue Drop Certification criteria. The results create an enabling environment whereby the Water Services Authority (WSA) and DWS identify, prioritise and implement targeted and specific interventions to improve performance.

The South African National Standard for Drinking Water (SANS:241) is the definitive reference on acceptable limits for drinking water quality determinants. SANS:241 prescribes the minimum numerical limits that must be met for drinking water quality to be deemed safe for human consumption. There are over 1300 drinking water treatment works in South Africa, mostly owned by municipalities, water boards or privately owned. Several determinants are analysed in the laboratory to determine compliance which are mainly grouped into microbiological, chemical (acute) and chemical (chronic). In addition, physical and aesthetic determinants are also monitored.

Blue Drop assessments are detailed assessments of the entire water value chain, the audit scorecard is designed to consider evidence against 5 Key Performance Areas (KPAs):

- Capacity Management;
- Drinking Water Quality Risk Management;
- Financial Management;
- Technical Management; and
- Drinking Water Quality Compliance.

Each KPA and sub-criteria carries a different weighting based on the regulatory priorities. These assessments are supplemented by a physical Technical Site Assessment (TSA) to confirm the findings of the desktop audit. The TSA score reflects the physical condition of the raw water handling system (abstraction facility, pumps and pipelines), the water treatment plant (inlet works to disinfection and sludge treatment), and the distribution system (command reservoir/s or tower/s, including pump stations and bulk pipelines).

The Blue Drop report, which is a comprehensive assessment of the state of all drinking water systems was released by the Minister of the Department of Water and Sanitation on **05 December 2023.**

- *2023 Blue Drop Report Findings*

The findings from the 2023 Blue Drop assessment are summarised as follows:

- All 144 WSAs, i.e., municipalities given the responsibility for water services provision by the Minister of COGTA were audited during the period 1 July 2021-30 June 2022.
- 26 WSSs scored more than 95% and qualified for the prestigious Blue Drop Certification. In 2014, 44 WSSs were awarded Blue Drop status, there is an overall decline in excellence noted between 2014 and 2023.

- 277 of 958 (29%) WSSs (in 62 WSAs) were identified to be in a critical state of performance compared with 174 of 1036 (17%) WSSs (in 33 WSAs) in 2014.

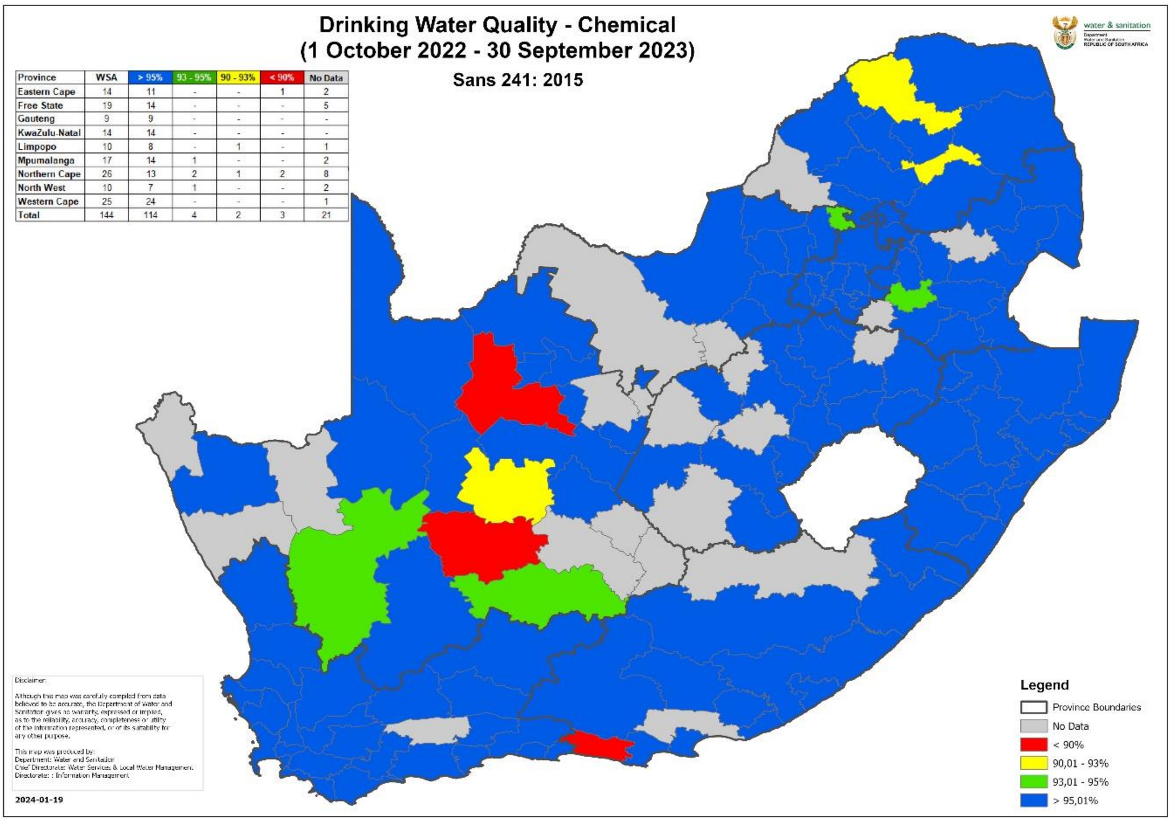
10.4.4 Drinking Water Quality Compliance (Oct 2022 – Sept 2023)

i. Chemical Drinking Water Compliance

Chemical water quality is determined by determinants prescribed by SANS:241 or WHO, which may be acute or chronic health with specific health risks associated with each determinant. Acute health risks can result in death if the limit is exceeded, while chronic limits provide maximum limits that can be ingested over a period of time before health effects are observed.

Chemical determinants contrary to microbiological determinants may be monitored at least once per annum for drinking water provided that a risk to consumers has not been prior identified. In compliance monitoring, all WSAs are required to perform a full SANS:241 as prescribed by the standard. At a minimum, for the supply system to be considered safe, drinking water must achieve a **95%** chemical compliance status.

A total of 144 water services authorities were assessed for the 2022/23 hydrological year as shown in Figure 10.10. However,14.6% of the water services authorities did not upload data on the Integrated Regulatory Information System (IRIS). The results of the Water Supply Systems (WSS) compliance in terms of chemical drinking water quality from October 2022 to September 2023 show that 79% of the systems had excellent compliance in terms of chemical quality compliance, 2.8% had good compliance, while 3.5% demonstrated poor chemical quality compliance. In cases where non-compliance was observed (< 90%), the reasons should be further investigated. The non-reporting and non-compliant WSAs will be continuously monitored and supported by the Department.

