NATIONAL STATE OF WATER REPORT 2022

WATER IS LIFE - SANITATION IS DIGNITY

SOUTH AFRICA IS A WATER SCARCE COUNTRY

water & sanitation

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Water and Sanitation
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ACRONYMS

Acronym	Description
AMD	Acid Mine Drainage
AmWSS	Amatole Water Supply System
AmWSS	Amatole Water Supply System
AWSS	Algoa Water Supply System
BMGF	Bill and Melinda Foundation
BRVAS	Berg River Voelvlei Augmentation Scheme
CMA	Catchment Management Agency
CoGTA	Department of Cooperative Governance and Traditional Affairs
CWRWSS	Crocodile West River Water Supply
DTN	Delivery Tunnel North
DWS	National Department of Water and Sanitation
EC	Electrical conductivity
EWR	Ecological Water Requirements
FRAI	Fish Response Assessment Index
FSC	Full supply capacity
FSMS	Faecal Sludge Management Strategy
GBWSS	Greater Bloemfontein Water Supply System
GBWSS	Greater Bloemfontein Water Supply System
GwLS	Groundwater level status
GWSs	Government Water Schemes
GWSs	Government Water Schemes
HDS	High Density Sludge
HSDG	Human Settlements Development Grant
IHI	Habitat Integrity
IUA	Integrated Unit of Analysis
IVRS	Integrated Vaal River System
JV	Joint Venture
KZNCMWSS	KwaZulu-Natal Coastal Metropolitan Water Supply System
LHWP	Lesotho Highlands Water Project
MCWAP	Mokolo Crocodile (West) Water Augmentation Project
MIRAI	Macroinvertebrate Response Assessment Index
MMM	Mangaung Metro Municipality
MOI	Memorandum of Incorporation
MWP	Mzimvubu Water Project
NCMP	National Chemical Monitoring Programme

NEMP	National Eutrophication Monitoring Programme
NGA	National Groundwater Archives
NIWIS	National Integrated Water Information System
NMMP	National Microbial Monitoring Programme
NRW	Non-Revenue Water
NWRS2	National Water Resource strategy 2
OCS	Off-Channel Storage
ORWRDP-2	Olifants River Water Resources Development Project Phase 2
ORWSS	Olifants River Water Supply System
REMP	River EcoStatus Monitoring Programme
RQOs	Resource Quality Objectives
RTTS	Telemetry systems
RUs	Resource Units
SANS	South African National Standards
SASTEP	South African Sanitation Technology Enterprise Programme
SAWS	South African Weather Services
SIV	System Input Volume
SPI	Standardised Precipitation Index
STTCC	Sanitation Technology Technical Coordination Committee
TCTA	Trans-Caledon Tunnel Authority
TDS	Total dissolved solids
USAID	United States Agency for International Development
USDG	Urban Settlements Development Grant
VEGRAI	Vegetation Response Assessment Index
WCWDM	Water Conservation and Water Demand Management
WCWSS	Western Cape Water Supply System
WMAs	Water Management Areas
WMS	Water Management System
WSA	Water Service Authority
WSP	Water Service Provider
WWTW	Wastewater Treatment Works
ZQM	National Groundwater Quality Monitoring

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Department of Water and Sanitation, the custodian of the nation's water resources and a public trustee, 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 current report, which is published annually, communicates the available water resources information to the public and aims to assist water users in decision-making, evaluate the implementation of legislation, highlight identified problem areas, and outline measures taken by the department to eradicate highlighted issues and balance the water demand and supply.

During the summer months of the reporting period, the monthly maximum temperatures were above average by up to 4 degrees Celsius in some areas, mainly in the Western Cape Province and southern parts of the Eastern Cape Province. The Western Cape Province again experienced higher-than-average maximum temperatures in the winter months.

The rainfall received during the hydrological year 2021/22 was above normal for almost all parts of South Africa, apart from a strip on the southwestern coastline of the Western Cape Province. The Western Cape Province winter rainfall region has shown a drying trend or phase from July to September, which may intensify drought conditions. Rainfall was significantly above (>200% from normal) for the Northern Cape Province, covering the Orange WMA, Middle, and Lower Vaal WMAs. The country's eastern half has received significantly above-normal rainfall in the past two hydrological years (2020/21 & 2021/2022). This has resulted in decrease in number of areas in the country experiencing drought conditions over the past four hydrological years. The Nelson Mandela Bay, Sarah Baartman, Sekhukhune, Namakwa, City of Cape Town, Eden, Overberg, West Coast, and the Cape Winelands Districts Municipalities have been affected by meteorological drought in the last 24 months and require close monitoring and interventions.

The country also experienced a significant flood event in the KwaZulu-Natal Province, where the South African Weather Service (SAWS) reportedly measured rainfall ranging between 200-500 mm between April and May 2022. The rainfall resulted from a strong cut-off low weather system off the east coast of Southern Africa. The heavy rains led to a rapid increase in dam levels as most of the dams were already at their full supply level before heavy rains between the 11 and 12 of April 2022. On the 13 of April 2022, the KwaZulu-Natal floods were declared a provincial disaster. At the end of May 2022, approximately 448 fatalities were reported, and the homes, businesses, roads, bridges, electricity and water infrastructure were damaged or destroyed. An estimated 130 000 people were affected, with more than 19 182 houses and 264 schools destroyed.

The most affected Municipal District areas in April 2022 were Ugu, eThekwini, King Cetshwayo, uMgungundlovu, and iLembe. While in May 2022, Hluhluwe, eThekwini, Jozini, KwaDukuza, Mandeni, Maphumulo, Mkhambathini, Mthonjaneni, Mtubatuba, Ndwedwe, Nongoma, Ulundi, uMdoni, uMhlabuyalingana, uMhlathuze, uMlalazi and uPhongolo District Municipal areas were most affected. A severe decline in water quality was observed in the affected areas following the flood event, mainly emanating from the failure of WWTW, resulting in untreated sewage discharging directly into the watercourses between March and April 2022. *E.coli* counts in some rivers reached unacceptable levels of 10 000 cfu/100ml.

Although the country may have received above-normal rainfall in some parts, the river flow data has demonstrated that most South African rivers continuously deviate from the historical flows. The changes in flow regime are both natural and anthropogenic, driven by rainfall temporal and spatial variation, population increase, land and water use changes, and dam operations (flood management, abstractions, and curtailment) playing significant roles. Flows were above average for the Orange River in the past two hydrological years. In contrast, flows were below normal for the Tugela River for the past eight years, below or near normal for the Gamtoos River in the past seven years, while the Olifants has only experienced one year (2020/21) of above-normal streamflow in the past eight years.

The national dam storage levels for the past two hydrological years - 2020/21 and 2021/22, have been the highest for most of the months in the past five hydrological years. At the end of the hydrological year (September 2022), approximately 4% of the dams were at critical storage levels, 11% were at risk, and over 85% were either spilling or at optimal storage levels. Most of the dams at critical storage conditions at the end of the reporting period were in the Eastern Cape, Limpopo, and Western Cape. Notably, all median storages for the 2021/22 hydrological year are higher than the past year for all WMAs, apart from the Berg Olifants and Breede Gourits WMAs. The Algoa Water supply systems (WSS) in the Eastern Cape remain with water restrictions in response to the low water storage levels.

The national average groundwater levels Status (GwLS) has been showing an upward recovery trend since October 2019, and the GwLs was just below 60% (normal) at the end of the reporting period. This can be attributed to the above-normal rainfall received in the current and previous years, which has recharged aquifers. Regarding groundwater quality, the Strategic Water Source Areas with groundwater quality exceeding the SANS 241 drinking water quality guidelines/limits for Nitrate/nitrite were in the Free State and Limpopo Regions. All the exceedances within the SWSAs had nitrate/nitrite concentrations ranging from 13 mg/l to 62 mg/l indicative of impacts of land use activities that should be prevented or controlled before significant groundwater pollution occurs.

There is a severe challenge of microbial contamination in the South African water resources (Rivers and Dams). More than half of the sampled sites presented a high health risk if water from the source was used for irrigating crops that were eaten raw, and only 42% indicated a low risk. The results also revealed that water in 64% of the sampled sites was unsuitable for recreational activities. Using these sites for such activities would be associated with a high risk of infections.

The trophic status calculation revealed that fourteen sites were hypertrophic, one eutrophic, nine mesotrophic, and 32 oligotrophic. Eutrophication potential was classified as serious (26 sites), significant (13 sites), moderate (10 sites), and negligible (14 sites). The sites characterised by serious eutrophication problems were catchments hosting densely populated urban developments, poorly functioning sewer networks, and wastewater treatment work.

The Department has taken initiatives to address South African water resources quality. One of the successful projects was the development of the Eutrophication Management Strategy of 2022, which will be used as a tool to address issues related to the degradation of the water resources due to excessive nutrient enrichment in the water resources. Moreover, the Department has also made commendable progress in the surface water resource classification process. To date, several resource classification and Reserve determination studies have been either finalised or are in the final stages. As of September 2022, the Department is only left with the Orange River System, which has outstanding water resource classes and the Resource Quality Objectives determination study.

The Blue Drop and Green Drop assessments were both conducted in 2021 (01 July 2020 to 30 June 2021), and the reports for the said audit period have been published. The Blue Drop programme thoroughly assesses drinking water quality compliance, and plant and process controller registration to calculate the Blue Drop Risk Rating (BDRR) for each system. 144 Water Services Authorities in South Africa comprising 1186 water supply systems were assessed during the assessment period. It was established from the Blue Drop assessment that 48% of water supply systems are in the low-risk category (The large proportion of low-risk supply systems are in the Gauteng and Western Cape), while 34% of systems reside in the high-risk and critical risk categories.

The Green Drop programme assesses the design and operating capacity of WWTWs, compliance of the effluent to agreed standards, local regulation and infrastructure management and condition. A total of 144 municipalities were audited during the 2021 Green Drop certification process, and it was established that most rural municipalities struggle to score more than 50%. Only 5% of rural municipalities achieved this score in comparison to 75% of systems in Gauteng. In the assessment, only 22 Water Services Institutions were Green Drop certified, led by Western Cape (12), Gauteng (7), and KZN (3).

The Department has noted significant progress that South Africa has made in addressing the sanitation backlog and providing appropriate sanitation to poor households in the country since 1994. The country has achieved 84% sanitation delivery, and the percentage of households with access to improved sanitation increased by 22,4 percentage from 61,7% in 2002 to 84,1% in 2021. The most improved provinces are the Eastern Cape, where the percentage of households with access to improved sanitation increased by 58,3%, and Limpopo which increased from 31,6% to 58.6% in 2021.

1

INTRODUCTION

1 INTRODUCTION

1.1 Background

The Department of Water and Sanitation as the public trustee or custodian of the nation's water resources, 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.

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. River systems are the common surface water expression of water availability in South Africa, with others being lakes, ponds, and pans.

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. The time has come when a mix of water resources is required to reconcile supply and demand, including sustainable ground water use, reuse of wastewater, and desalination.

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.

1.2 Water Sector Institutional Reform

The South African Water Sector Institutional Reform has not been completed, and the outlook as of October 2022 is illustrated in Figure 1.1. 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), although there is some level of uncertainty currently. This supports the principles of good governance, where water is managed locally. In water management areas where a CMA has not been established, the responsible authority (DWS national and provincial offices) continues to act as a CMA to perform all water resource management functions at a catchment level.

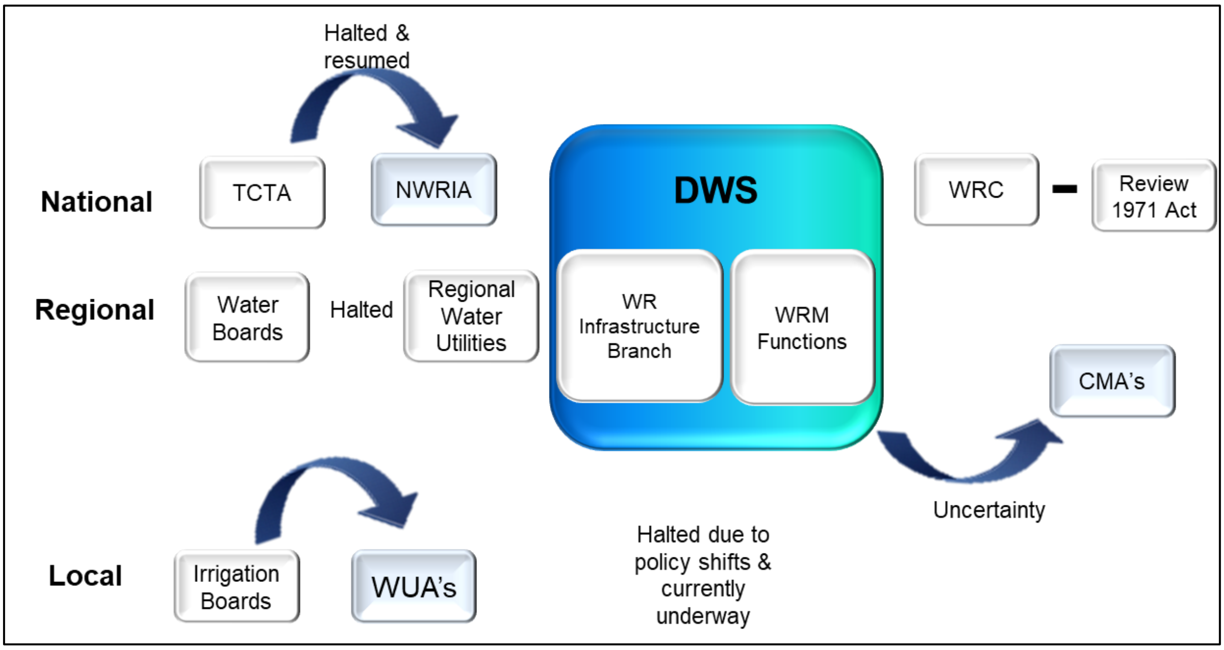


Figure 1.1 Water Sector Institutional Landscape in 2020

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 (IBs) into Water User Associations (WUAs) has been halted due to policy shifts that are currently taking place.

Furthermore, although not shown in the illustration, we find Water Services Institutions 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). These WSAs and WSPs that provide water and sanitation services are regulated by the Department of Cooperative Governance and Traditional Affairs (CoGTA). A water services authority means 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 persons who provide 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.

1.3 Water Management Areas

Based on the outcome of the Departmental Institutional Reform and Realignment (IRR) study, the NWRS2 established the nine WMAs in South Africa in July 2012. 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 status and trends of water resources provided in this report have been analysed and presented based on the nine WMAs or, in some instances, Provinces, as shown in Figure 1.2.

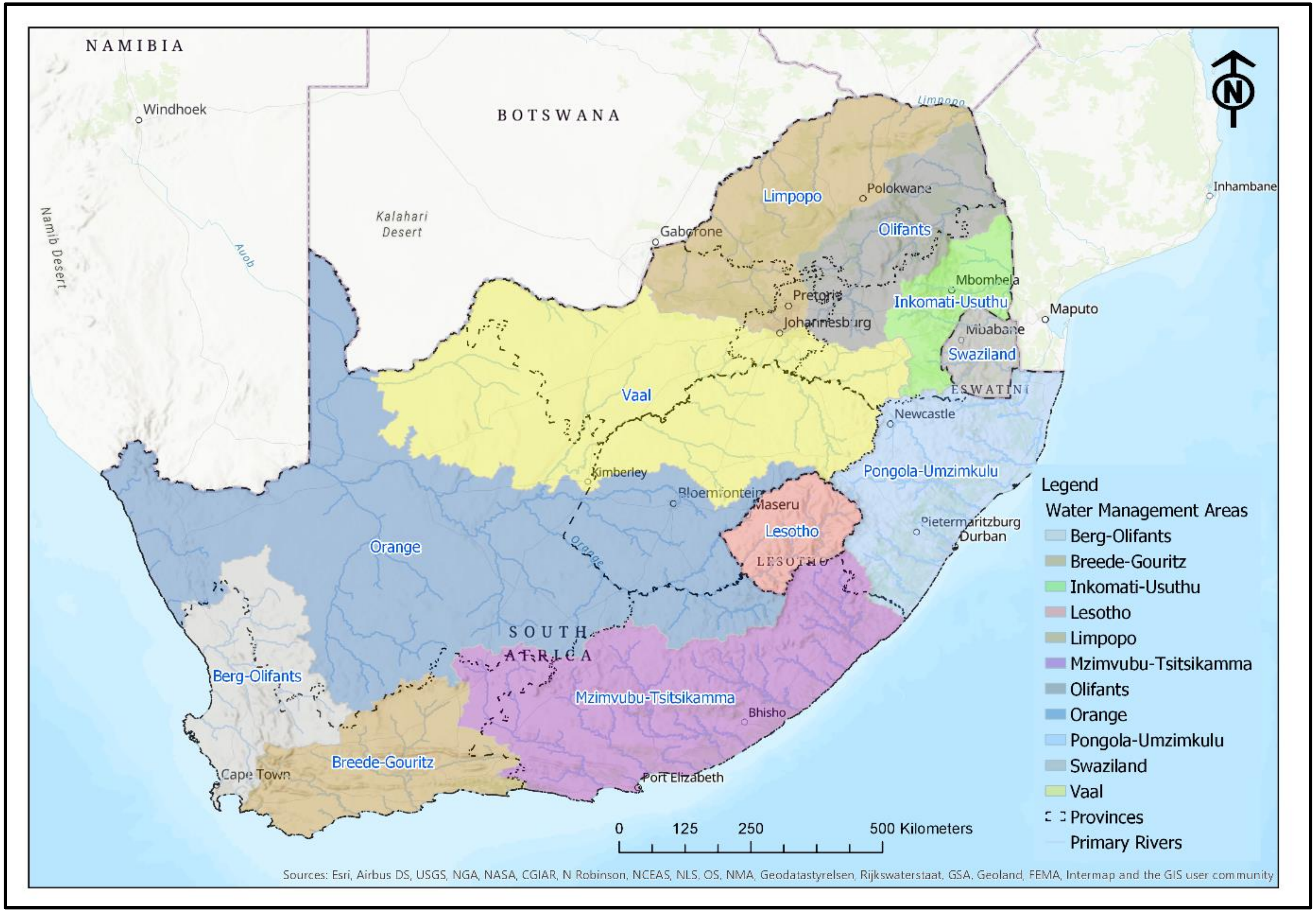


Figure 1.2 South African Nine Water Management Areas as of 2012

1.4 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 CMA. 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.

A proposal has been made to reduce the number of CMAs from nine to six through the consolidation of WMAs (see Figure 1.3.). The CMAs will be for: Limpopo-Olifants (1); Inkomati-Pongola (2); Mhlatuze-Mzimkhulu (3); Vaal-Orange (4); Mzimvubu-Tsitsikamma (5); Breede-Olifants (6).

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 below.

Table 1-1 CMA Establishment Progress October 2022

NAME OF THE CMA	STATUS OF CMA ESTABLISHMENT	Next Steps
Breede-Olifants	A business case is completed The Minister has signed the Gazette notice for the establishment of the Breede – Olifants CMA	Will publish the Gazette notice as soon as the decision on staff transfer has been finalised. This should take place by the end of November 2022
Vaal-Orange	CMA was gazetted for public consultation in May 2022 A business case is finalised Consultation with stakeholders is underway	The CMA will be gazetted for establishment by Dec 2022
Pongola-Umzimkulu	CMA was gazetted for establishment in 2014	The Board appointment process has been initiated and should be finalised by November 2022
Limpopo-Olifants	Business case development is completed Consultation with provincial offices is ongoing	CMA will be gazetted for public consultation in November 2022
Mzimvubu-Tsitsikamma	CMA was gazetted for public consultation in 2016 A business case is under development Consultation with the internal and external stakeholders	The CMA will be gazetted for establishment by March 2023
Inkomati-Usuthu	No configuration will be done	

Figure 1.3 Proposed New WMAs and CMA configuration

1.5 Water Pricing Strategy

The pricing strategy provides the framework for the pricing of water use (as defined in Section 21 of the National Water Act, 36 of 1998) from South Africa's water resources, i.e., the use of raw (untreated) water from the water resource and/or supplied from government waterworks and the discharge of water into a water resource or onto land. It is developed in terms of the National Water Act, which empowers the Minister of Water & Sanitation (the Minister), with the concurrency of the Minister of Finance, to establish a pricing strategy for charges of any water use within the framework of existing relevant government policy. The **third revision** of the strategy is currently being finalised to incorporate social-economic, environmental, and other changes.

The primary objectives of the pricing strategy are to:

- Ensure that the costs of achieving and maintaining the Resource Quality Objectives are sufficiently recovered through the water use charges.
- Ensure that there is adequate funding for the effective operation, maintenance, and development of waterworks by the Department and other water management institutions.
- Provide an enabling framework for the provision of financial assistance and the use of water pricing to support the redress of racial and gender imbalances in access to water and to support the redistribution of water for transformation and equity purposes.
- Facilitate financial sustainability of water management
- Promote/facilitate water use efficiency.

The pricing strategy recognises the developmental context of the South African water sector and acknowledges that for social equity, environmental or affordability reasons, where water management cannot be sustainably financed from specific water users, then that shortfall must be recovered transparently. The following principles underpin the revised pricing strategy:

- ***Hybrid tariff approach*** – The pricing strategy provides for a combination of national charges and water management-specific charges to facilitate the development of affordable tariffs for all users; some elements of the water charge will be levied based on a national charge for a particular sector(s), and some on the basis of the scheme based or catchment level charge in terms of sections 56(3) and 56(4) of the NWA.

- ***User pays, and recovery of costs*** – The intent of the pricing strategy is to provide for the full recovery of costs associated with the management, use, conservation, and development of water resources and the associated administrative and institutional costs. Users must pay for the costs of their water use in this regard, considering the need for targeted subsidies where, due to socio-economic conditions, users are not able to afford the costs resulting from the full application of these principles. In line with section 61 of the NWA (56)(2)(a) and (b).

• ***Polluter pays*** – Aligned to the principle above, this principle sets out that polluters must pay for the costs of their water discharge or pollution.

• ***Differential charges and capping of water use charges*** – The pricing strategy allows for differential charges and the capping of water use charges to designated water use sectors to support the achievement of key national objectives, such as food security, racial and gender equity, job creation, economic development.

• ***Fiscal support*** – The Department will provide fiscal support for core national and public interest functions. The source of funding will come from National Treasury, undertaken by water management institutions, which cannot be recovered fully through water use charges.

• ***Ecological sustainability*** – The pricing strategy will facilitate funding to ensure the provision of water for the ecological reserve and the water sector's contribution to maintaining water ecosystems.

• ***Accountability*** – Funding will be allocated to specific water management institutions so that there is transparency and accountability for the funds that are generated through the pricing strategy of Section (57)(3)(b). • Efficiency – The pricing strategy makes provision for the independent economic regulator charge to ensure that the water management charges are maintained at affordable levels. • Multi-year tariffs – The pricing strategy provides for multi-year tariff determination to facilitate longer-term planning and greater levels of certainty for water institutions and users.

1.6 Internationally Shared Basins

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.

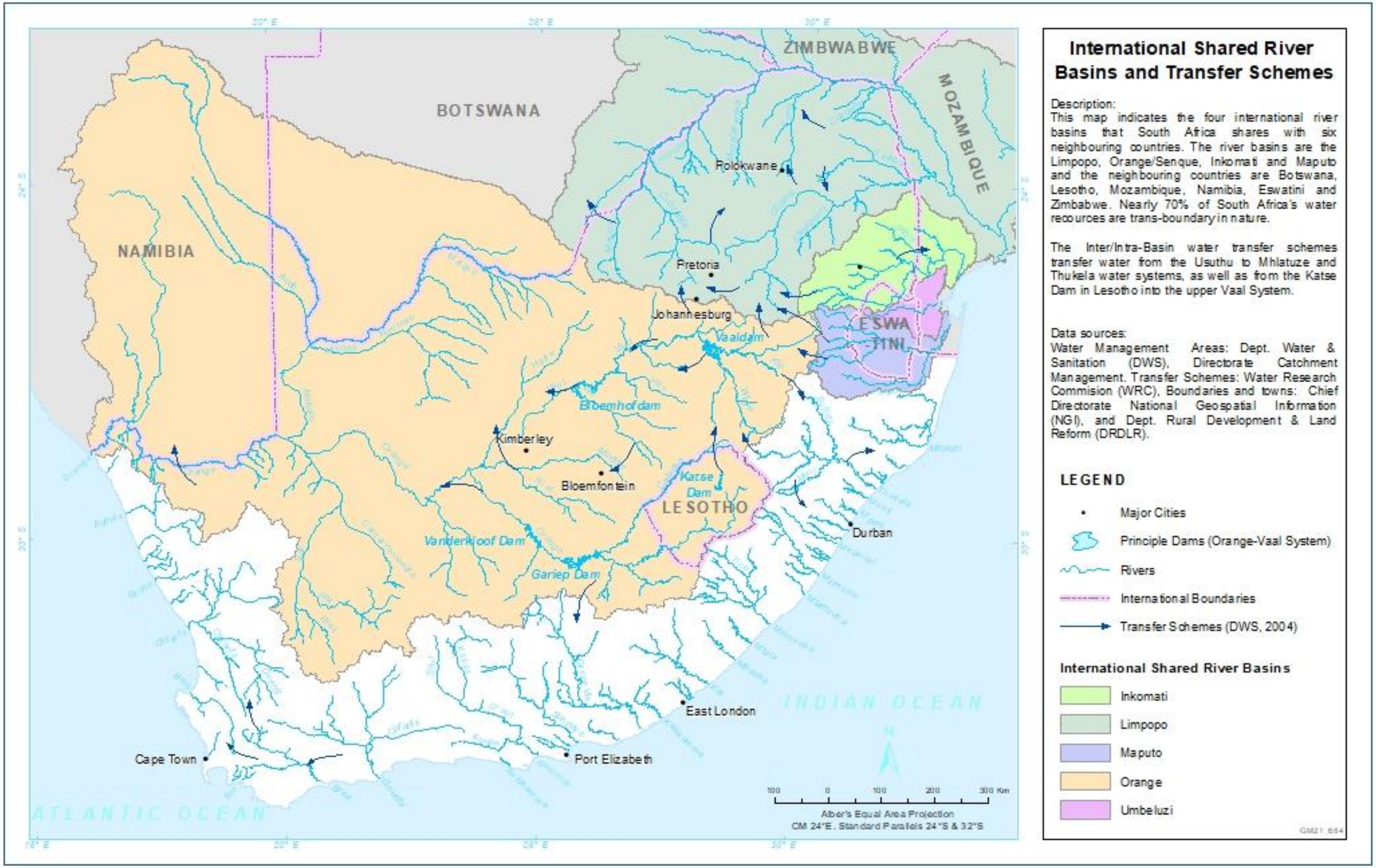


Figure 1.4 International shared basin and transfer schemes

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, 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, Republic of Namibia, and Republic of South Africa	Agreement between SA and ORASECOM for the Hosting of the ORASECOM Secretariat	2008	2008	Active	The South African Department of Water and Sanitation has been responsible for paying office rental for the hosting of the RASECOM secretariat in Centurion every year since 2008
Republic of Botswana, Kingdom of Lesotho, and Republic of South Africa (JSMC Agreement)	Memorandum of Agreement between the Government of Republic of Botswana, Kingdom of Lesotho and Republic of South	2017/11/16	2017/11/16	Active	• RSA, Botswana, and Lesotho experts (engineers) jointly study the possibility of Botswana extracting water from the

Country	Title of the Agreement	Date signed	Date entered into force	Status of Agreement	Areas of Cooperation
	Africa on the Lesotho-Botswana Water Transfer Feasibility Study				Lesotho Highlands Water Project. • JSMC monitors the study on a regular basis • Implementation of Phase II • Procurement process implementation • establishment of Project management
Republic of Mozambique, Kingdom of Swaziland/Eswatini, and Republic of South Africa (TPTC)Agreement)	**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 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.

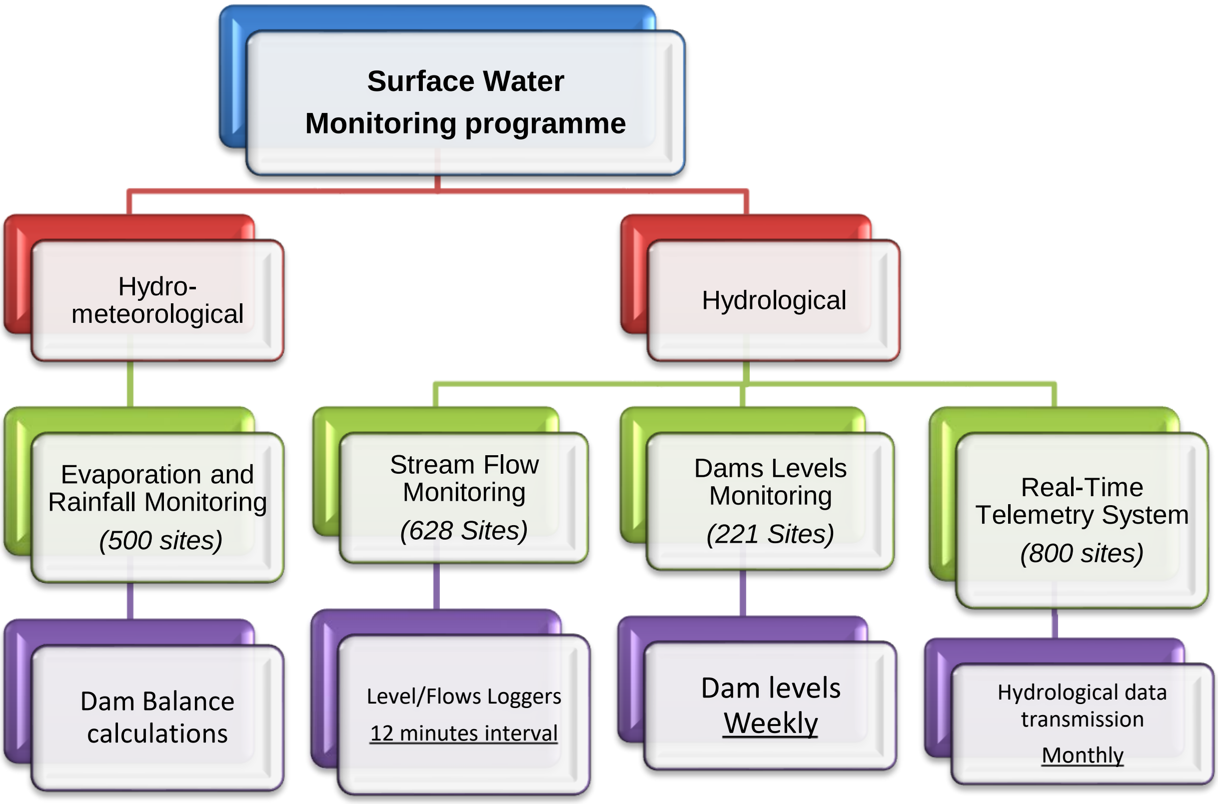


Figure 2.1: Summary structure of the surface water monitoring programmes

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 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.