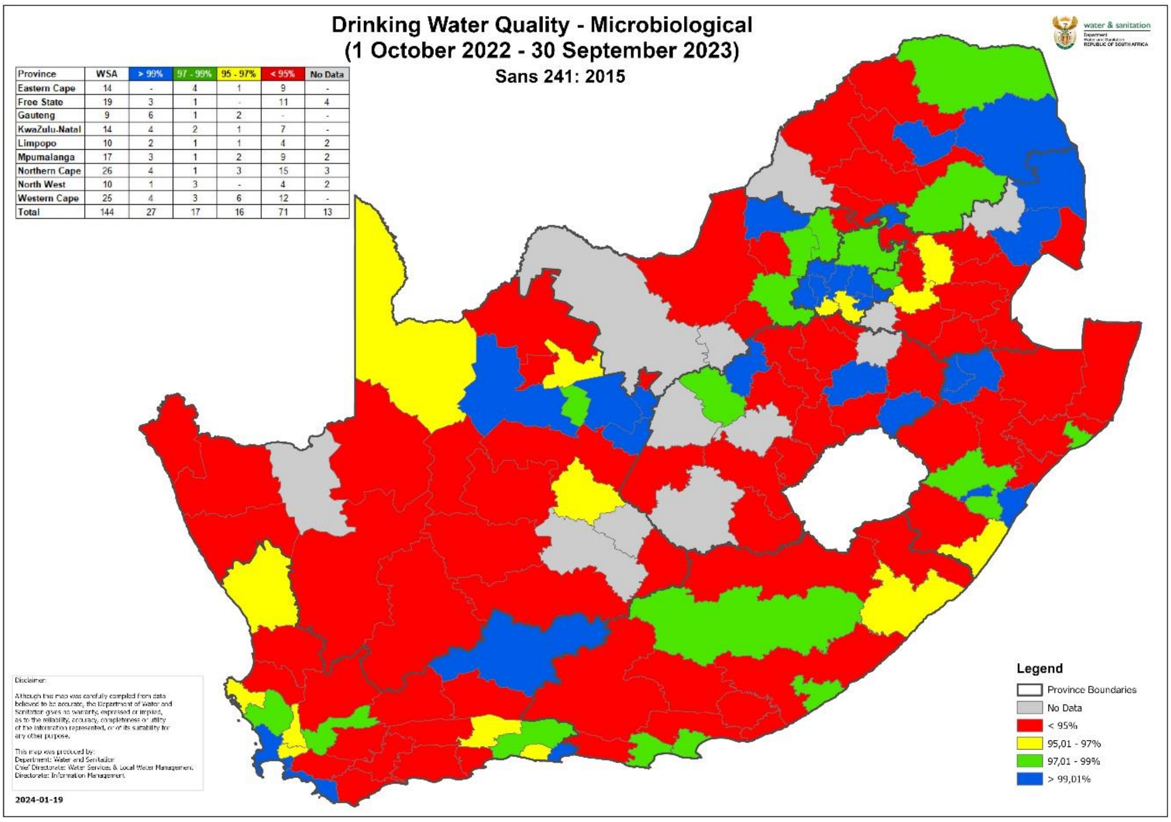


Province	WSA	> 95%	93 - 95%	90 - 93%	< 90%	No Data
Eastern Cape	14	11	-	-	1	2
Free State	19	14	-	-	-	5
Gauteng	9	9	-	-	-	-
KwaZulu-Natal	14	14	-	-	-	-
Limpopo	10	8	-	1	-	1
Mpumalanga	17	14	1	-	-	2
Northern Cape	26	13	2	1	2	8
North West	10	7	1	-	-	2
Western Cape	25	24	-	-	-	1
Total	144	114	4	2	3	21

Figure 10.10: Status of drinking water chemical quality compliance.

ii. Microbiological Drinking Water Compliance

Microbiological compliance results presented in Figure 10.11 reflects the actual compliance of the final water and distribution system from Oct 22 - Sept 2023 against microbiological determinants. The presence of these determinants in water is a strong indication of recent sewage or animal waste contamination and there is potential for contracting diseases from pathogens, thus the WSIs are expected to be compliant 99.9% of the time for all microbial indicators analysed.



Province	WSA	> 99%	97 - 99%	95 - 97%	< 95%	No Data
Eastern Cape	14	-	4	1	9	-
Free State	19	3	1	-	11	4
Gauteng	9	6	1	2	-	-
KwaZulu-Natal	14	4	2	1	7	-
Limpopo	10	2	1	1	4	2
Mpumalanga	17	3	1	2	9	2
Northern Cape	26	4	1	3	15	3
North West	10	1	3	-	4	2
Western Cape	25	4	3	6	12	-
Total	144	27	17	16	71	13

Figure 10.11: Status of drinking water microbiological quality compliance.

An observation is made that **72%** of the WSSs in the country did not meet SANS:241 requirements for the reporting period (1 Oct 2022- 30 Sept 2023) and only **18%** of the WSSs achieved an excellent status (>99.9%). It was also noted that 13 WSAs did not submit their drinking water quality data as prescribed by the norms and standards, thus impacting the national outlook as these WSAs could not be assessed in the absence of drinking water quality data submission to the Department.

The overall low compliance results are of serious concern to the Department as most of the WSSs present a potential health risk to the consumers. The Department through its provincial offices, is continuously monitoring and engaging with the relevant WSAs which achieved microbiological compliance below 99.9% including those that are not submitting water quality data to the Department.

11

SANITATION SERVICES

11 SANITATION SERVICES

The National Development Plan's target of ensuring that all South Africans have full, affordable, and reliable access to sufficient water and sanitation by 2030, aligns well with the Sustainable Development Goal 6.2 (SDG 6.2) target which states “By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations”.

In 2015, South Africa adopted a revolutionary approach under the theme – “It is not all about flushing”, recognising that South Africa is a water-scarce country, with a projected 17% deficit in the availability of water by 2030 if the same rate of water consumption is maintained. The projected water deficit will have a significant impact on the historic way of providing waterborne sanitation and requires the sector to reconsider sanitation provision approaches, with more investment in non-sewered, low water and waterless sanitation solutions as a means to increase the rate of sanitation service delivery within the 7 years left until 2030.