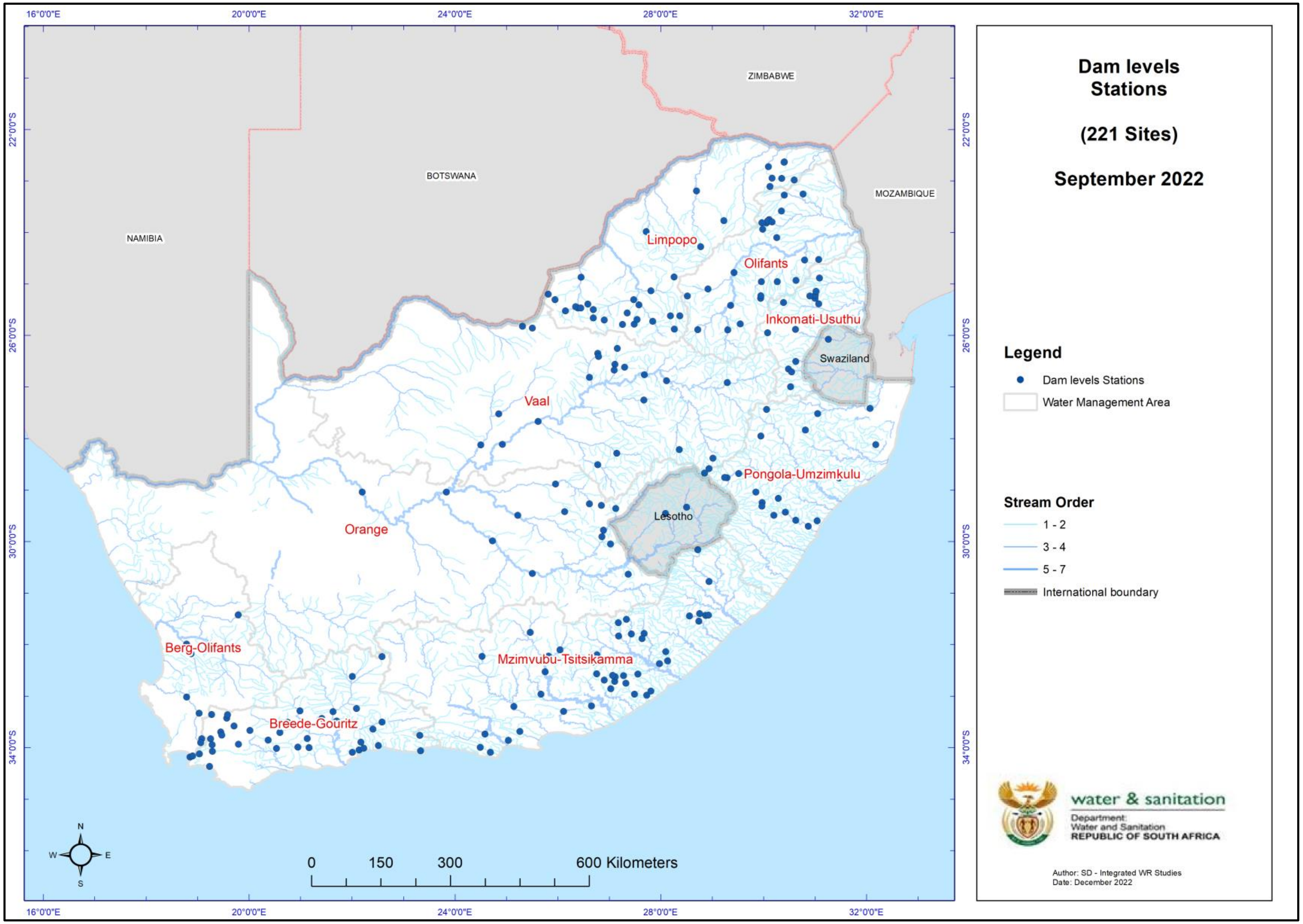


Figure 2.2 Dam levels monitoring stations network

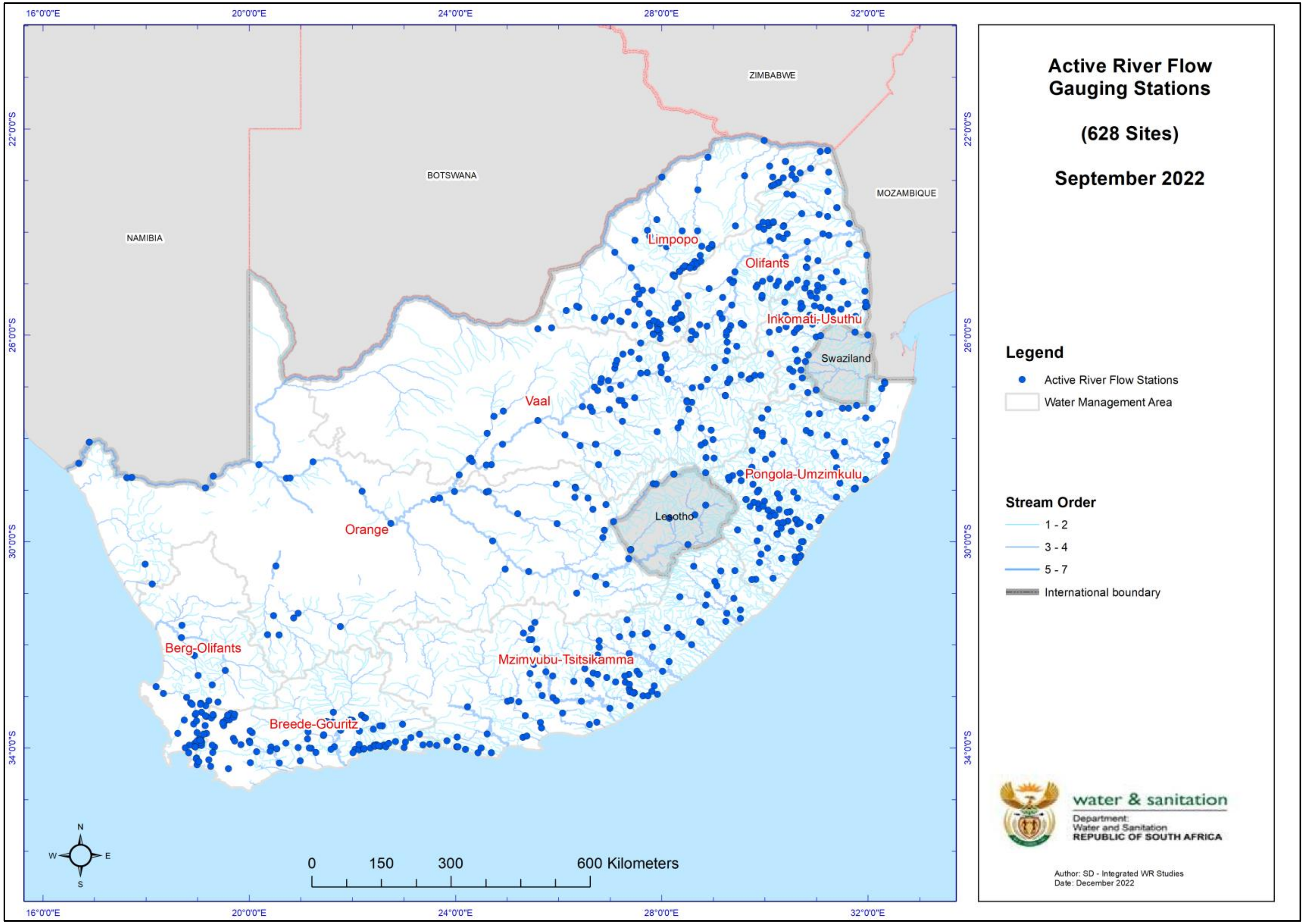
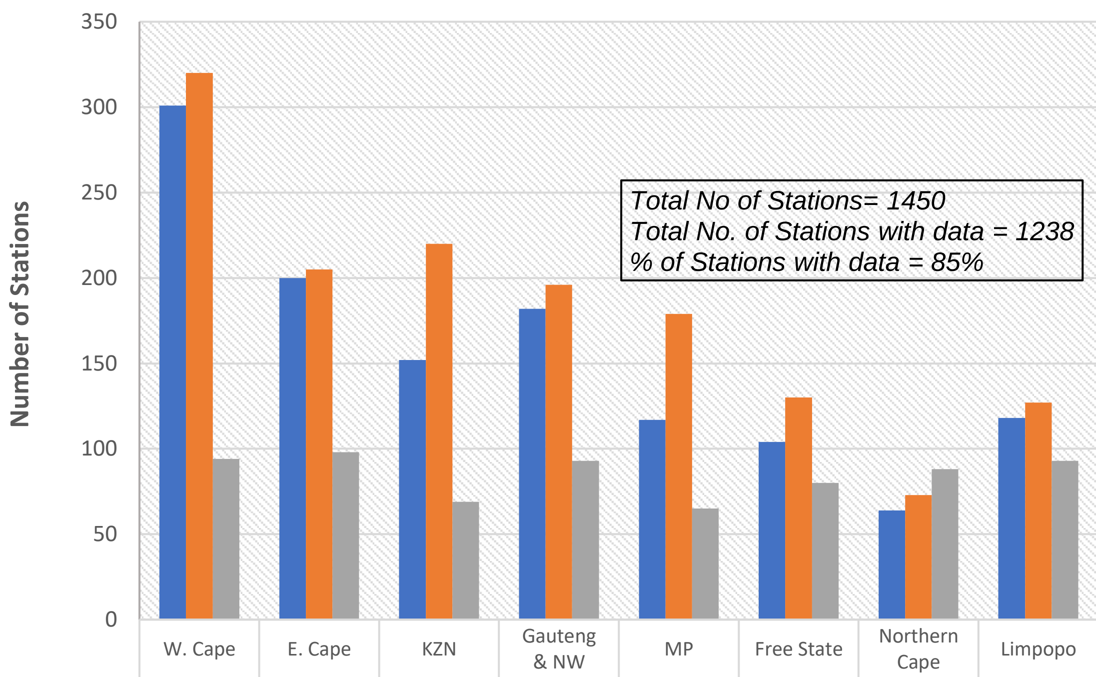


Figure 2.3 Streamflow monitoring network

2.1.1 Surface Water Monitoring Network Data Availability

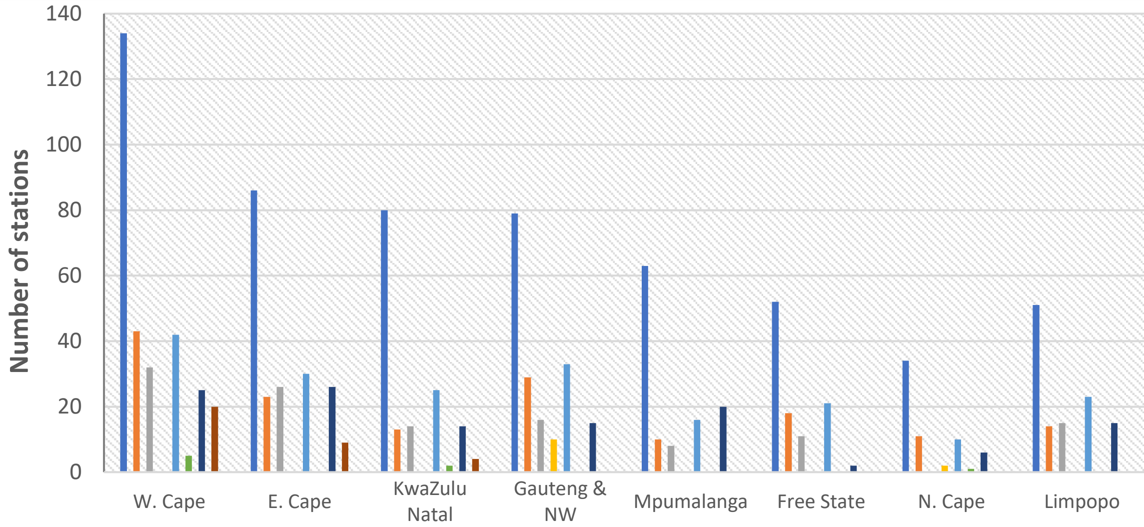
There are currently 1450 stations for the surface water monitoring network distributed across the provinces, as demonstrated in Figure 2.4. At the end of the current reporting period, 1238 stations were active and had data. All station types across provinces had commendable data availability, led by Eastern Cape, Western Cape, Limpopo, and Gauteng (includes NW) Provinces, with over 90% data availability at the end of the reporting period, achieving a national percentage of 85%.



	W. Cape	E. Cape	KZN	Gauteng & NW	MP	Free State	Northern Cape	Limpopo
Stations with data	301	200	152	182	117	104	64	118
Total Stations	320	205	220	196	179	130	73	127
% with data	94	98	69	93	65	80	88	93

Figure 2.4: Summary of monitoring networks across South Africa as of November 2022.

The station types per province presented in Figure 2.5 demonstrate a dominant number of stations for river flow monitoring, with Western Cape, Eastern Cape, KwaZulu-Natal, and Gauteng having the most stations, respectively. The estuaries are monitored in the coastal areas, and the active stations in the Western Cape Province have doubled from 10 stations in the 2020/21 hydrological year to 20 stations in the current reporting period. All provinces demonstrated a reasonable number of active stations in the reservoir monitoring led by the Western Cape Province. DWS has positively reported a significant improvement in the inflow of data into HYDSTRA captured by regional offices, which indicates that regions have caught up with monitoring and adjusted to the working conditions after the 2020 national lockdown.



	W. Cape	E. Cape	KwaZulu Natal	Gauteng & NW	Mpumalanga	Free State	N. Cape	Limpopo
RIVER	134	86	80	79	63	52	34	51
CANAL	43	23	13	29	10	18	11	14
PIPELINE	32	26	14	16	8	11	0	15
EYE	0	0	0	10	0	0	2	0
RESERVOIR	42	30	25	33	16	21	10	23
LAKE	5	0	2	0	0	0	1	0
MET	25	26	14	15	20	2	6	15
ESTUARY	20	9	4	0	0	0	0	0

Figure 2.5: Station types with available data per province as of November 2022.

2.2 Groundwater Monitoring

Groundwater monitoring within the DWS consists of two programmes which are groundwater quality monitoring and groundwater level monitoring, as presented in Figure 2.6 below.

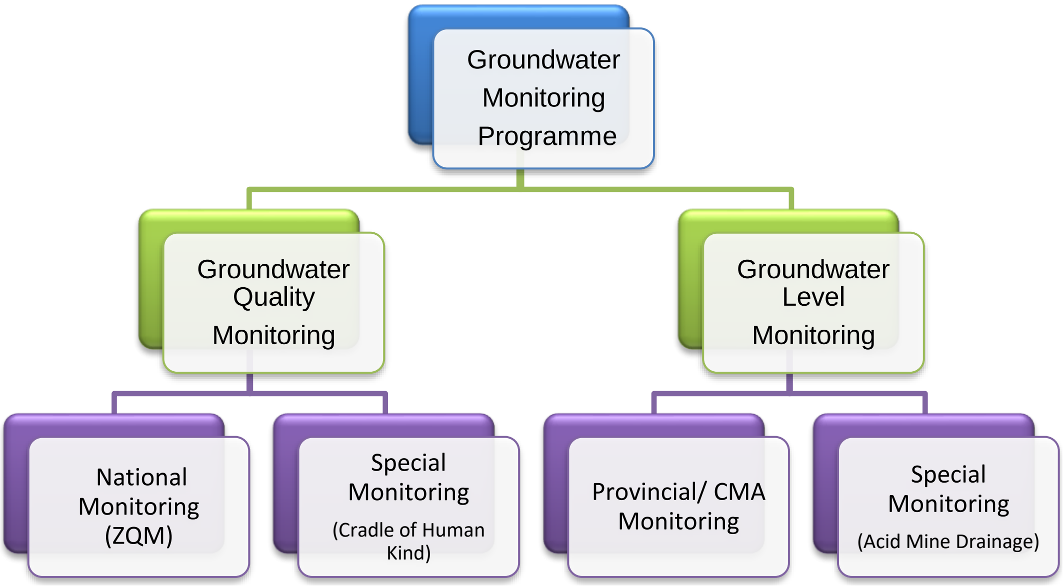


Figure 2.6 Groundwater Monitoring Programmes

2.2.1 Groundwater Level Monitoring

Over 1 800 groundwater-level sites (geosites) are monitored throughout the country. Figure 2.7 indicates the locations of 1 787 active sites and responsible regional offices as of September 2022. The monitoring data is archived on HYDSTRA, whereas additional station data is stored on the National Groundwater Archive (NGA) (https://www.dws.gov.za/groundwater/NGA.aspx). Data requests for groundwater level data monitored by DWS can be sent to the geo-request service at georequests@dws.gov.za .

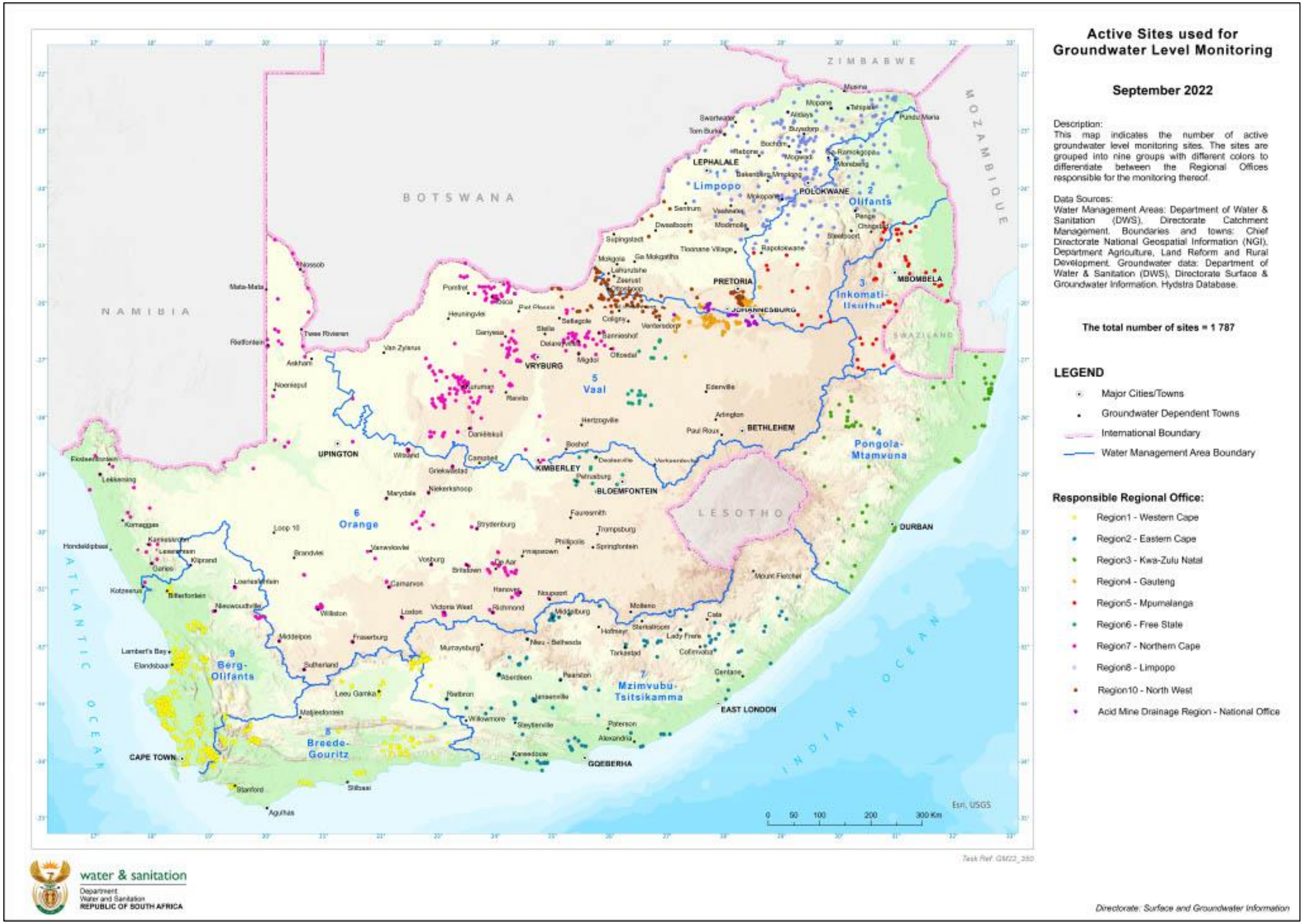


Figure 2.7 Active Groundwater Level Monitoring sites (geosites), September 2022

From the Special Water Level monitoring – Acid Mine Drainage (AMD) monitoring of the Eastern, Central, and Western Basins is conducted on a monthly basis. The data from this network is analysed on a regular basis, and results are shared with the Chief Directorate of Mine Water Management to manage the risks related to AMD, where flooding of mines may lead to contamination of shallow groundwater and decant into the environment. Figure 2.8 provides an example of the analysis for the AMD special water level monitoring within the Witwatersrand Basin.

2.2.2 Available Groundwater Level Monitoring Data

The number of total active sites with data as of 30 September 2022 was 1 674. 94% of the total number of active sites had available data by the end of September 2022. Mpumalanga and the Free State regions have 100% of their active sites with data available on the central database. Gauteng region reported 77% of the total sites with available data by September 2022. Figure 2.9 presents the graph depicting the available groundwater level data given the surface area of South Africa versus the current active national groundwater level monitoring geosites. There is a need to expand the existing monitoring network and pull together public, private, and other groundwater level monitoring databases within the country to get a clear picture of groundwater level trends. The Department has thus initiated a National Digitised Integrated Water and Sanitation Monitoring Systems Project in the Chief Directorate: National Water Resource Information Management within the Branch: Water Resource Management to apply digital innovations in the water monitoring space.

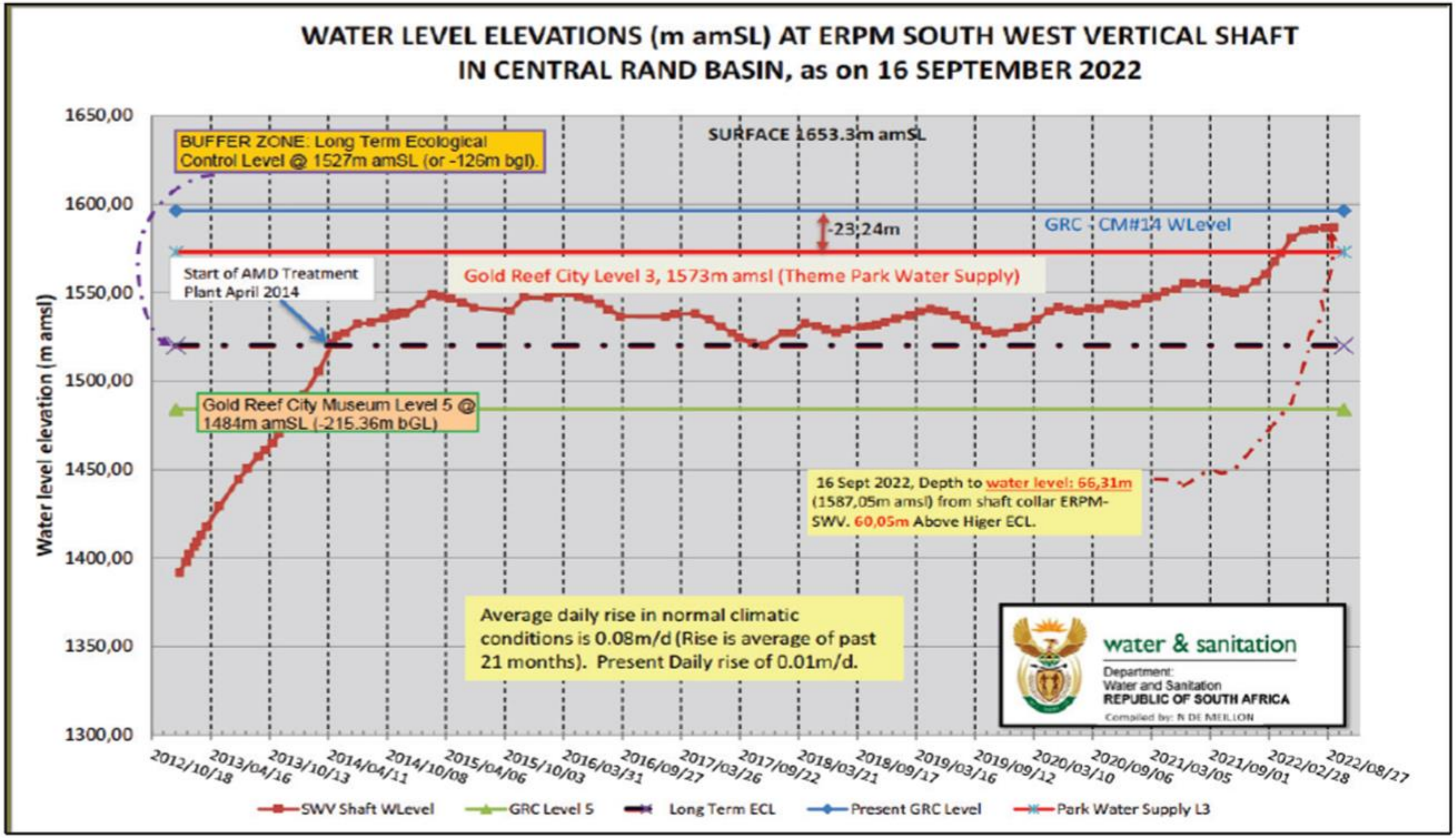


Figure 2.8 Water Level Special Monitoring for AMD data analysis

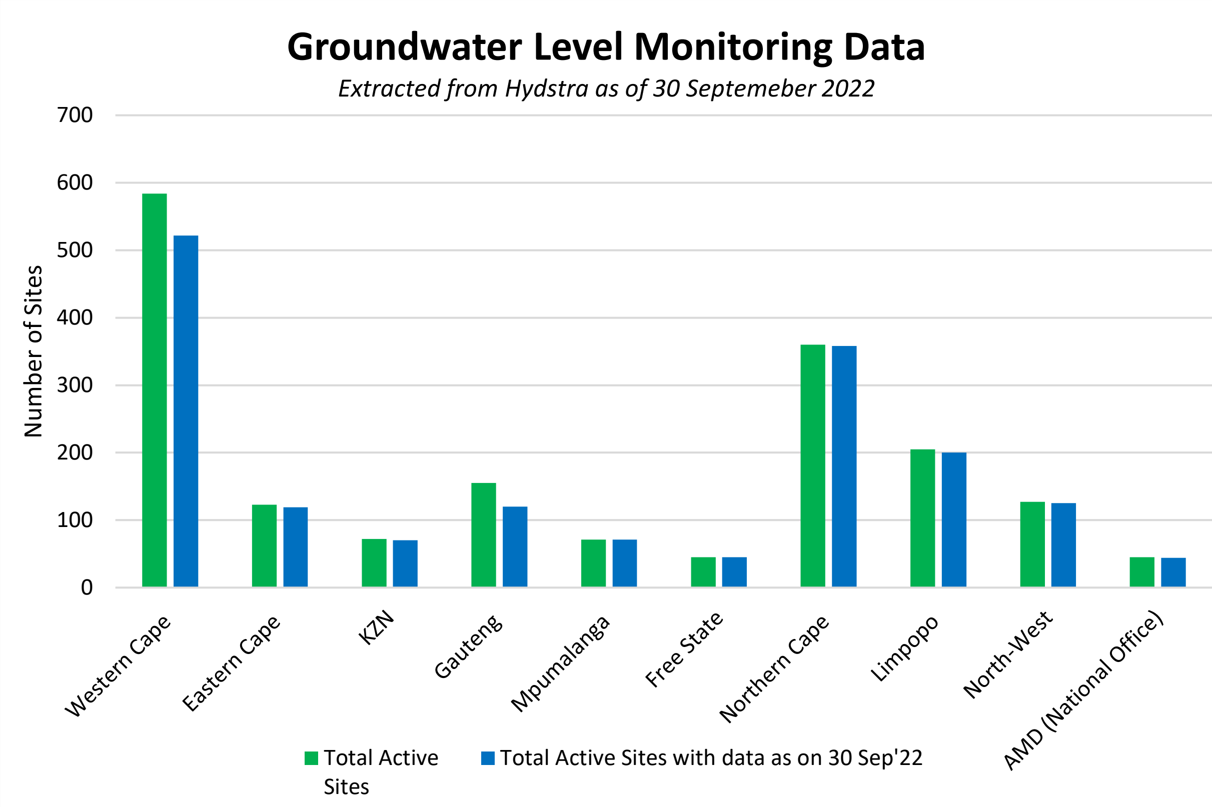


Figure 2.9 Groundwater Level Available Data September 2022

Most groundwater level monitoring equipment is still predominately manually utilizing a dip meter. KwaZulu-Natal, Gauteng, Free state, and the North West regions are 100% monitored by electronic data loggers. Electronic data loggers improve the timeliness of data which can be helpful to the water sector in helping with sustainable management of groundwater resources in the wake of climate change.

The promise of the data revolution has not been oversold, and researchers have highlighted the need for investment to build robust, validated models and infrastructure. Figure 2.10 indicates the percentage of sites using either manual or electronic data loggers to monitor groundwater levels in the different regions.

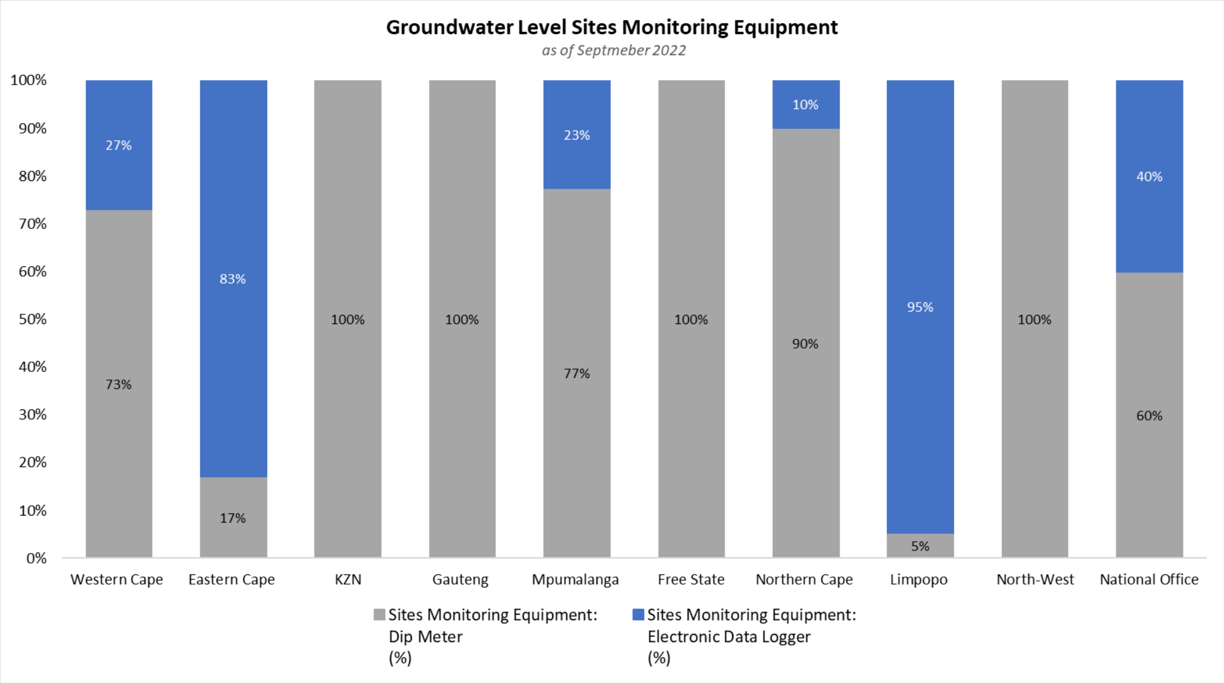


Figure 2.10 Geosites monitored by manual vs. electronic data loggers

2.2.3 Available Groundwater Quality Monitoring Data

Groundwater quality data declined significantly in 2022 back to the pre-2019 levels. Compared to the 308 samples collected and analysed in the previous year, no samples were analysed in 2022 at the reporting time. Data from the 2022/2023 sampling run have not been received from the regional offices, and monitoring is still underway. Regional offices are expected to complete groundwater sampling by the end of November 2022. Figure 2.11 presents the groundwater quality samples from 2016, including 2022.

The key challenge in getting the groundwater quality data analysed in time is the expired laboratory contracts for water quality analysis across the country and the gap in the implementation of new contracts. This breaks the momentum of water quality collection efforts and, in turn, the availability of timely water quality data to inform water managers. To mitigate this, innovative supply chain management processes would need to be deployed to avoid a gap between the start and end of one contract from another and capacitate the RQIS laboratory, weighing out the need to establish DWS laboratories at crucial locations at other parts of the country.

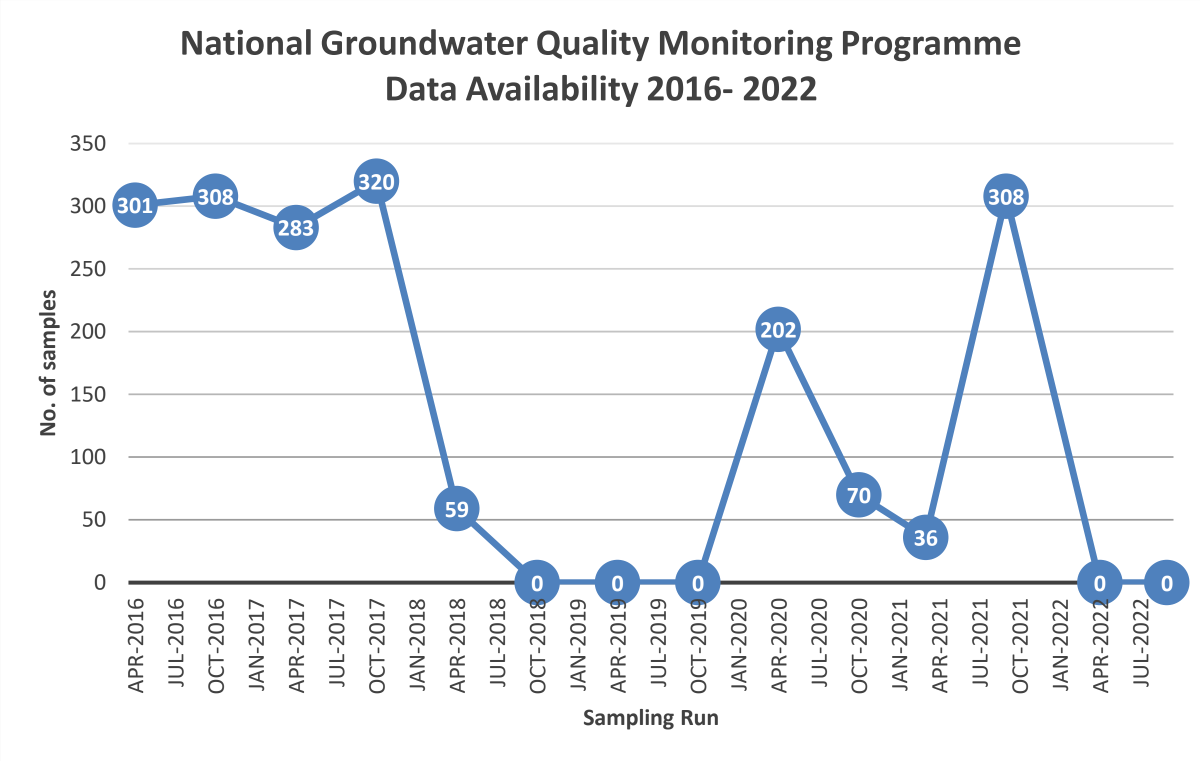


Figure 2.11 Groundwater Quality Samples Analysed - end September 2022

2.3 Surface Water Quality Monitoring Programmes

2.3.1 National Chemical Monitoring Programme (NCMP)

The NCMP was established in the 1970s based on the information requirements and national priorities at the time. It has been amended over the years to remain relevant. This is the longest-running South African water quality monitoring programme which has provided data and information for more than 48 years for the inorganic chemical quality of surface water resources at various sites. The programme has been highly dependent on Regional Office officials for sample collection and the Resources Quality Information System (RQIS) laboratory for sample analysis, quality assurance and data capturing onto the WMS database. These data and other resources are available to the public through the link: https://www.dws.gov.za/iwqs/wms/default.aspx.

The main objectives of this national scale programme include:

- Determining the inorganic status and trends in South African rivers.
- Supporting the National River Ecostatus 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 parameters monitored 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 NCMP also measures the ammonium and nitrate-nitrite levels, indicating nutrient loading from discharges and return flows into water resources.

The priority NCMP sites had a sampling compliance of 1.1% for the 2020/21 hydrological year, while the sampling compliance for 2021/22 increased to 7.0%. Site visits also increased from 15.9% for the 2020/21 period to 42.2% for the 2021/22 hydrological year, as shown in Figure 2.12. This figure is anticipated to increase to at least 70% in 2022/23.

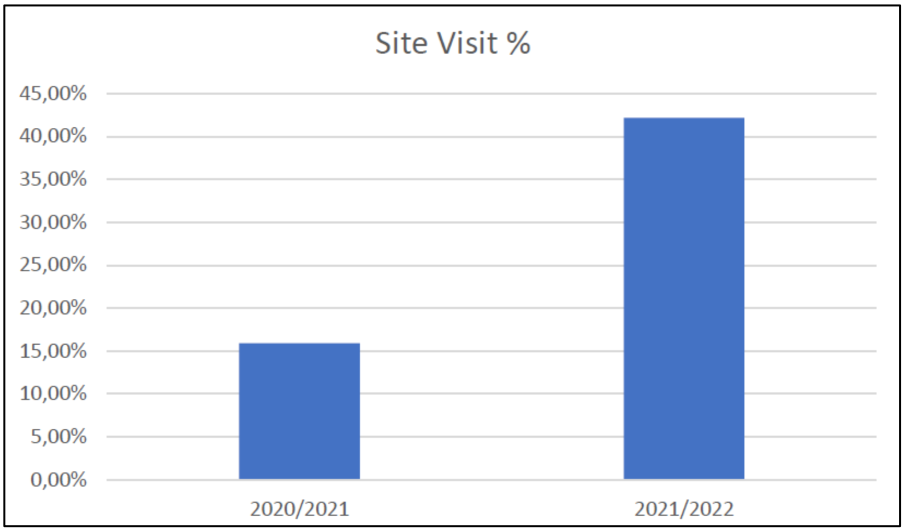


Figure 2.12: Percentage of Priority NCMP sites sampled over the past two hydrological years.

The Department is currently reviewing all sampling sites in line with the optimised network to consider possible additional sampling sites and to refine the current sample site list of the priority NCMP. Additionally, the formalisation of the working relationship with DWS Regional Offices through Service Level Agreements (SLAs) is at an initial stage to ensure better understanding and cooperation between sampling and coordination.

2.3.2 National Eutrophication Monitoring Programme (NEMP)

The NEMP 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 NEMP 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 done 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 during the 2021/22 hydrological year, and this was a significant improvement from 52 sites reported during the 2020/21 period (Figure 2.13). The improvement can be attributed to the improvement of RQIS laboratory capacity after method development, recruitment of additional sampling personnel, and committed monitoring in the RQIS, IUCMA, Limpopo Regional Office, Eastern Cape Regional Office, and various Water User Associations. Plans are underway to reactivate monitoring in Northern Cape, Western Cape, and KwaZulu-Natal Provinces.

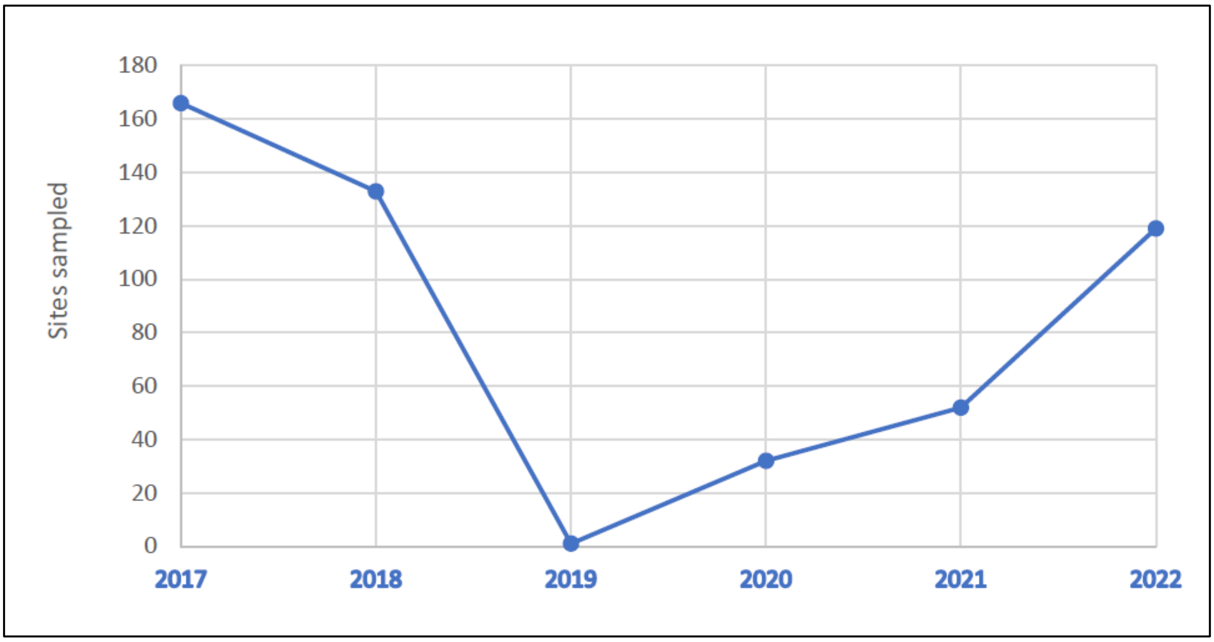


Figure 2.13: NEMP data availability from the year 2017 to 2022.

A map showing the dam and river sites monitored during the 2021/22 hydrological year is provided in Figure 2.15. Samples were received from 53% of the sites that were scheduled for monitoring. A significant improvement in the number of sites was noted during the hydrological year due to the availability of laboratory capacity, recruitment of additional samplers, and return of the entire staff complement after Covid19 disruptions.

2.3.2.1 NEMP Optimisation

The NEMP is currently under review, and optimisation is to focus on monitoring strategic sites representative of the country's ambient water quality. This approach focuses on monitoring key strategic catchments while meeting international obligations, including SDG reporting. An Optimised NEMP programme consisting of sixty-one dams has been recommended for initial implementation in the 2022/23 financial year. The map depicting the spread and location of Optimised NEMP sites is provided in Figure 2.14 below. Thirty-five sites in the optimised NEMP were monitored during the 2021/22 period.