The DWS has recognised that due to **a)** the impact of climate change, **b)** water resources constraints, and **c)** energy supply challenges; the historic approach of providing waterborne sanitation is no longer sustainable and realistic to achieve universal access to safely managed sanitation. The envisaged 17% deficit in availability of water and projected demand by 2030, requires the water sector leader to embrace the use of a range of appropriate sanitation solutions and innovative technologies which require little, or no water or recycled water to lower water requirements.

SDG 6.2 has significantly changed the approach to how sanitation services are managed from access to a household sanitation facility as previously prioritised under the Millennium Development Goals, to ensuring “safely managed sanitation”. This calls for a paradigm shift as it is no longer about simply constructing a toilet, but a holistic approach to sanitation management across the entire sanitation service chain. The sanitation service chain refers to containment, emptying, transportation, treatment, and disposal or reuse. Hence, there is a need to embrace a combination of on-site, off-grid; sewered or non-sewered sanitation systems including centralised or decentralised wastewater treatment solutions. In addition, South Africa must accept the reality that the country no longer has the luxury of flushing 9 to 12 litres of potable water while some parts of the country do not have access to drinking water.

Although the flush toilet system is everybody’s aspiration, it comes at a big cost which at times is not viable as it does not justify economies of scale and population density. The adoption of alternative sanitation systems can be a driver for water security in the country.

In response to the National Sanitation Policy (2016), DWS developed the National Sanitation Framework (NSF). It is an implementation framework that will assist government in providing equitable and safe sanitation in all settlement types. It guides towards ensuring appropriate support to Water Services Authorities (WSAs) in cases of service delivery lapses, and non-compliance to regulator prescripts leading to a deterioration in the provision of sanitation services. The NSF provides for the revision of the national minimum norms and standards as it relates to sanitation services thus ensuring more equitable provision of sanitation underpinned by the strengthened monitoring and compliance to these standards. The NSF reinforces the importance of prohibiting the provision of bucket toilets by municipalities as a sanitation solution, ending open defecation and eradicating sanitation backlogs by rolling out a range of support measures to poor-performing municipalities, thus ensuring a turnaround of sanitation services. In doing so, the future choice of sanitation technology options for the provision of sanitation services must be based on technical considerations and include population density, groundwater pollution risks and economies of scale. In line with the National Water and Sanitation Master Plan (NWSMP) actions, all new settlements and developments should use water-efficient sanitation solutions.

11.1 Development of The National Sanitation Integrated Plan (NSIP)

The NSIP provides a 10-year roadmap for ensuring access to adequate sanitation services, eradicating open defecation, providing innovative solutions, and creating a pathway to generate new sanitation opportunities. The main goal of the NSIP is to assist the sanitation sector in providing adequate and innovative sanitation services and solutions to enable long-term sustainable management of sanitation services in South Africa. The NSIP will help prioritise sanitation provision aligned to commitments of the National Development Plan (NDP) 2030, NWSMP, and SDGs. The vision of the NSIP is a coordinated plan that considers South Africa's scarcity of resources, promotes the delivery of equitable, efficient and sustainable sanitation services to all and contributes to public health and a clean environment.

Figure 11.1 shows that a significant proportion of the households in South Africa are reliant on on-site sanitation. No municipality is 100% sewered in South Africa. Only Gauteng and Western Cape have waterborne systems provided to over 90% of the households.

To strengthen governance, support and implementation of the NSIP, Provincial Sanitation Task Teams are set up to work as a vehicle to drive integrated planning, monitoring, reporting and implementation of sanitation programmes and projects in a coordinated manner.

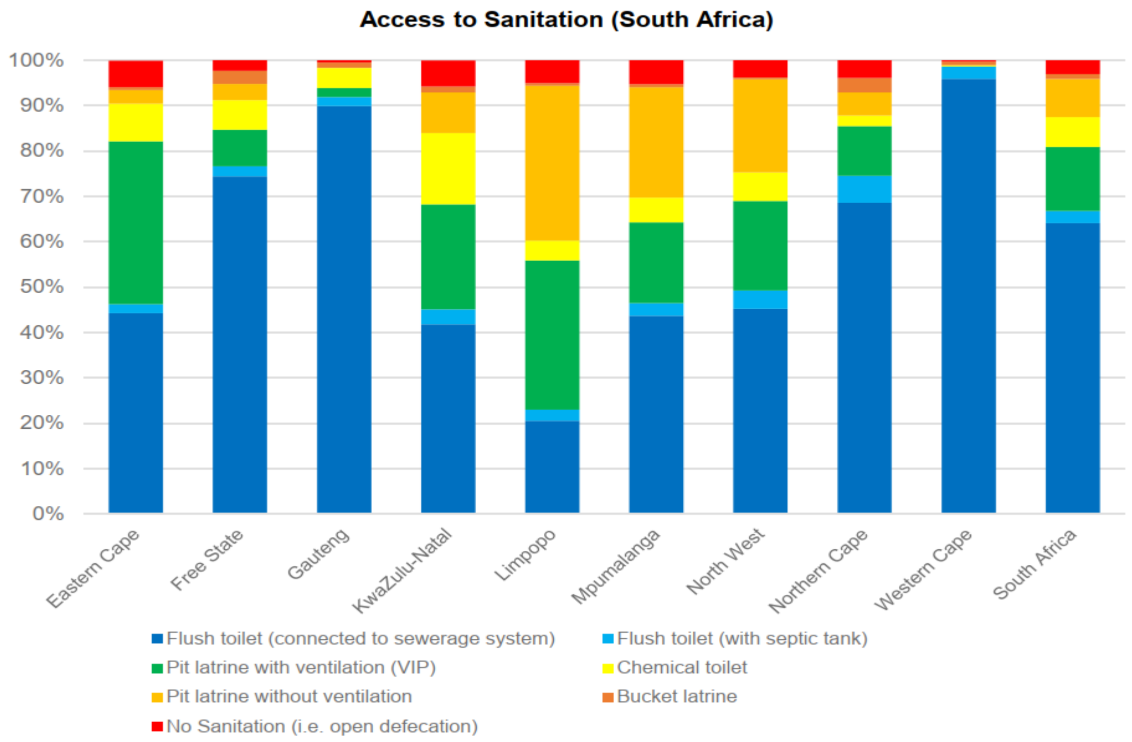


Figure 11.1: Access to sanitation in South Africa 2023.

11.2 The National Faecal Sludge Management Strategy

The National Faecal Sludge Management (FSM) Strategy encourages sustainable sanitation management along the sanitation service chain to prevent health hazards and protect the environment. It also enhances the operation and maintenance of on-site sanitation systems and prevents groundwater contamination. The strategy introduces a paradigm shift of safely managing sanitation along the sanitation services chain. Of importance is the need to recover, re-use and recycle resources from faecal sludge and wastewater sludge for beneficial use. The water and sanitation sector has embraced the reality that sanitation has an economic value, therefore there is a need to explore approaches to creating economic and job opportunities along the sanitation service chain. This can be realised by transitioning to a circular economy and converting faecal and wastewater sludge into various by-products such as biogas, composting, and biochar. The Department is working with various Research Institutions and Universities to fast-track resource recovery initiatives from sludge. The private sector is also encouraged to take advantage of the faecal sludge reuse and resource recovery business opportunities.

As guided by the provisions of SDG 6.2, the overall objective of the strategy is to mainstream faecal sludge management as part of sanitation services in South Africa, and:

- To establish clear regulatory and financing frameworks for FSM across the service chain.
- To establish an enabling framework for private sector opportunities in FSM service provision.
- To provide strategic guidance to WSAs concerning the management of on-site sanitation.
- To promote the beneficial use of faecal sludge as a resource, with the potential to create jobs and economic opportunities, through the sanitation circular economy.

Figure 11.2 shows the six pillars upon which the National FSM Strategy is built **(1)** Policy, Legislation, Regulation and Enforcement **(2)** Institutional Arrangements **(3)** Planning **(4)** Financing **(5)** Capacity, Technical Assistance and Technology **(6)** Promotion and User Engagement.

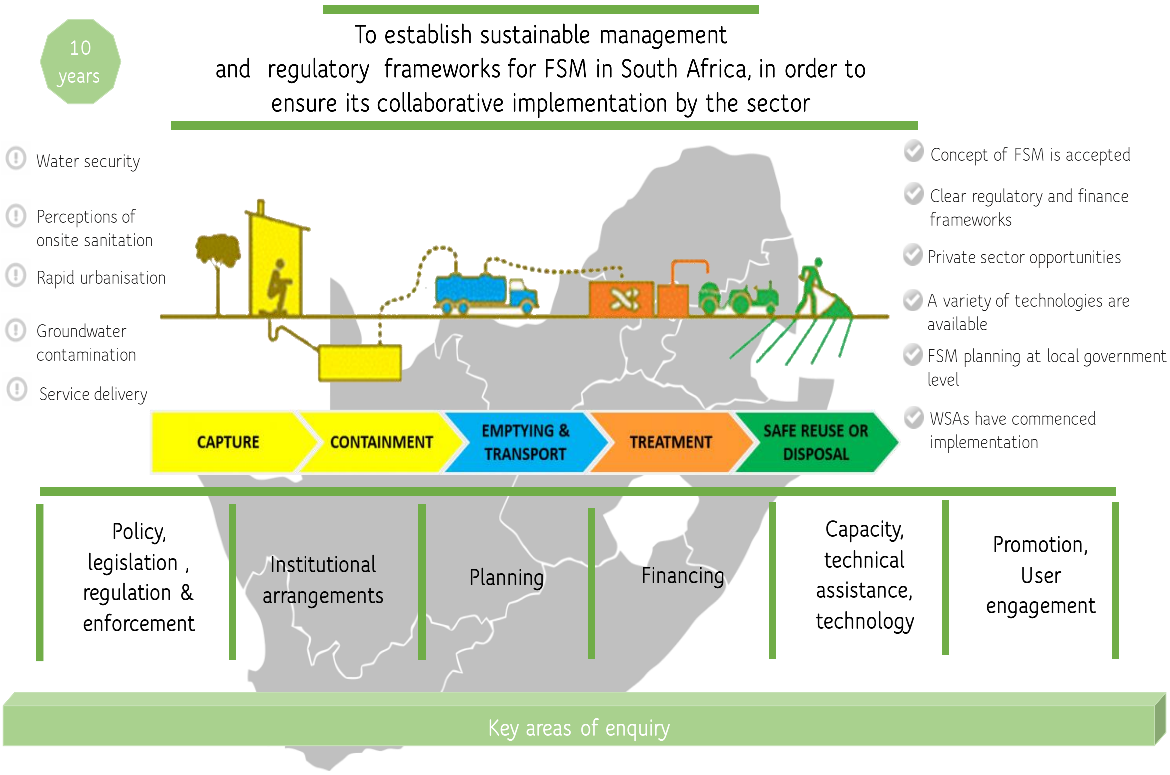


Figure 11.2: Conceptual framework for FSM in South Africa over the next ten years.

11.3 Developing Shit / Excreta Flow Diagram Capacity Building Programmes

A Shit Flow Diagram (SFD) presents a clear picture of how human excreta generated in a municipal area is contained as it moves from defecation to disposal or end-use. It functions as a tool to identify where sanitation improvements are needed. The purpose of the SFD is to estimate a proportion of the population using safely managed sanitation. It consists of a diagram, a narrative report, and a record of data sources. SFD has been identified as a useful tool to better understand the sanitation situation within South Africa. At present, SFDs have been developed for only a few WSAs in South Africa. It is therefore not currently possible to develop a provincial or national view of the status of sanitation using SFD outputs. DWS is aiming to roll out SFDs in a phased approach starting with 36 WSAs across the country. SFD development at selected WSAs will be initiated in 2024. Considering that it will take some time to develop SFDs for all 144 WSAs in South Africa, a SFD approximation was developed using available sanitation data. The output from this exercise has been dubbed the "1st Order SFD" and these outputs have been developed for South Africa and all 9 provinces.

The 1st order SFD is a useful tool to guide and influence appropriate strategy and planning (Figure 11.3). Benefits include:

- Lower cost or shorter time to obtain strategic overview of key challenges along the sanitation service chain,
- Common language for the sector,
- Contribution to national planning and reporting obligations, and
- Alignment to international reporting obligations.

The 1st order SFD highlights significant gaps in the sanitation value chain. These deficiencies, all potentially have a negative impact on communities (water supply) and the environment (water sources).