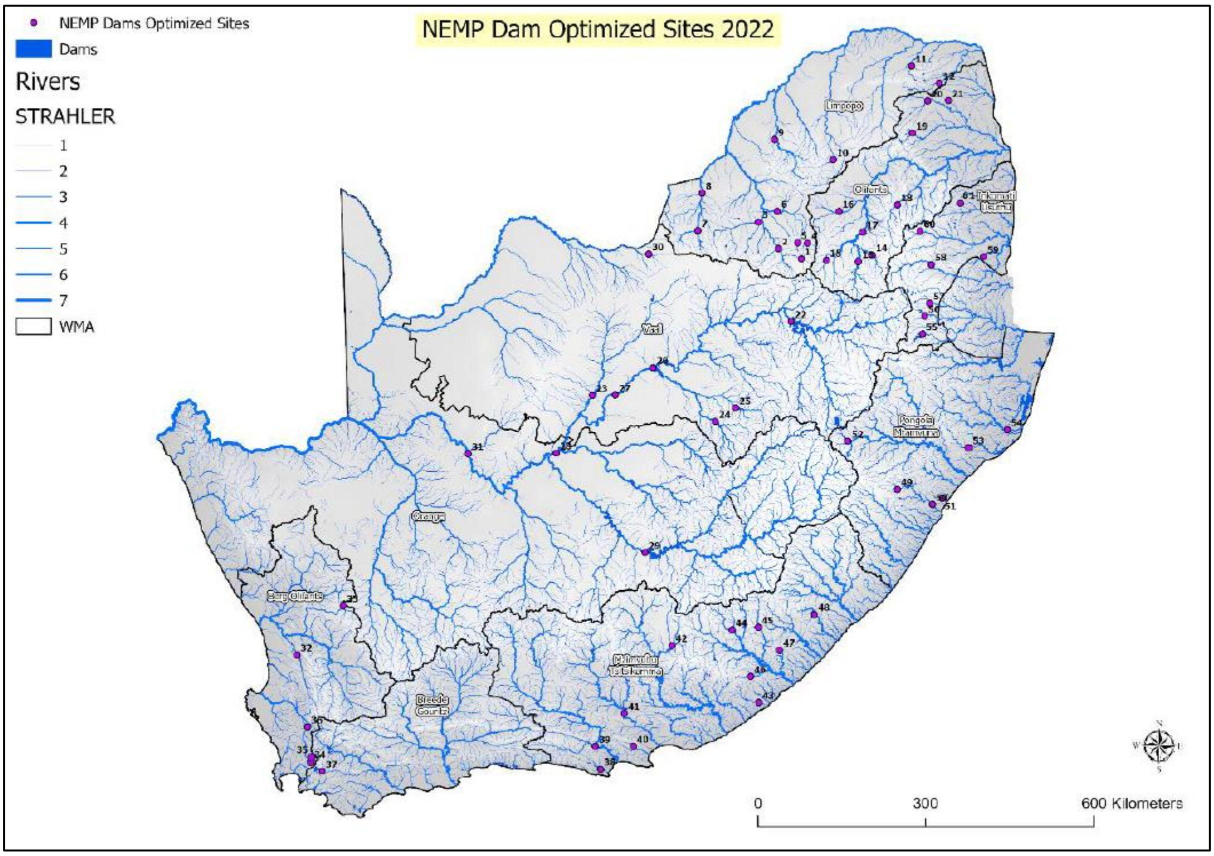


Figure 2.14: Distribution of Optimised NEMP dam sites across the country.

The reporting of sampling compliance in the next reporting cycle will be based on the sixty-one sites identified for the optimised NEMP.

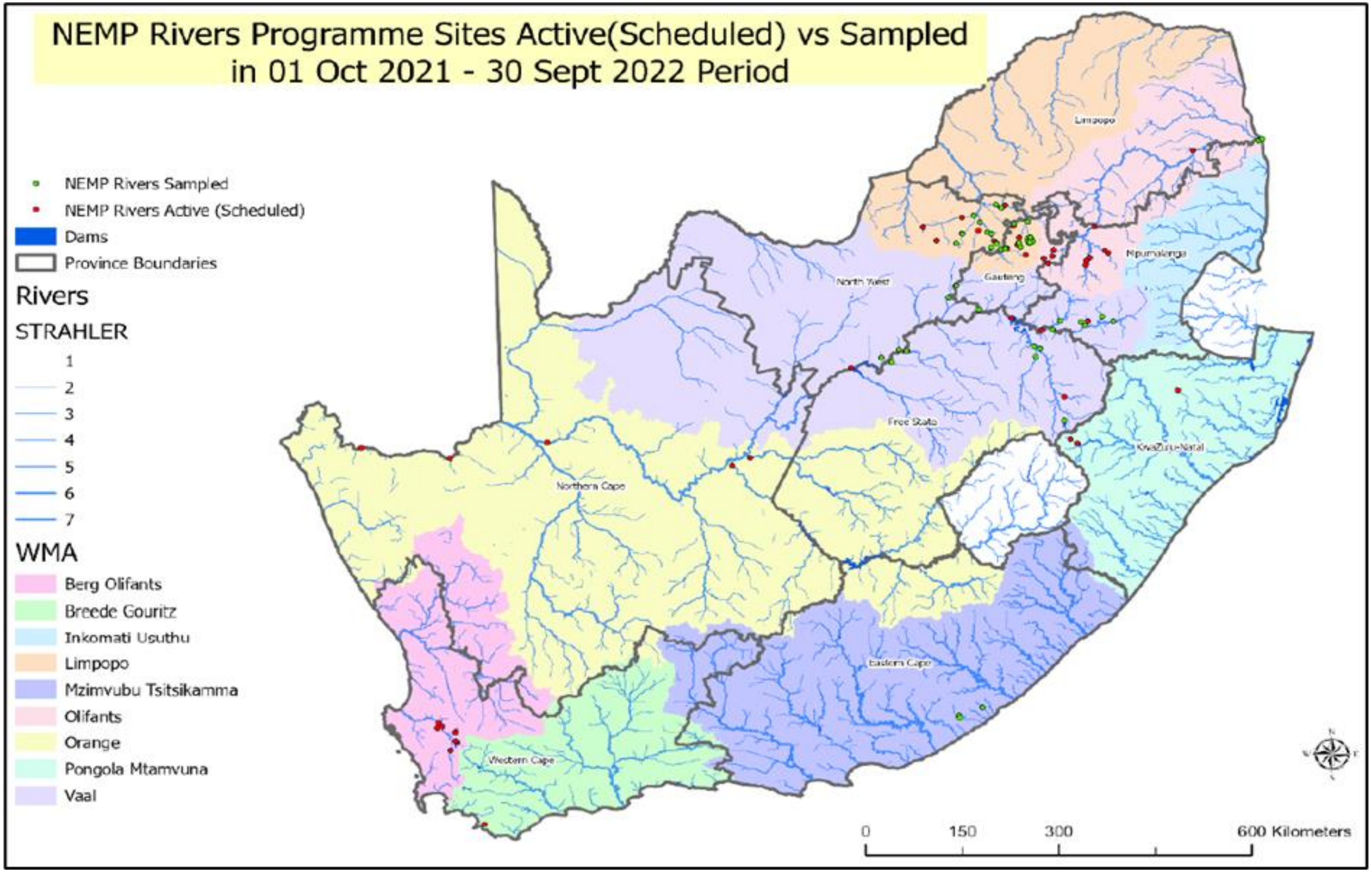


Figure 2.15 Map showing scheduled NEMP rivers versus sampled sites

2.3.3 National Microbial Monitoring

The National Microbial Monitoring Programme (NMMP) has been implemented in phases nationwide since the year 2000. The programme uses the presence of faecal coliform bacteria in the water to indicate contamination. The main objectives of the NMMP 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 priority areas. Furthermore, is to provide information to help assess the potential health risk to humans associated with the possible use of faecal polluted water resources. The parameters measured are faecal coliform, *E. coli*, pH, turbidity, and temperature.

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. 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.

Currently, NIWIS can provide water-related information in the areas of, Climate and Weather, Disaster Management, Enforcement, Water Infrastructure, Water Monitoring Networks, State of Water, Water Ecosystems, Water Quality, Water Quantity, Water Services, Water Supply Risk, Water Tariffs, Water Use, and other Water Resource Management areas. The NIWIS dashboards covering various themes are presented in Figure 2.16.

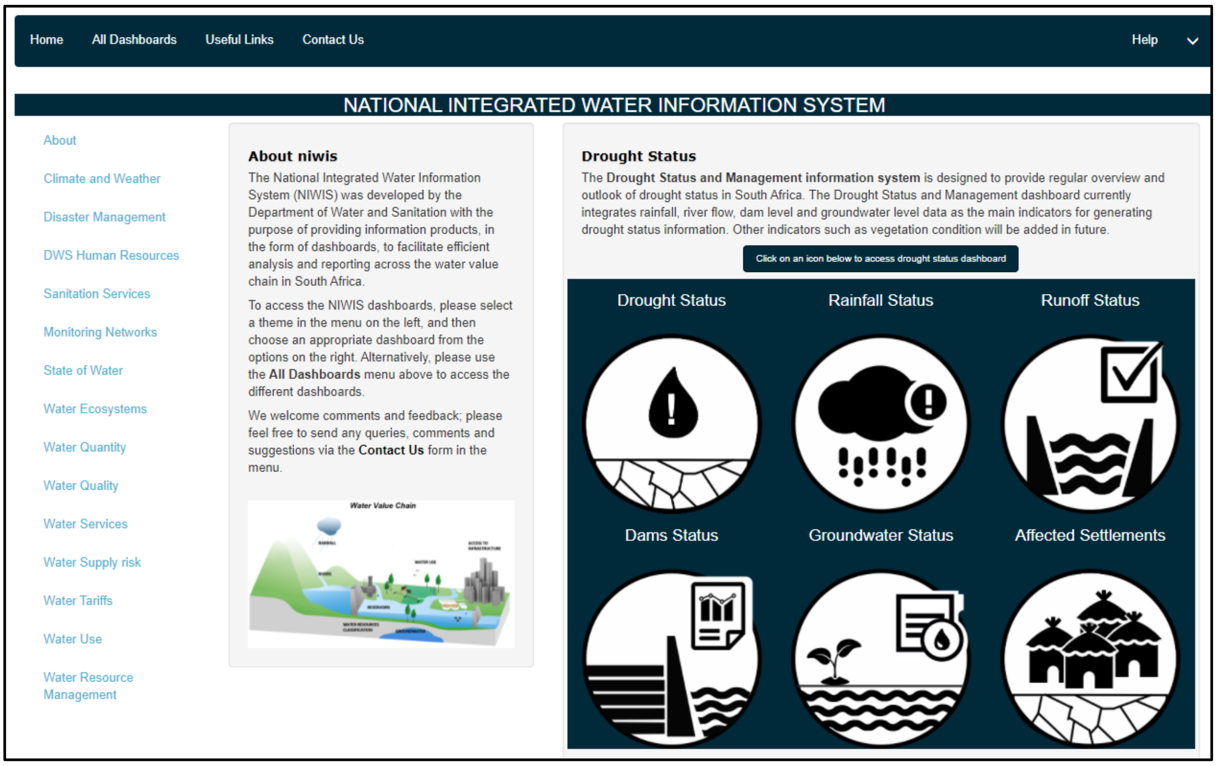


Figure 2.16 NIWIS landing page (https://www.dws.gov.za/niwis2/)

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 each other, albeit sharing the same client or water information in some cases. However, there are further developments of NIWIS in progress despite several challenges.

3

CLIMATIC ENVIRONMENT

3 CLIMATIC ENVIRONMENT

3.1 Climate

3.1.1 Background South African Climate

Climate is one of the most important drivers of the hydrological response of a catchment. It includes indicators such as rainfall, temperature, solar radiation, relative humidity, wind speed, and evaporation, and these are characterised by temporal and spatial variability, which in turn does affect and impact water availability, and water supply for drinking, rain-fed agriculture, groundwater, forestry, biodiversity,

Climate change puts additional pressure on the naturally stressed water resources of South Africa. This puts pressure on water availability, accessibility, quality, and demand. Climate change can have an exaggerated effect on runoff, and the complex response of the hydrological system worsens the impacts.

The South African Weather Services (SAWS) is the custodian of meteorological data in South Africa, and the data presented in this chapter is based on data and information provided by the SAWS.

3.1.2 Temperature

The maximum monthly temperature deviations from the normal period (1981 – 2010) for the summer season and winter seasons are presented in Figure 3.1 and Figure 3.2, respectively.

During the summer season months, the maximum temperature deviations were above-normal (positive) by up to 4^{0}c in some areas mostly in the Western Cape Province and southern parts of the Eastern Cape Province from January to March 2022. The country's eastern half also experienced higher-than-normal maximum temperatures during November 2021 and February 2022.

During the winter months, an observation is again made that the Western Cape Province has, for the months of May to September 2022, experienced maximum temperatures above normal.

Generally, the whole country experienced below-normal maximum temperatures during December 2021 and April 2022. These correlate with months when the eastern half of the country received high amounts of rainfall (Figure 3.4 and Figure 3.5).

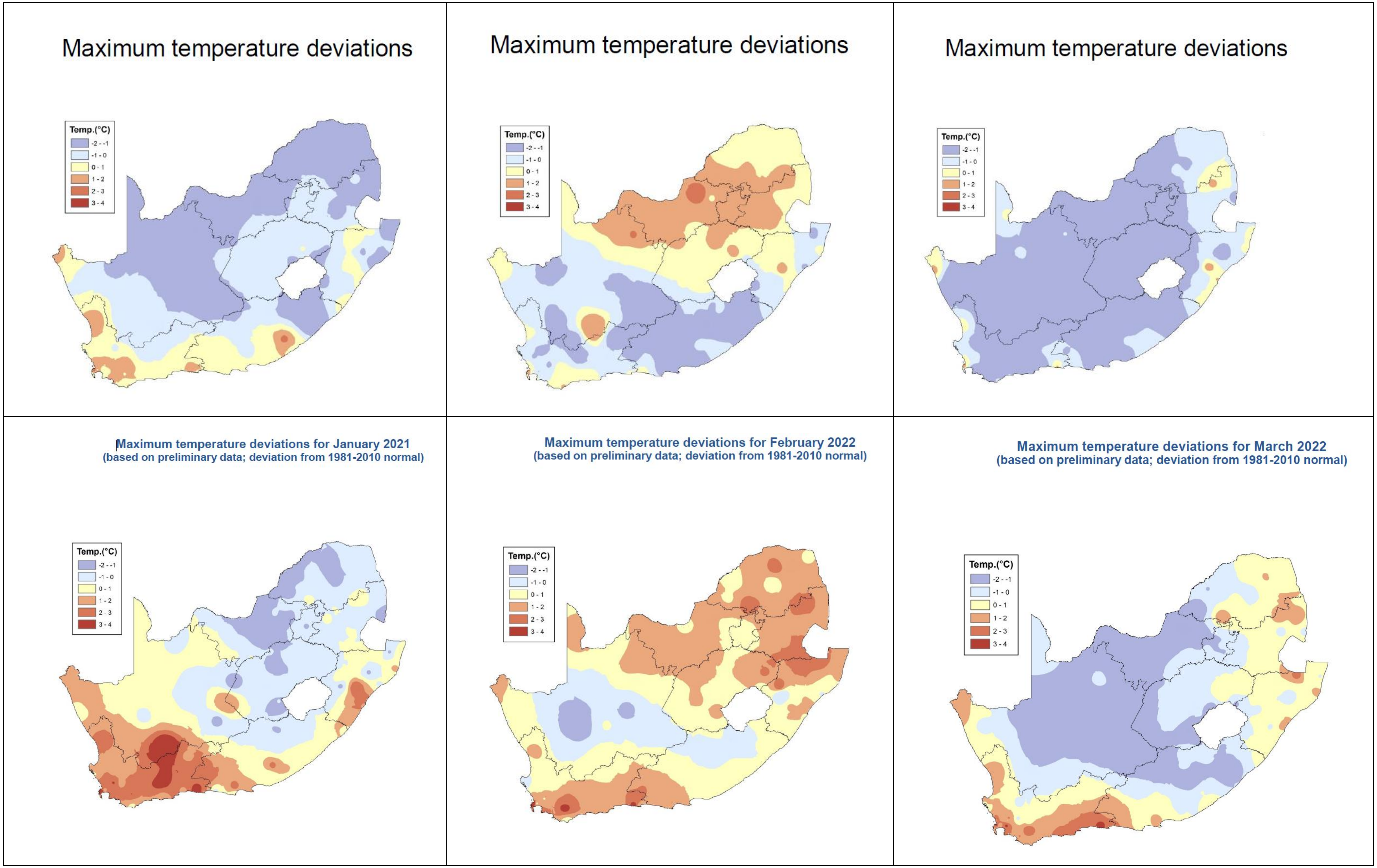


Figure 3.1 Maximum temperature deviations for the summer season months (October 2021 to March 2022) (SAWS, 2022)

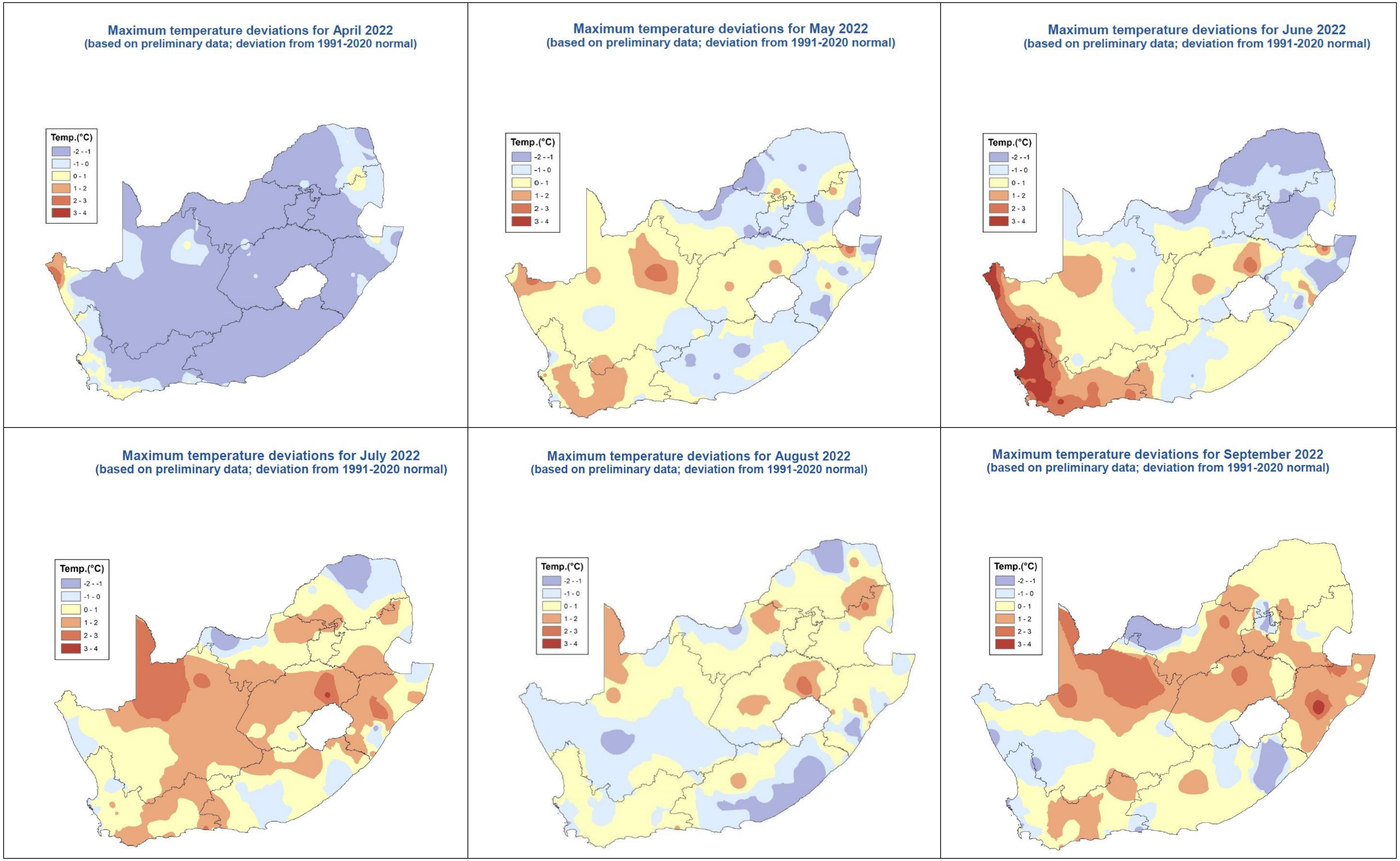


Figure 3.2 Maximum temperature deviations for the winter season months (April 2022 to September 2022) (SAWS, 2022)

3.1.3 Rainfall

A significant feature of the rainfall received during the hydrological year 2021/22, presented in Figure 3.3, is above-normal rainfall received for almost all parts of South Africa, apart from a strip on the southwestern coastline of the Western Cape Province. Rainfalls were significantly above (>200% from normal) for the Northern Cape Province, covering the Orange WMA, Middle, and Lower Vaal WMAs.