As improved data and information become available through SFD development or other related sanitation initiatives, the 1st Order SFD can continue to be reviewed and refined. SFD has been identified by DWS as a useful tool to better understand the sanitation situation within South Africa. DWS is aiming to roll out SFDs in a phased capacity-building approach.

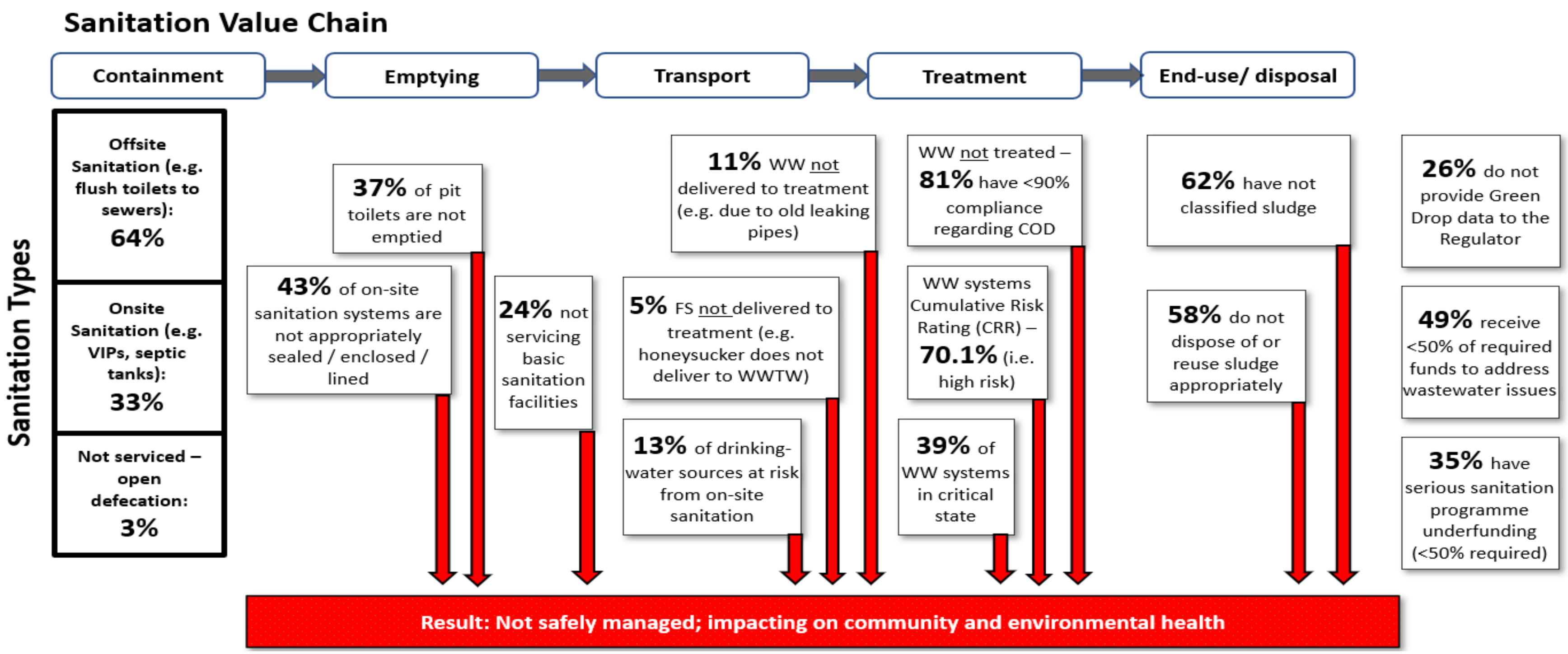


Figure 11.3 1st Order SFD for South Africa.

11.4 Development of Regulatory Mechanisms for non-sewered sanitation services

In South Africa sanitation services are provided with a mix of sanitation systems which include onsite and offsite (centralised and decentralised systems). South Africa needs a tool to plan, regulate, and report on safely managed sanitation for onsite sanitation systems. Faecal sludge and non-sewered sanitation are not currently a Green Drop focus, though faecal sludge from pits is often disposed of at wastewater treatment works. The impact of this on the treatment processes is often not monitored, and the loads inserted from vacuum tankers and buckets are not adequately assessed. There are challenges of full pits, stockpiling of sludge, safety concerns regarding poorly constructed onsite sanitation systems, and unsafe handling of human excreta in the entire sanitation service chain.

The regulation mechanisms are available for wastewater systems through the Green Drop Certification Programme while existing regulatory mechanisms for onsite sanitation systems are limited to package plants, decentralised systems and vacuum tank discharges through bylaws and enforcement. To address this gap, a new set of criteria has been developed and incorporated into the Green Drop Certification process. These new criteria will be communicated to WSAs and rolled out accordingly.

The inclusion of the non-sewered sanitation criteria into the Green Drop Certification Audit will be achieved in a phased manner, with appropriate accompanying (1) stakeholder advocacy and awareness engagements; and (2) water services institutions training and capacity building to ensure that the sanitation sector is ready and able to respond to the amended criteria.

This approach aims to provide sufficient time for:

- Sector stakeholders to grasp and understand complexities of including assessment of non-sewered sanitation systems,
- WSAs to improve current monitoring and evaluation systems,
- DWS to further refine the criteria through practical testing of the draft criteria (through pilot trials at selected WSAs).

12

CONCLUSIONS

12 CONCLUSIONS

Key features that characterise water resources availability in South Africa are the following:

- South Africa is characterised by spatial variability in rainfall, with the east of the country lying in the summer rainfall zone with high rainfalls. In contrast, the country's west lies in an all-year-round or winter rainfall region that is semi-arid to arid.
- The seasonal variability in the country's climate influences water availability and storage dynamics.
- River systems (mostly through the surface water storage in large dams) are the common surface water expression of water availability in South Africa, with others being lakes, ponds, and pans.
- Aquifer (groundwater) storage is another expression of water availability in the country where an increased groundwater utilisation in the country's water mix has been observed due to the significant potential of the groundwater resources in adaptation to climatic-related stresses and augmenting conventional surface water supply systems.
- South Africa's water supply is dependent on Strategic Water Source Areas (SWSAs). SWSAs are defined as areas of land of national importance that either (a) supply relatively large quantities of mean annual surface water runoff compared to their size (b) have high groundwater recharge and high dependence, or (c) areas that meet both criteria (a) and (b). They include transboundary Water Source Areas that extend into Lesotho and Swaziland.
- South Africa is a water-scarce country. Water insecurity has become severe as almost 98% of the available freshwater resources are already allocated, and over 60% is used for crop production. Water availability is highly variable, determined by rainfall variability in the national territory.

The following features characterise water resource management in South Africa:

- The water sector institutional reform is ongoing; for the current outlook, the National Department of Water and Sanitation is the custodian of water resources with an obligation to perform water resource management functions. The water resource management functions are to be delegated to the six Catchment Management Agencies (CMAs), where two are existing and four are being established; this supports the principles of good governance, where water will be managed locally.
- At a local level, there are Water Services Institutions (WSI), which comprise Water Services Authorities (WSAs) that provide water services or outsource water services provisions to the private Water Services Providers (WSPs).

- The four new CMAs, namely Breede-Olifants CMA, Vaal-Orange CMA, Pongola-Mzimkulu CMA, Mzimvubu-Tsitsikamma CMA have been established, with three of the four CMAs already having interim CEO appointed.
- South Africa shares four international river basins, namely the Limpopo, Orange/Senqu, Inkomati, and Maputo, with six neighbouring countries, Botswana, Lesotho, Mozambique, Namibia, eSwatini, and Zimbabwe. These water resources are managed through shared watercourse institutions, commissions, and international agreements to promote international transboundary cooperation.
- The Department of Water and Sanitation has established various monitoring networks (along rivers, dams, estuaries, eyes, canals, pipelines, groundwater aquifers, wetlands, and abandoned mines), monitoring programs, and information systems to ensure water resource data is freely available and accessible.
- South Africa faces water, energy, and food insecurity; while the country is food secure at a national level, over 50% of households still face food insecurity, 98% of the country's water resources are already allocated, and the country currently faces instability in the energy sector (StatsSA, 2019).

Rainfall and Temperatures

A warming trend of approximately 0.17 ºC per decade is indicated for the country over the period 1951-2023, statistically significant at the 5% level (SAWS, 2024). The summer periods for the hydrological years 2020/21, 2021/22, and 2022/23 have fallen within the protracted 2020-2023 La Niña event. Wetter and cooler conditions occurred for extended periods of the summer, as is typical during La Niña events.

Over South Africa from October 2022 to September 2023, there were several notable periods of extremely hot or cold conditions, two of which include the anomalously hot period of 9-23 January 2023 and the anomalously cold period of 9-12 July 2023. With extreme hot events, there is typically increased water demand not only for domestic consumption but also for agricultural and industrial uses. These heightened water demands, coupled with increased evaporation, can easily strain water resources. On the other hand, extremely cold temperatures can also impact water resources, but to a lesser extent. In the context of cold waves (and the 9-12 July 2023 cold wave) and other extremely cold temperature events (e.g., cold snaps), the impact on water availability can be felt through freezing over of water bodies, limiting available water that can be used for drinking and household, irrigation, and industrial use.

Drought

Based on the long-term SPI time series, over most parts of the country (north-eastern central to western, eastern to south-eastern) parts, wetter periods occurred around 2017 and then again during the 2021-2023 period. Drier periods, with widespread drought, occurred during the 2015-2016 period as well as 2018 – 2020.

Surface Dam Storage

The national dam storage levels for the 2021/22 and 2022/23 hydrological years were the highest for most of the months in the past five hydrological years, especially after the beginning of summer rainfalls received between November and February 2023 for the eastern parts of the country. The two dams that were in critical storage condition at the end of the reporting period were each from Eastern Cape and Limpopo.

Water Restrictions

Some parts of the country were still experiencing dry conditions, for example, the southern parts of the Eastern Cape, parts of the Northern Cape, and the southwestern parts of the Western Cape Province. The Department implements water use restrictions in these areas that are experiencing dry conditions, which affect dam storage levels in standalone dams or dams within a WSS or cluster to avoid the risk of failure of water supply or non-supply to the various water use sectors, including users with a high assurance of water supply such as strategic users in the power generation industries.

The Algoa WSS remains with water restrictions in response to the low water storage levels. Notably, restrictions have been lifted for the Amathole WSS as the system recovered. Due to infrastructure limitations, permanent restrictions are still applicable for the Polokwane WSS in Limpopo and Bloemfontein WSS in the Free State Province.

Eutrophication

In the current reporting period, forty-five of the sixty-one monitored sites were analysed for trophic status and eutrophication potential. The trophic status assessment found nine (9) dams to be hypertrophic, two (2) eutrophic, three (3) mesotrophic, and twenty-four (24) oligotrophic. The nine hypertrophic dams included Rietvlei Dam, Hartbeespoort Dam, Bon Accord Dam, Klipvoor Dam, Vaalkop Dam, Roodeplaat Dam, Modimola Dam, Bronkhorstspruit Dam and Witbank Dam, while the eutrophic dams included Loskop Dam and Disaneng Dam.

Microbial Quality

The microbial quality of water for the current reporting period is determined based on the sampling of 43 hotspot sites in the country. Microbiological data collected from October 2022 to September 2023 suggests that water at all 43 newly selected sites is unsuitable for drinking without treatment, as they all exhibit a high risk if consumed directly from the source. Treating water at the household level through methods such as boiling, filtration, or chlorination can help mitigate the potential health risks. However, 35% of the sampled sites still demonstrated a high risk associated with using the water even after undergoing limited treatment. Furthermore, the findings indicated that 41% of the sites were unsuitable for irrigating crops intended for raw consumption, and 67% of the sampled sites were deemed unsuitable for recreational activities, posing a high risk of infection for individuals engaging in such activities. These recreational activities include full-contact activities such as swimming, washing laundry, and events like baptisms.

Ecological State

Based on the assessment of riverine macroinvertebrates at 455 sites during the 2021/22 hydrological year, approximately 60% of the rivers were found to be moderately modified (C). The upper portions of the Crocodile West catchment are located in Gauteng's industrial and urban areas and, thus, are heavily impacted. The Jukskei River, Modderfonteinspruit River, and Crocodile Rivers upstream of Hartbeespoort Dam, Hartbeesspruit just upstream of Roodeplaat Dam, the Apies and Hennops Rivers were all in very poor condition (D/E and E). The Sabie, Komati, and Usuthu catchments had a high proportion of sites in largely or nearly largely natural conditions (B and B/C categories). The remaining largely natural sites were either in the upper reaches closer to the source for Magalies, Debengeni, Berg, and Breede-Gouritz sites, protected areas (Eerste, Klerkspruit, Perskeboomspruit, Glen Reenenspruit, Ribbokspruit), or rural areas (the former Transkei, Mkomazi, uMhlatuze, and Pongola catchments).