The eastern half of the country, characterised by summer rainfalls, has received significantly above-normal rainfall in the past two hydrological years (2020/21 & 2021/2022). These have resulted in areas in the country experiencing drought conditions decreasing over the past four hydrological years.

The monthly rainfall distribution during the hydrological year for the summer and winter seasons are presented in Figure 3.4 and Figure 3.5, respectively. During the summer, significant rainfalls mostly covering the eastern half of the country were received during December and January 2022. During the winter season, again, the eastern half of the country received significant rainfalls in April 2022, with a strip along the coastal line of KwaZulu-Natal receiving significant amounts, between **200 mm to 500 mm** of rain just in April 2022.

The long-term rainfall trend analysis per water management area is presented in Figure 3.6, Rainfall (% of Normal) for October 1981 - September 2022. The Normal Period used is October 1981 to September 2010.

Highlights from the anomaly’s plots presented in Figure 3.6 is that for the 2021/22 hydrological year, most WMAs were classified as having experienced an above-average year. These are the Mzimvubu-Tsitsikamma WMA, Pongola-Umzimkulu WMA, Vaal and Orange WMA. Surface storage Dam levels are expected to have been the highest in these water management areas during the reporting period.

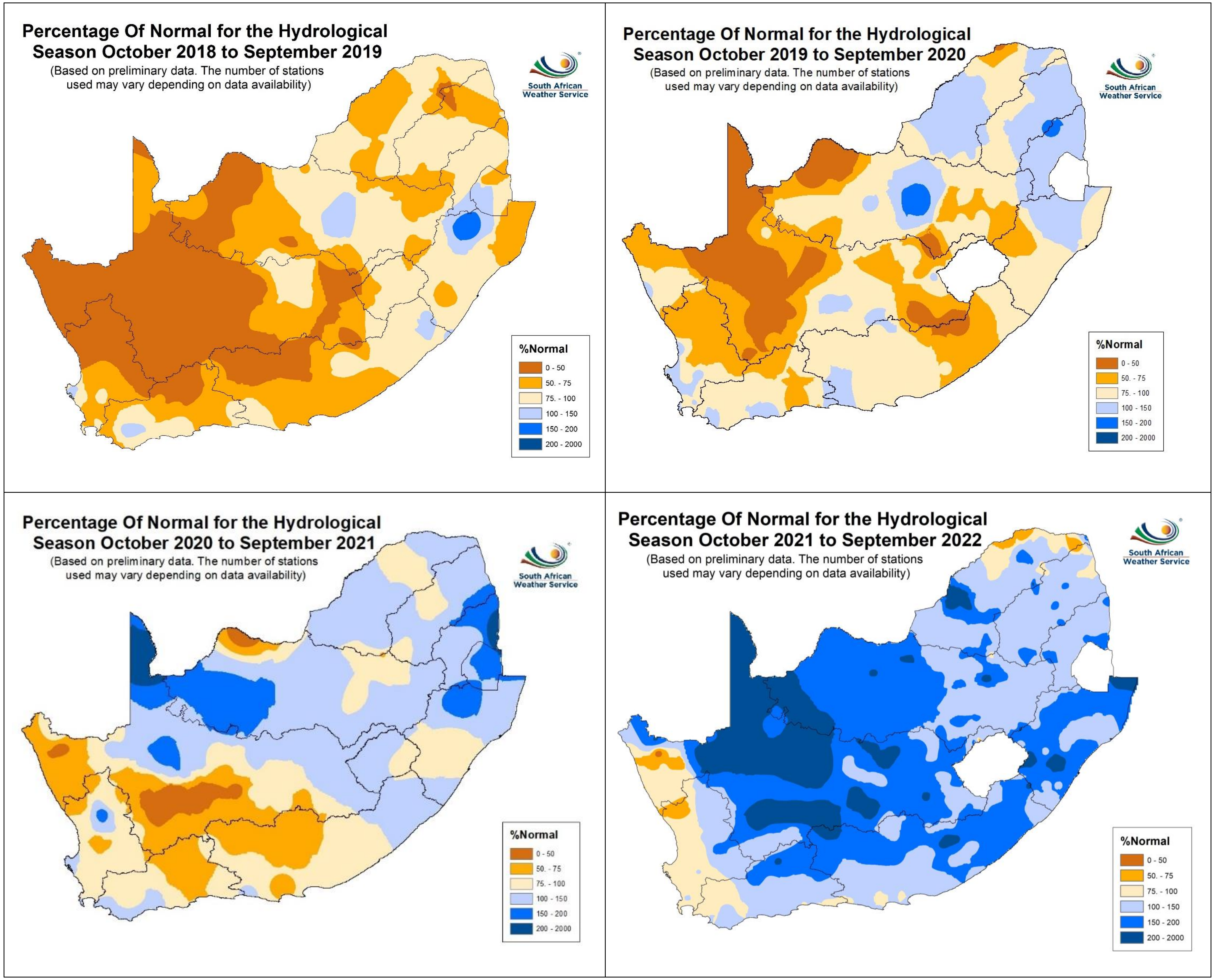


Figure 3.3 Rainfall % anomalies for the past three hydrological years in comparison to 2021-2022. Blue shades are indicative of above-normal rainfall, and the darker yellow shades of below-normal rain ((Source: SAWS https://www.weathersa.co.za/home/historicalrain)

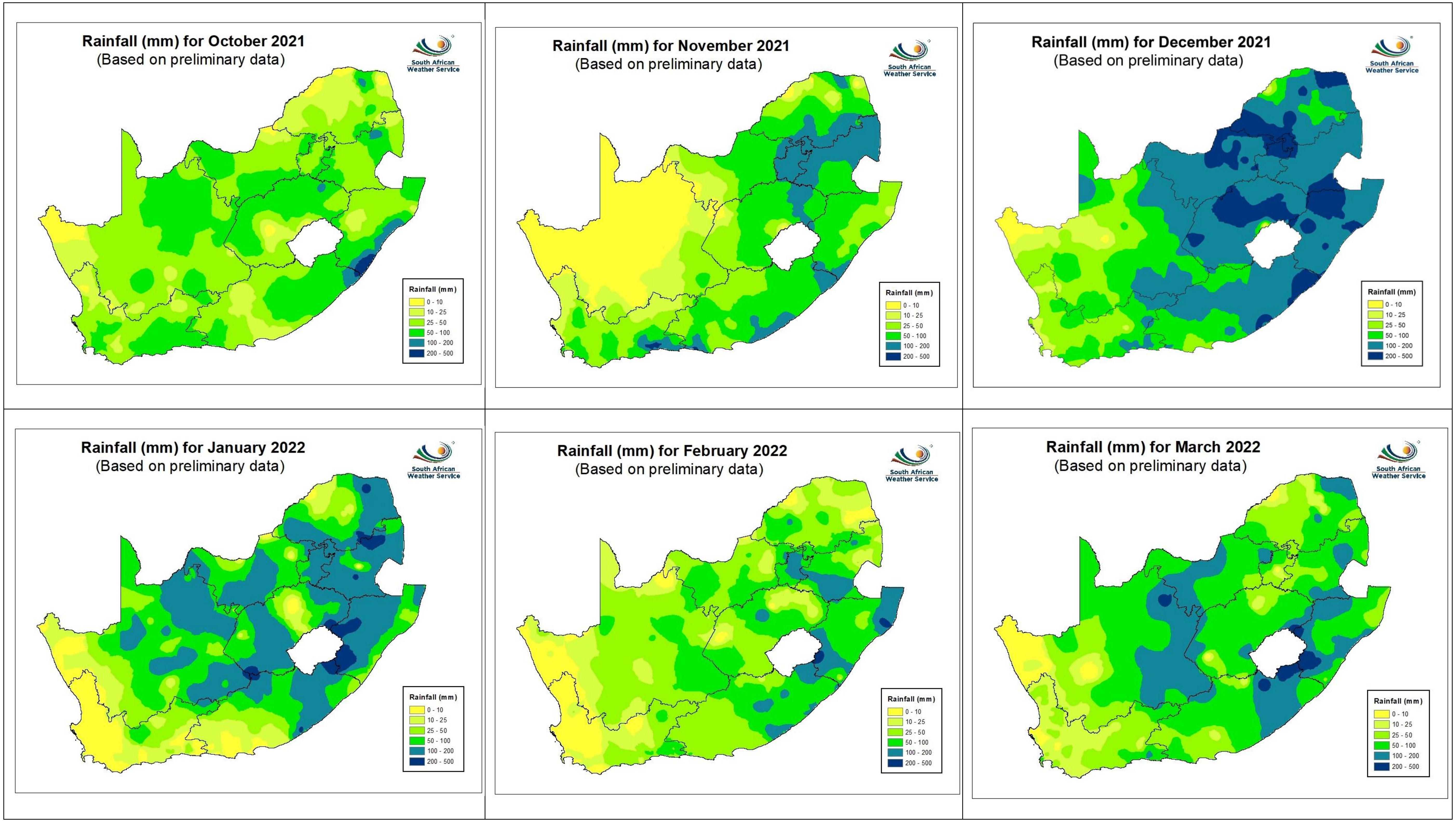


Figure 3.4 Summer season monthly rainfall distribution (Source: SAWS https://www.weathersa.co.za/home/historicalrain)

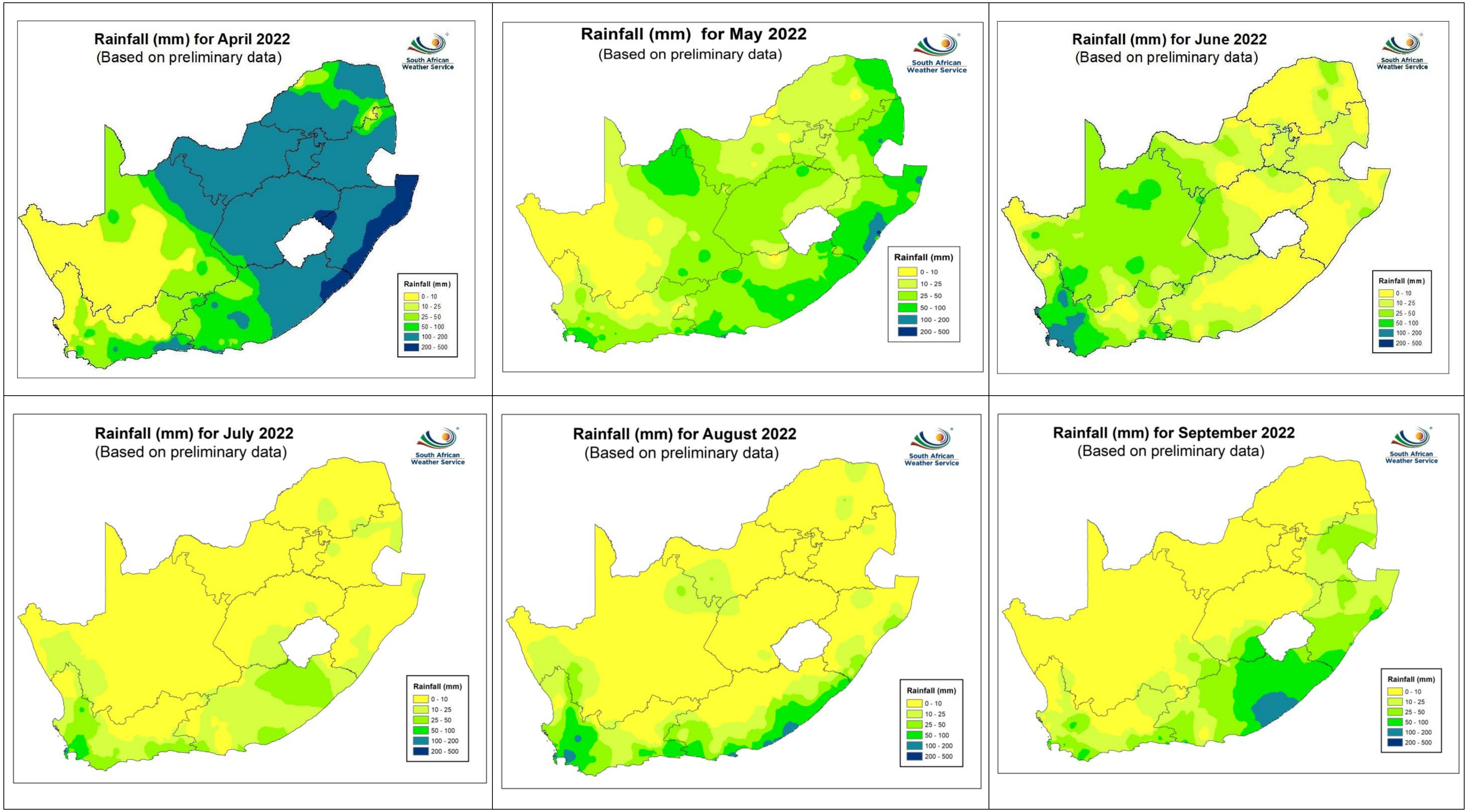


Figure 3.5 Winter season monthly rainfall distribution (Source: SAWS https://www.weathersa.co.za/home/historicalrain)

Figure 3.6 Hydrological year long-term trends of Rainfall Anomalies: > 125% (wet) & < 75% (dry) (Data Source: SAWS)

3.2 Indicators of Drought

The definition 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, reservoir, and groundwater levels. When precipitation is low for a long time, it is reflected in declining surface and subsurface water levels.

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.

The 24-months (long-term) SPI for the end of the hydrological year (September 2022) is presented in Figure 3.7. Based on the SPI, 5 Provinces have been affected by drought in the last 24 months. Table 3-1 lists drought-affected Provinces, District Municipalities, and Local Municipalities.

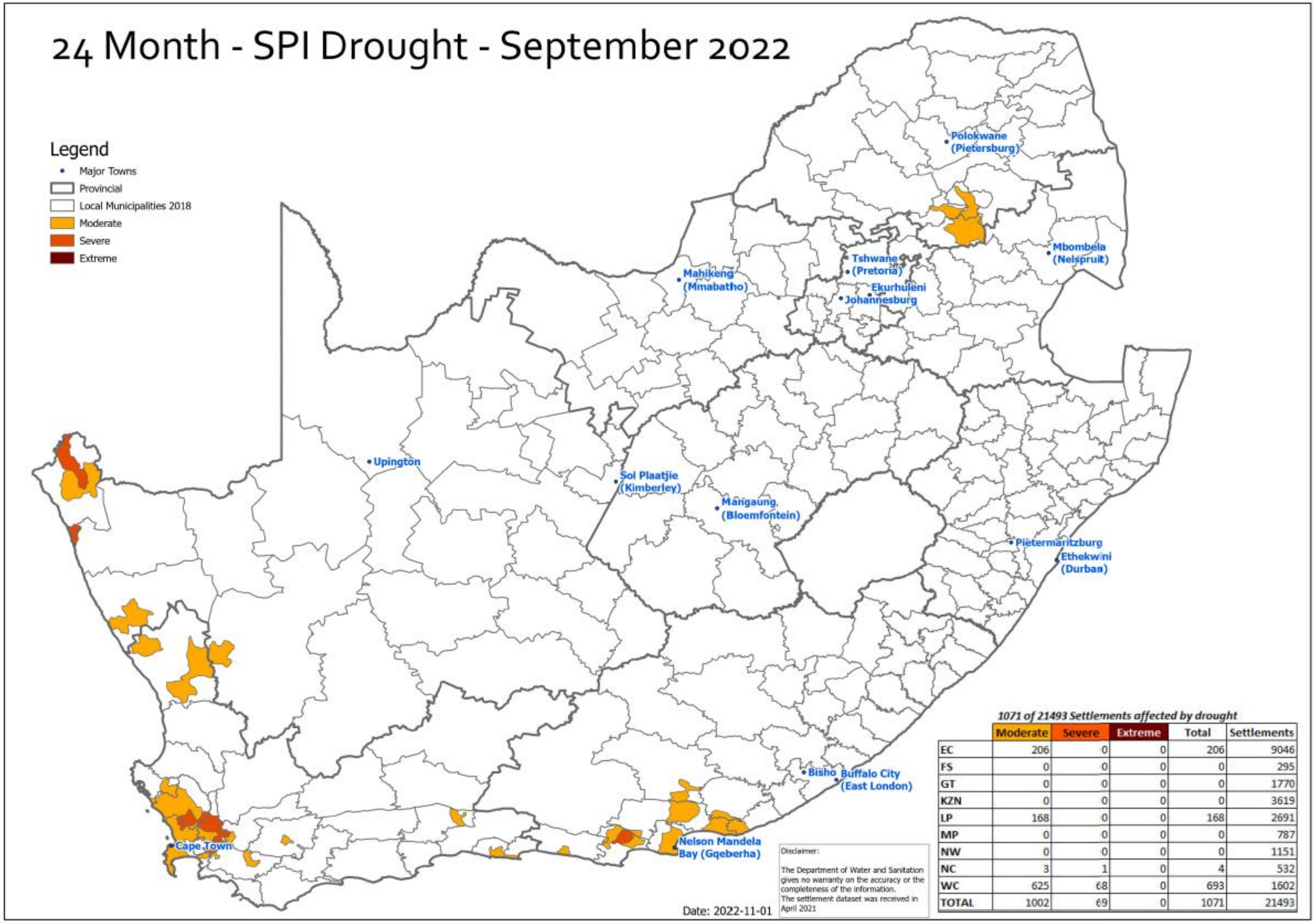
Table 3-1 Drought Affected Areas September 2022

Province	Affected District Municipalities	Affected Local Municipalities
Eastern Cape	Nelson Mandela Bay	Nelson Mandela Bay Local Municipality
	Sarah Baartman	Kou-Kamma Local Municipality
	Sarah Baartman	Ndlambe Local Municipality
	Sarah Baartman	Sundays River Valley Local Municipality
Limpopo	Sekhukhune	Elias Motsoaledi Local Municipality
	Sekhukhune	Ephraim Mogale Local Municipality
	Sekhukhune	Fetakgomo/Greater Tubatse Local Municipality
	Sekhukhune	Makhuduthamaga Local Municipality
Northern Cape	Namakwa	Kamiesberg Local Municipality
	Namakwa	Richtersveld Local Municipality
Western Cape	Cape Winelands	Breede Valley Local Municipality
	Cape Winelands	Drakenstein Local Municipality
	Cape Winelands	Langeberg Local Municipality

Province	Affected District Municipalities	Affected Local Municipalities
	Cape Winelands	Stellenbosch Local Municipality
	City of Cape Town	City of Cape Town Local Municipality
	Eden	Bitou Local Municipality
	Eden	Knysna Local Municipality
	Eden	Oudtshoorn Local Municipality
	Overberg	Theewaterskloof Local Municipality
	West Coast	Matzikama Local Municipality
	West Coast	Saldanha Bay Local Municipality
	West Coast	Swartland Local Municipality

3.2.1 Temporal Patterns of the SPI

Presented as a time series, the SPI shows its evolution of the SPI over time. SPI values of these longer timescales help determine the persistence, magnitudes of drought events, and flash points where hydrological droughts (low streamflow, reservoir levels, and even groundwater levels) are likely. This time series also makes it possible to analyse and visualise the intensity of the drought in an area of interest. Figure 3.8. presents the variation in SPI values for each of the South African Provinces over the past six years.



	Moderate	Severe	Extreme	Total	Settlements
EC	206	0	0	206	9046
FS	0	0	0	0	295
GT	0	0	0	0	1770
KZN	0	0	0	0	3619
LP	168	0	0	168	2691
MP	0	0	0	0	787
NW	0	0	0	0	1151
NC	3	1	0	4	532
WC	625	68	0	693	1602
TOTAL	1002	69	0	1071	21493

Figure 3.7 24-months Spatial Precipitation Index – September 2022 (DWS - NIWIS - Disaster Management - (dwa.gov.za)

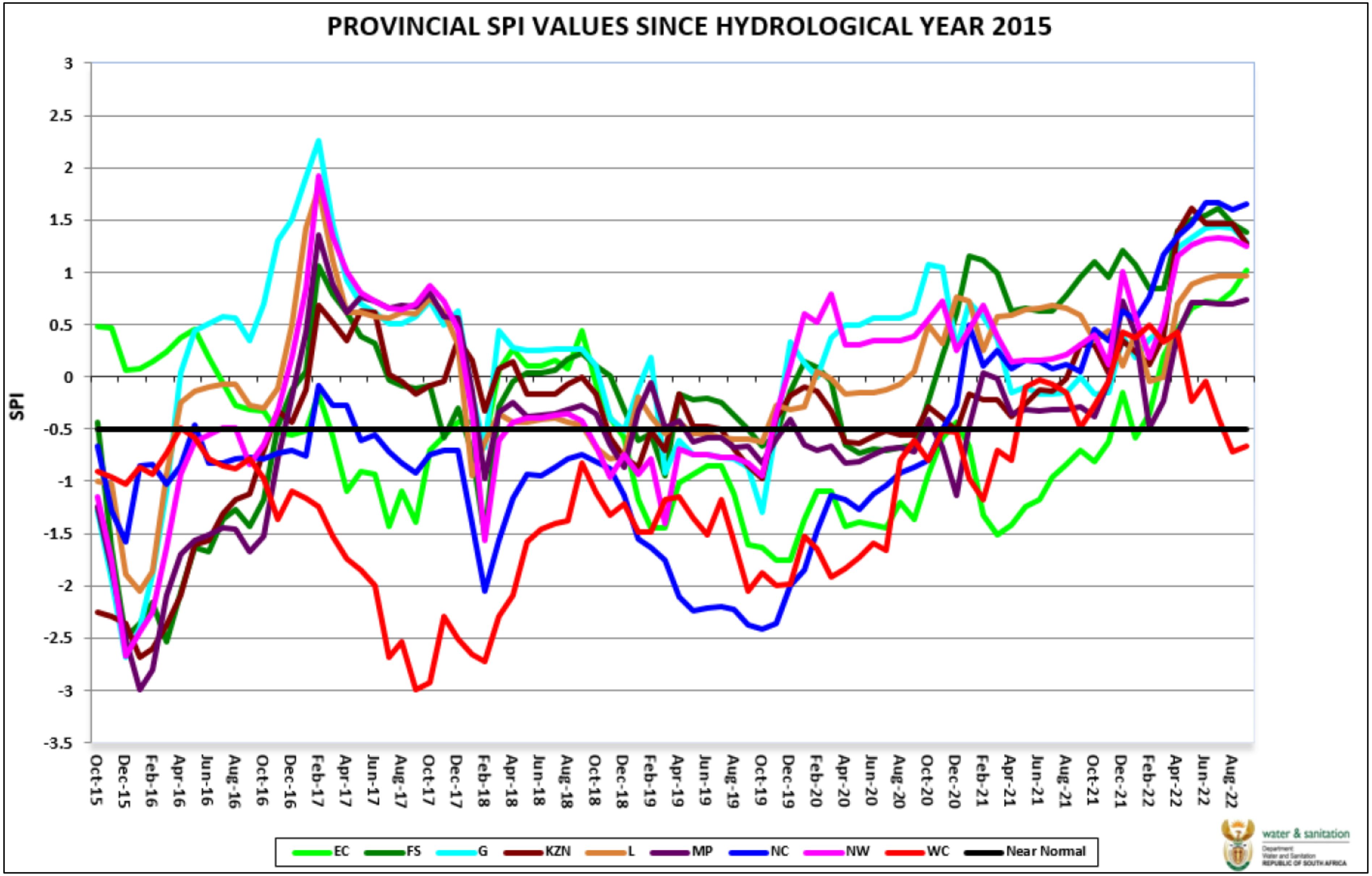


Figure 3.8 Provincial SPI time series from October 2015 – September 2022

Drought conditions had already manifested by October 2015 over all the provinces, except for the Eastern Cape, as the SPI values were below the -0.5-threshold line on the graph. These provinces experienced extreme drought conditions from December 2015 to April 2016, resulting in severe water shortages.

In 2016, most Provinces except the Western Cape Provinces had good rains during the summer rainfall season, easing the drought briefly for about a year. In early October 2017, following a below-normal winter rainfall season, Cape Town had estimated five months of storage left before water supplies were depleted. By December 2018, the drought had spread to all provinces except Gauteng, Limpopo, and Mpumalanga, whose SPI values were above the near-normal line. Winter rains led to a rise in dam levels in the Western Cape in 2018. It was a dry year from March to November, but the severity of the drought varied across provinces.

The Northern Cape experienced arid conditions. The dry conditions eased in Free State, Gauteng, Limpopo, and KwaZulu-Natal in December 2019 but persisted in Mpumalanga, Northern Cape, Western Cape, and Eastern Cape until November 2020.

Since December 2020, conditions have been near-normal in most provinces, with the Western Cape, Eastern Cape, and Mpumalanga crossing the near-normal line only in March, June, and November 2021, respectively. The summer rainfall region was usually wet from October 2021 to April 2022, with some areas experiencing rain well into June. Over that time, the SPI for provinces has increased, confirming the wet conditions. There are parts of the summer rainfall region where SPIs have exceeded 1.0 and reached levels last touched five years ago.

Based on ARC data, the winter rainfall region received between 25-75% of its normal rainfall again in September, following a similar observation for August. This reflects a drying phase in response to successive months of below-normal rainfall. The SPI generally showed a drying trend throughout the winter season, which ended in September. In this region, closer monitoring is needed because the SPI indicates a deepening dry phase that may intensify drought conditions.

3.3 Extreme Events

3.3.1 Floods

An upper-air cut-off low was situated over the southern parts of the country on the **11** to **12** of **April 2022** (Figure 3.9**)**, and with a high southeast of the country, cold to cool conditions with thundershowers and showers as well as light rain, occurred over the eastern half of the country. Heavy falls were measured in KwaZulu-Natal.

Diagrams below show cut off low-pressure system experienced by KZN Province

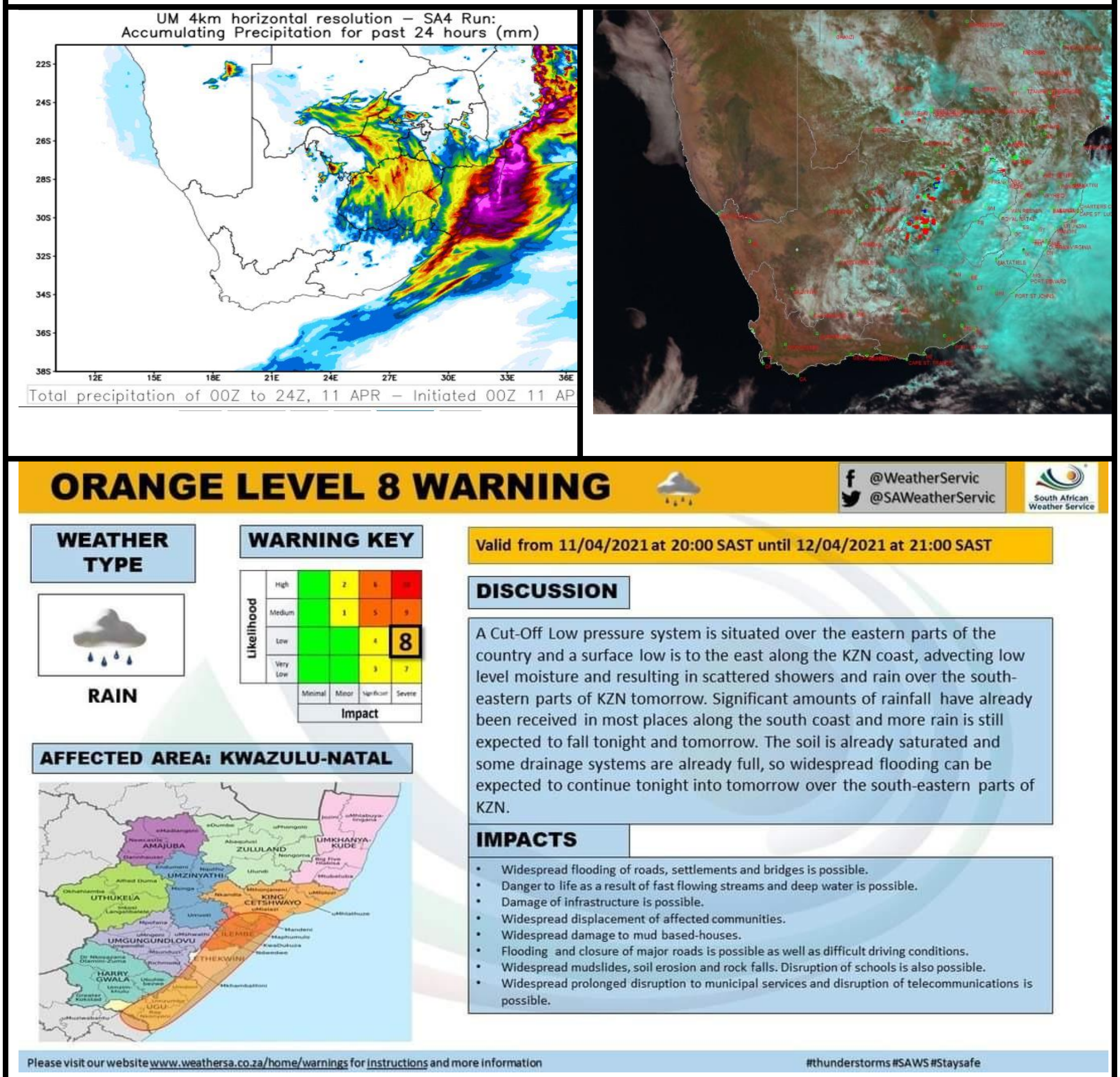


Figure 3.9 Cut off low-pressure system experienced by KZN Province April 2022

A surface trough was situated over the eastern parts of the country between the **20** and **22** of **May 2022**. Heavy rainfalls were measured over the KwaZulu-Natal coastal areas and in places over Mpumalanga. The South African Weather Services again issued a warning of high rainfall between 20 and 22 May, which resulted in more damage to infrastructures and loss of lives (Figure 3.10)

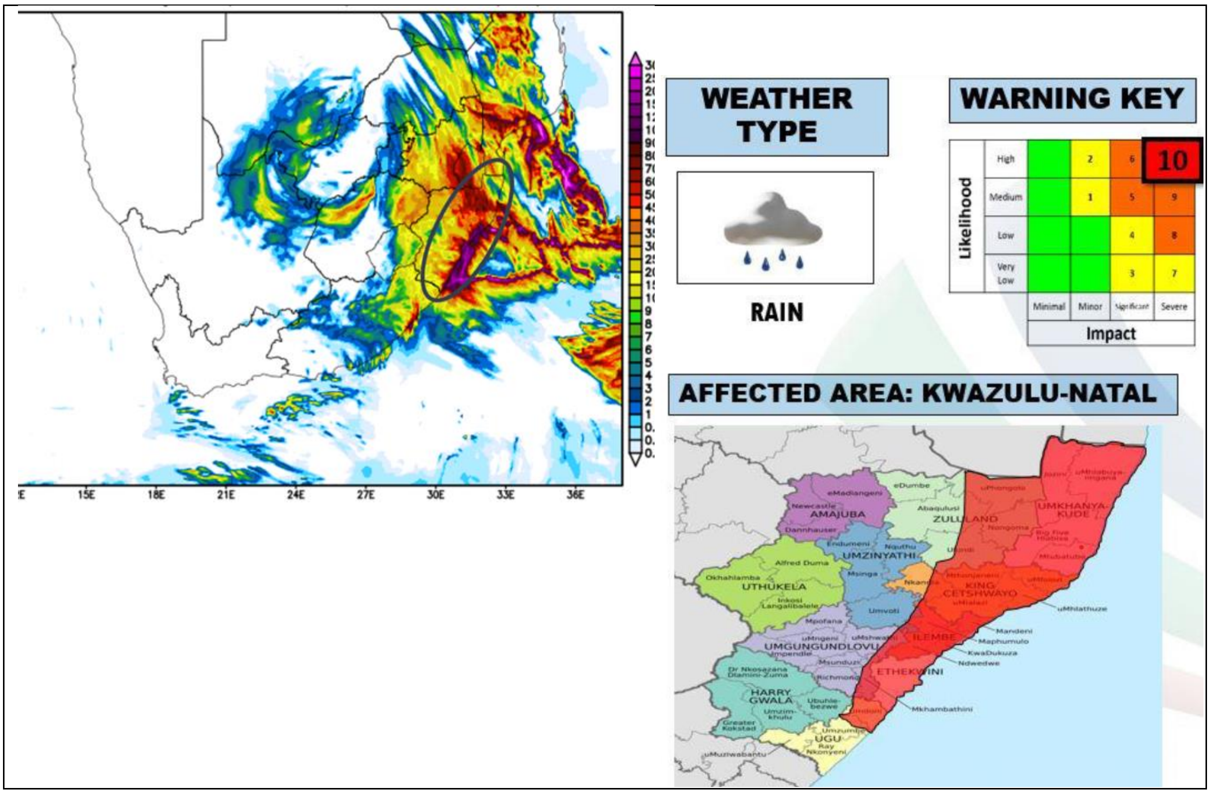


Figure 3.10 Flood Warning for KZN issued by SAWS for the May 2022 Storm

The rainfall ranging between (200-500 mm) was accumulated in KwaZulu-Natal in April and May 2022 (SAWS), and it has led to localised flooding in the area. A strong cut-off low weather system off the east coast of southern Africa caused the rain. Cut-off lows frequently occur in KZN during the autumn months.

Rainfall recorded within eThekwini areas between 11 and 12 April 2022 ranged from **60mm** to **311mm** (Schulze, 2022). The heavy rains led to a rapid increase in dam levels in the KwaZulu-Natal since most of the dams were almost at their full supply level before heavy rains between 11 and 12 April 2022, resulting in damage to infrastructure and loss of lives.

3.3.2 Impacts of Floods

The KwaZulu-Natal floods were declared a provincial disaster on the 13 of April 2022. On the 17 of April 2023, 435 fatalities were reported, and the homes, businesses, roads, bridges, and electricity and water infrastructure were damaged or destroyed. An estimated 130000 people have been affected, with more than 19182 houses and 264 schools destroyed (Table 3-2 and Figure 3.12). The worst affected districts include Ugu, eThekwini, King Cetshwayo, uMgungundlovu, and iLembe. (Figure 3.11)

Table 3-2 Number of incidents and impact per District/Metro Municipality

Municipalities	**Number of Incidents**	**Households Affected**	**Houses Destroyed**		**Homeless**	**People Affected**	**Fatalities**	**Injuries**	**Missing Person**
			Totally Destroyed	**Partially Damaged**					
uMkhanyakude	03	86	78	08	10	273	00	01	00
uThukela	05	224	192	131	15	1480	00	03	00
uMzinyathi	04	206	153	124	21	1208	02	01	02
uMgungundlovu	07	687	242	796	97	3705	02	04	02
Zululand	05	360	171	264	00	2348	00	00	00
eThekwini	505	11492	3000	7200	5423	±100 000	386	01	39
iLembe	20	3000	1391	1178	365	8006	31	21	00
Harry Gwala	17	650	297	252	250	1856	03	02	00
King Cetshwayo	155	490	242	501	172	2762	04	03	01
Ugu	35	1769	1049	910	288	7437	07	04	04
Amajuba	29	218	111	157	14	1022	00	00	00
TOTAL	**785**	**19182**	**6926**	**11521**	**6655**	**130097**	**435**	**40**	**48**

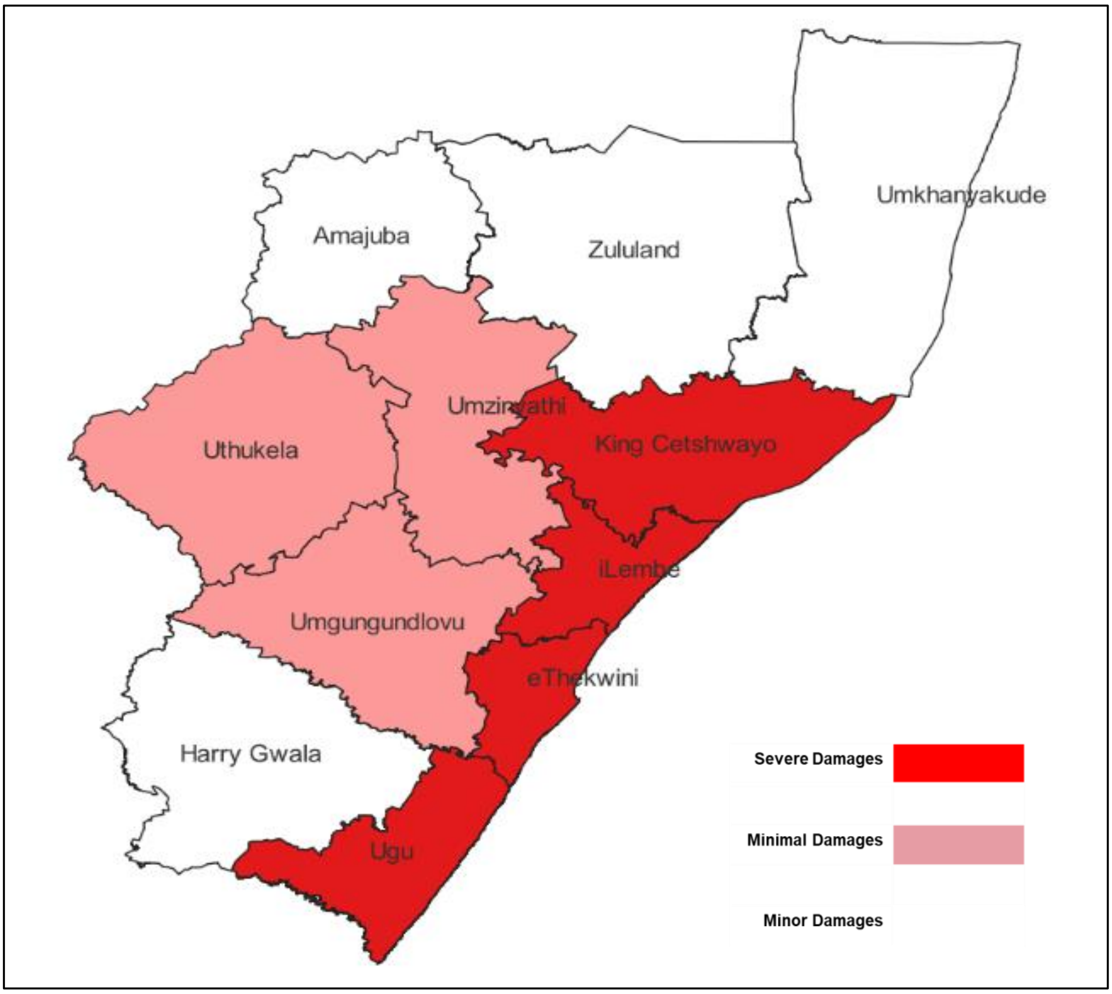


Figure 3.11 Map showing the affected municipality in KZN

Figure 3.12 Infrastructure damage caused by Floods in KZN South Africa April 2022

At the end of May 2022, approximately 448 fatalities were reported, and the homes, businesses, roads, bridges, as well as electricity and water infrastructure, have been damaged or destroyed. An estimated 130 000 people have been affected, with more than 19 182 houses and 264 schools destroyed.