Groundwater

The national average groundwater level status indicates a recovery trend from below normal in 2019 to above normal at the end of September 2023. This can be attributed to the above-normal rainfall received in the current and previous two hydrological years, which has significantly recharged aquifers, now showing above-normal percentile levels.

Relatively high groundwater nitrate concentrations are found in some parts of South Africa, particularly the Limpopo and Vaal WMAs. Fluoride concentrations higher than 1.5 mg/L are found in the Limpopo WMA, mainly associated with geothermal springs. The spatial Electrical Conductivity (EC) data shows higher salinity dominating the following WMAs: Limpopo, Vaal, Mzimvubu-Tsitsikamma, and Berg-Olifants. Evidently, the Limpopo WMA has nitrate, Fluoride, and EC water quality concerns. Groundwater in Limpopo and North West plays a significant role in the water supply regime, and together, the two provinces have the most groundwater strategic water source areas.

Groundwater use

Over 3 232 Mm^3 groundwater is abstracted per annum, with three sectors dominating the groundwater use by volumes, with over 55% (1 788 Mm^3/a) of the abstracted groundwater going to irrigation, while 21% (677 Mm^3/a) goes to mining and 11% (340 Mm^3/a) goes to water supply. The balance 13% (424 Mm^3/a) goes to other minor users such as aquaculture, livestock, schedule 1, industry, urban, power generation, and recreation.

Water use Efficiency

Non-revenue water (NRW) in South Africa is a big problem. Approximately 41% of municipal water does not generate revenue. While figures vary between service providers, average physical losses in municipal systems are estimated to be around 35%, against a global best practice of about 15%. As a result, municipalities are losing around R 9.9 billion each year.

The National Water Balance of June 2023 indicates a SIV of 4.39 billion m^3/a, water losses of 1.79 billion m^3/a (40.8%), and NRW of 2.08 billion m^3/a (47.4%). NRW and water losses have increased by a notable 5.9% and 4.3%, respectively, since June 2016. The volume NRW in Categories A (metropolitan), B1, and B2 (secondary cities and large municipalities) municipalities account for almost 75% of the national NRW and should be a focus area of the national WC/WDM programme.

There is significant scope for improvement of NRW, and all municipalities would benefit from targeted demand management programmes, including community education and awareness, leak repair, infrastructure refurbishment, pressure management, and installation of bulk meters, amongst other measures.

Water Consumption

National trends as of June 2023 indicate that the per capita water consumption has remained constant (218-220 l/c/d) over the past 7 years, which is commendable. However, WC/WDM efforts must be elevated considering the level and reliability of service and inefficiencies, and South Africa is one of the 30 driest countries in the world. The per capita consumption has significantly declined after peaking at 237 l/c/d national average in June 2016 because of the prevailing droughts in parts of South Africa, deteriorating infrastructure, and service delivery.

Water Leakage

The Infrastructure Leakage Index (ILI) deteriorated drastically from 2016 to date, showing signs of improvement in 2017 and 2018. The COVID-19 pandemic escalated the deterioration from 2020. The ILI of 6.9 and 7.0 for 2022 and 2023, respectively indicates poorly managed physical losses; this trend is expected to improve once municipalities have returned to normal, eliminated the leak repair backlogs, and improved revenue collection.

Cost of water supply

Based on the functional expenditure and SIV of 127 WSAs, the average cost of supplying water is R 13.07/kl. This ranges from R 17.32/kl for metropolitan municipalities to R 12.06/kl for Category B3 municipalities. The cost of supplying rural municipalities (Categories B4 and C2) is the highest, ranging from R 14.26/kl to R 17.64/kl. This is a meaningful change from previous assessments that suggested that the cost of supplying water in rural schemes is less than in large municipalities. The higher cost is justified, considering that these schemes often consist of many small systems with boreholes, which are expensive to operate. Using the national average and category average tariffs, the estimated cost to supply water in South Africa is between R 60 and R 70 billion per annum, and revenue of between R 42 and R 44 billion is generated from water sales. The value of NRW is between R 28 and R 33 billion at R 13.07/kl, which is higher than previous estimates. The increase is due to the above inflation in water tariff increases from water boards and the underestimation of water supply costs to rural municipalities.

Approximately R 1 billion per annum could be saved if the SIV is reduced by 2%, and municipalities would generate nearly R 1 billion per annum for every 2% increase in revenue. The net benefit could be R 10 billion per annum if revenue is increased by 10% and the SIV is reduced by 10%. Reducing the SIV by 10% and increasing the revenue by 10% would reduce the national NRW figure to 35.7%, and the per capita consumption to 195 l/c/d.

Ecological Infrastructure Rehabilitation

Several wetlands in South Africa have been rehabilitated and restored by different institutions, such as the Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), and the Working for Wetlands programme. DWS, in collaboration with the City of Ekurhuleni, the Gauteng Department of Agriculture, Rural Development, and Environment (GDARDE), is currently working to rehabilitate a wetland along the Blesbokspruit River, which, once completed, will contribute to cleaner and better-managed water for the Vaal Water Management Area (VWMA).

Water-Energy-Food NEXUS

The connectedness of current challenges (climate change, environmental degradation, population growth, migration, and the emergence of novel infectious diseases) requires circular and transformative approaches that holistically address these cross-cutting challenges. Managing the intricate relationships between distinct but interconnected sectors through nexus planning has provided decision-support tools to formulate coherent strategies that drive resilience and sustainability. As a result, the Water-Energy-Food (WEF) nexus has gained increasing attention in the research and decision-making communities in recent years as a prominent approach for integrated resources management. The systematic thinking embedded in the WEF nexus is priceless as it considers the synergies and trade-offs in resource planning, utilisation, and management. The developments in one of the three WEF sectors should always consider the impacts on the other two to avoid transferring problems from one sector to the other.

A working group of the country's WEF Community of Practice (WEF-COP) was formed to support the development and implementation of a 5-year country WEF programme. The working group is meant to harmonise policy documents and reduce sector-based management of resources that are still fragmented, sitting in distinct departments. Through its WEF nexus Lighthouse, the Water Research Commission (WRC) has been leading work and discussions as well as pilot projects that highlight the benefits of the WEF nexus approach. However, despite these efforts, South Africa still lacks a guiding WEF policy document to guide the implementation, monitoring, and evaluation of the nexus (WRC, 2018).

There is a need for a framework that facilitates proper coordination and identifies synergies and trade-offs across sectors to avoid duplication of activities, create opportunities for harmonising government priorities, and allocate resources effectively and efficiently.

Resource Protection

The Department has completed and gazetted the Water Resources Classes (WRCs) and the determination of associated RQOs in several WMAs, with Uthukela, recently finalised in March 2023. The final WRCs and RQOs have been implemented in some catchments, including Inkomati and Olifants-Doorn, and are currently being monitored through surface water resource monitoring programs. The Department is, as of September 2023, only left with the Orange River System (Upper and Lower Orange), which has outstanding WRCs and RQO determination studies.

Source Directed Controls

The Eutrophication Management Strategy for South Africa (EMSSA) was developed to provide direction concerning the management of eutrophication, particularly the control of anthropogenic sources of excessive nutrient enrichment, from a strategic country perspective. The Eutrophication Management Policy contains fourteen technical policy statements and five supporting policy statements, which are general and cross-cutting in nature, all of which are regarded as the most pertinent to eutrophication management in South Africa.

Protection of water resources is critical for ensuring healthy ecosystems and water availability for current and future use. To this end, sustainable development of water resources requires that water quality degradation be avoided, minimised, and remedied where applicable. There is an ongoing project that aims to develop rehabilitation management guidelines that address the following characteristics of watercourses: hydrology, geomorphology, water quality, habitat, and biota.

Compliance Monitoring

The Department of Water and Sanitation (DWS) constantly strives to enhance the Compliance Monitoring and Enforcement (CME) procedures, protocols, and instruments for effective functioning within the Environmental Management Network.

The development of the DWS CME or Environmental Management Inspector (EMI) Standard Operating Procedure (SOP) Manual has been finalised to harmonise and standardise operating procedures within the water sector that will allow the CME officials and EMIs to perform their duties in an administrative just and legal defensive manner and conform to the chain of custody process and actions at national, regional and Catchment Management Agency (CMA) levels to result in successful court cases.

The Compliance Monitoring team achieved 422 (including dam safety) and exceeded the target by 43 for the financial year 2022/23. The target set for the level of compliance with water user authorizations obligations per sector is 65%. The 422 users monitored achieved a combined average performance level of 58%, with the mining sector (49%) and landfills (45%) having the worst scores. To improve this, more emphasis needs to be placed on follow-up inspections to ensure findings are implemented and to follow through with enforcement actions and consequences where required.

Enforcement

During FY2022/23, a total of 460 cases were reported for non-compliance. Out of these reported cases, 385 were investigated, demonstrating a commendable achievement of 84% compared to the committed target of 80%. The DWS duly issued a total of 205 notices indicating its intention to subsequently issue directives. A total of 72 directives were issued. Moreover, the DWS recorded 17 criminal cases against offenders. Six cases, which had been initiated in the preceding financial years, were subsequently referred to the National Prosecuting Authority (NPA) for a decision.

Several complaints have been reported regarding unlawful water uses and pollution-related cases, highlighting non-compliance in various sectors. The agriculture sector and local government municipalities account for the highest proportion of reported cases, at 28% for each, followed by mining at 21%.

Drinking water compliance

A total of 144 water service authorities were assessed for the 2022/23 hydrological year. However,14.6% of the water services authorities did not upload data on the Integrated Regulatory Information System (IRIS). The results of the Water Supply Systems (WSS) compliance in terms of chemical drinking water quality from October 2022 to September 2023 show that 79% of the systems had excellent compliance in terms of chemical quality compliance, 2.8% had good compliance, while 3.5% demonstrated poor chemical quality compliance. In cases where non-compliance was observed (< 90%), the reasons should be further investigated.

In terms of microbiological compliance, 72% of the WSSs in the country did not meet SANS:241 requirements for the reporting period (1 Oct 2022- 30 Sept 2023), and only 18% of the WSSs achieved an excellent status (>99.9%). It was also noted that 13 WSAs did not submit their drinking water quality data as prescribed by the norms and standards, thus impacting the national outlook as these WSAs could not be assessed in the absence of drinking water quality data submission to the Department. The Department, through its provincial offices, is continuously monitoring and engaging with the relevant WSAs, which achieved microbiological compliance below 99.9%, including those that are not submitting water quality data to the Department.

Sanitation Services

The DWS has recognised that due to a) the impact of climate change, b) water resources constraints, and c) energy supply challenges, the historical approach of providing waterborne sanitation is no longer sustainable and realistic to achieve universal access to safely managed sanitation. Hence, there is a need to embrace a combination of on-site, off-grid; sewered or non-sewered sanitation systems, including centralized or decentralized wastewater treatment solutions. In addition, South Africa must accept the reality that the country no longer has the luxury of flushing 9 to 12 litres of potable water while some parts of the country do not have access to drinking water.

In response to the National Sanitation Policy (2016), DWS developed the National Sanitation Framework (NSF). It is an implementation framework that will assist the government in providing equitable and safe sanitation in all settlement types. It guides towards ensuring appropriate support to Water Services Authorities (WSAs) in cases of service delivery lapses, and non-compliance to regulator prescripts leading to a deterioration in the provision of sanitation services. Furthermore, the National Sanitation Integrated Plan (NSIP) has been developed and provides a 10-year roadmap for ensuring access to adequate sanitation services, eradicating open defecation, providing innovative solutions, and creating a pathway to generate new sanitation opportunities. The main goal of the NSIP is to assist the sanitation sector in providing adequate and innovative sanitation services and solutions to enable long-term sustainable management of sanitation services in South Africa.

The National Faecal Sludge Management Strategy has also been developed and encourages sustainable sanitation management along the sanitation service chain to prevent health hazards and protect the environment. It also enhances the operation and maintenance of on-site sanitation systems and prevents groundwater contamination. The strategy introduces a paradigm shift of safely managing sanitation along the sanitation services chain. Of importance is the need to recover, re-use and recycle resources from faecal sludge and wastewater sludge for beneficial use. The Department is working with various Research Institutions and Universities to fast-track resource recovery initiatives from sludge. The private sector is also encouraged to take advantage of the faecal sludge reuse and resource recovery business opportunities.

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