The most affected areas in May 2022 were Hluhluwe, eThekwini, Jozini, KwaDukuza, Mandeni, Maphumulo, Mkhambathini, Mthonjaneni, Mtubatuba, Ndwedwe, Nongoma, Ulundi, Umdoni, Umhlabuyalingana, uMhlathuze, uMlalazi and uPhongolo District Municipal areas.

The worst infrastructure damage in eThekwini was observed at the Surfside residential complex, which suffered significant damage due to a lack of stormwater infrastructure in development under construction upstream of the complex. The May floods also washed away the various repairs underway at the Umdloti Water Treatment Works.

3.3.3 KZN Surface Water Resource Quality (Post Flood)

The river water quality has declined because of untreated sewage discharging directly to the watercourses between March to April 2022, as shown in Figure 3.13 River water quality March and April 2022 in KZN (Pieterson, 2022)
A few rivers remain at acceptable levels (shown in green), while most rivers are at critical levels recording E.coli counts greater than ***10 000 cfu/100ml*** (shown in red). The Amanzimyama, Umbilo, Umkhumbane, Umgeni, Mlaas, Umhlatuzana, Isipingo, and Amanzimtoti Rivers are severely impacted, recording E.coli counts greater than ***800 000 cfuf/100ml***. The orange colour refers to rivers that are in poor condition, where the E.coli counts are between ***2000 – 10 000 cfu/100ml.***

The eThekwini Municipality issued a public awareness notification released jointly with the Health Department on 18 May 2022.This notice highlighted beach closures, hot spot rivers, dangers of using contaminated waters, and what the city was doing to fast-track infrastructure repairs.

The flood-related damage has resulted in the failure of the entire sewerage infrastructure network, posing a severe threat to water quality. Reports have been received of fish kills in the Durban Harbour due to pollution from the feeder streams. As river levels subside and the concentration of wastewater increases, the impacts of overflowing and untreated sewage discharges to the environment are likely to be exacerbated.

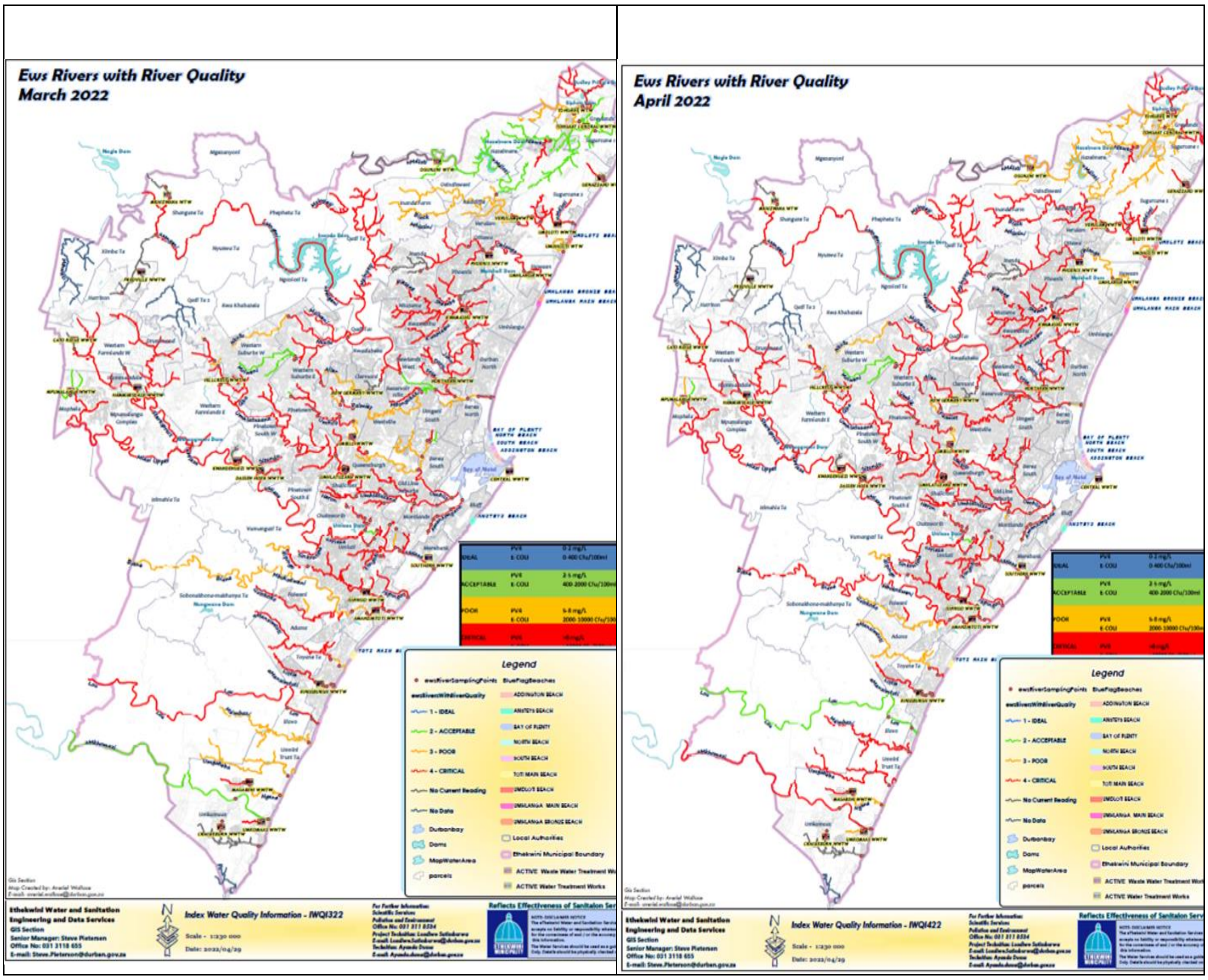


Figure 3.13 River water quality March and April 2022 in KZN (Pieterson, 2022)

The KZN flood disaster has impacted water resource quality as damaged wastewater treatment infrastructure (i.e., wastewater treatment works, pump stations, trunk sewer line, leaks, breakages, etc.) effluent overflows into the rivers. Some of the major rivers affected are Thongathi, Umdloti, Ohlanga, Umngeni, Umbilo, Umhlathuzana, Umlazi, Isipingo, Imbokodweni, Amanzimtoti and Amahlongwana in eThekwini Metro; Mvoti, Uthukela, Mbizana, Nonoti, in iLembe District; Uvongo, Nkhongweni in Ugu District.

More storm events pictures for April and May floods are given in (Figure 3.14), while the historical flood events magnitudes and hydrograph for the April 2022 event are presented in (Figure 3.15).

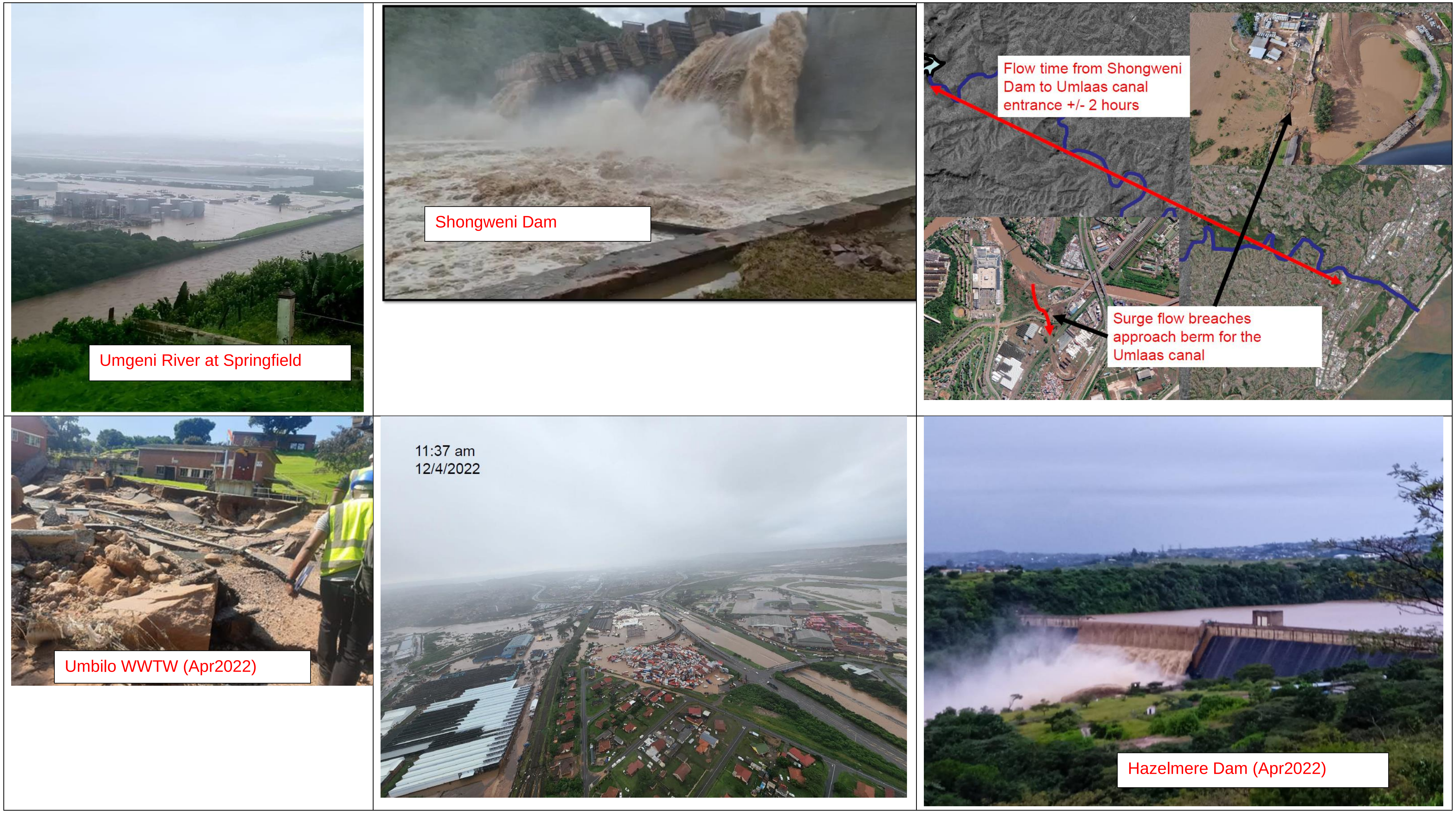


Figure 3.14 April and May 2022 KZN Storm Events Gallery

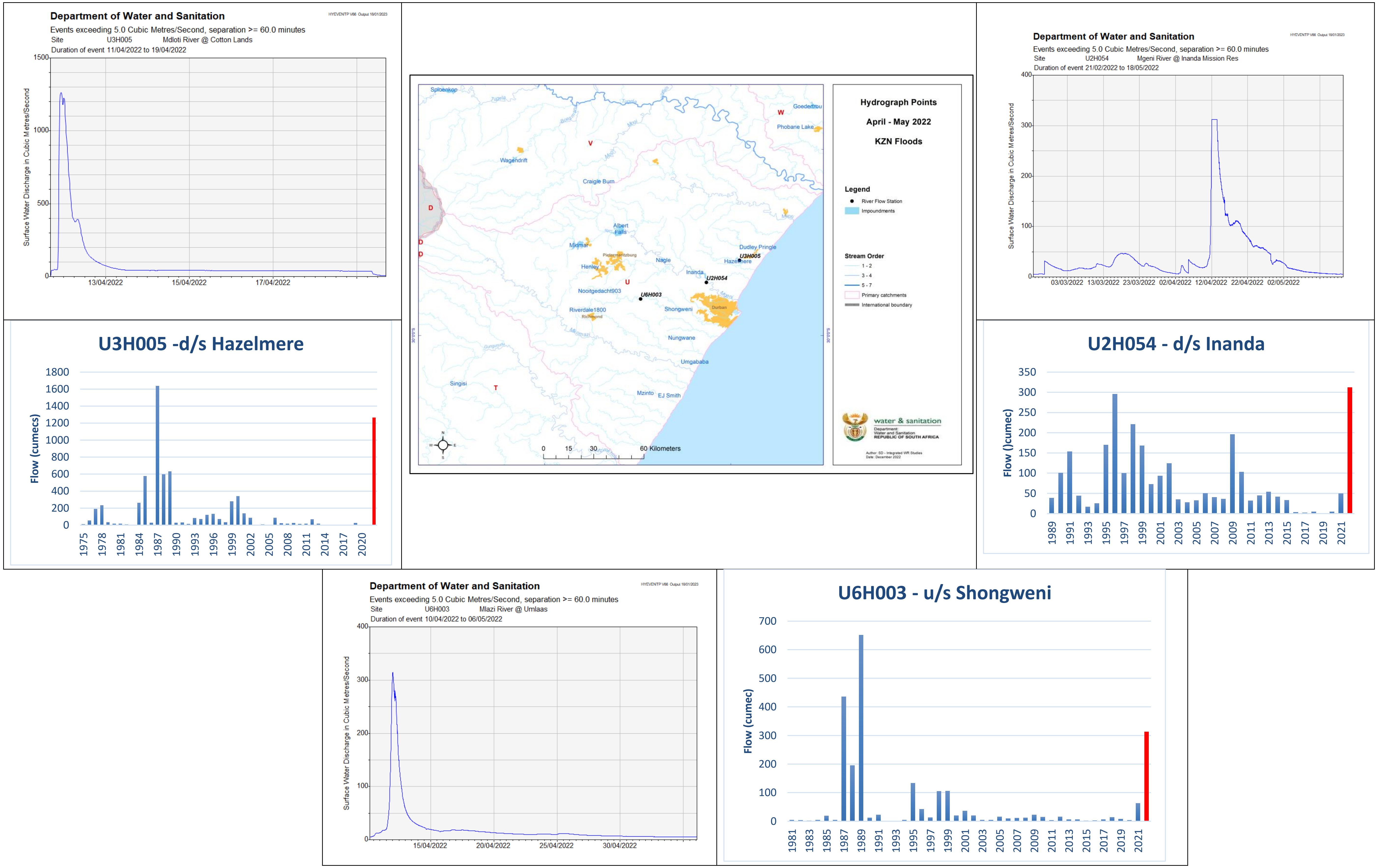


Figure 3.15 Historical flow events and hydrographs

4

STATE OF RIVERS

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 NWRS2 indicated that streamflow monitoring aims to address our national concerns and is also in response to our obligations within international river basins (DWS, 2013).

Approximately 60% of the streamflow in South African rivers is shared through transboundary water systems. Therefore, South Africa must implement Integrated Water Resource Management (IWRM) in a manner that conforms to international water protocols and treaties while being compliant with the legislation governing water resource management in South Africa (DWS, 2013). 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.

South African rivers demonstrate variations in flow regimes or flow sequences, continuously deviating from the historical flows. The flow regime changes are both natural and anthropogenically driven by high variability in rainfall, population increase, 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 Streamflow Anomaly at Strategic Points

The Department has several surface water monitoring points of strategic importance (outlet of catchments, international obligations importance, SDGs reporting). These strategic stations contain long-term data which were used to assess the deviation of streamflow during the current reporting period from the median of the normal period (1980-2010). A streamflow anomaly map displayed in Figure 4.1 shows the deviation of streamflow in the 2021/22 hydrological year from the median (median period of 1981-2010).

The map shows that of the 21 strategic stations displayed, four stations experienced below normal streamflow's, while eight stations were just above normal during the reporting period. One station in the Pongola-Mtavuma WMA V5H002 (Tugela River at

Mandeni) was flagged out as it was much below normal. The historical observed streamflow data revealed that this station was also moderately low in November 2021, and it tends to peak in January to March of each year, with the highest 5-year peak flow of 457 m^3/s observed in January 2017. Moreover, a detailed streamflow anomaly for V5H002 displayed in Figure 4.2 demonstrated that the flow in the station is continuously declining and has been below normal since the 2014/15 hydrological year.

Similarly, two stations in the Orange WMA, D8H014 (Blouputs River) and D7H005 (Orange River at Upington), were extremely above normal during the reporting period, and the observed flow data shows that in November 2021, the flow in these stations was also moderately high. The stream flow in D7H005 was further examined using a streamflow anomaly plot displayed in Figure 4.2, which detailed a variety of flow patterns over time. The plot demonstrated that a similar pattern (above normal flows) had been maintained in the station for the past two hydrological years.

A station of strategic importance, L7H006 (Gamtoos River), located in the Mzimvubu-Tsitsikamma WMA, was below normal, as shown in Figure 4.1, during the reporting period. The station was also examined using a streamflow anomaly plot (Figure 4.2) which demonstrated a continuously declining trend since the 2015/16 hydrological year. The station deviated from the median with **21,9 MCM** and **5,18 MCM** in the hydrological years 2020/21 and 2021/22, respectively. The station's lowest flow observed during the 2021/22 hydrological year was 0.13 m^3/s in May 2022, while the highest observed 5-year peak flow was 3.0 m^3/s (February 2019).

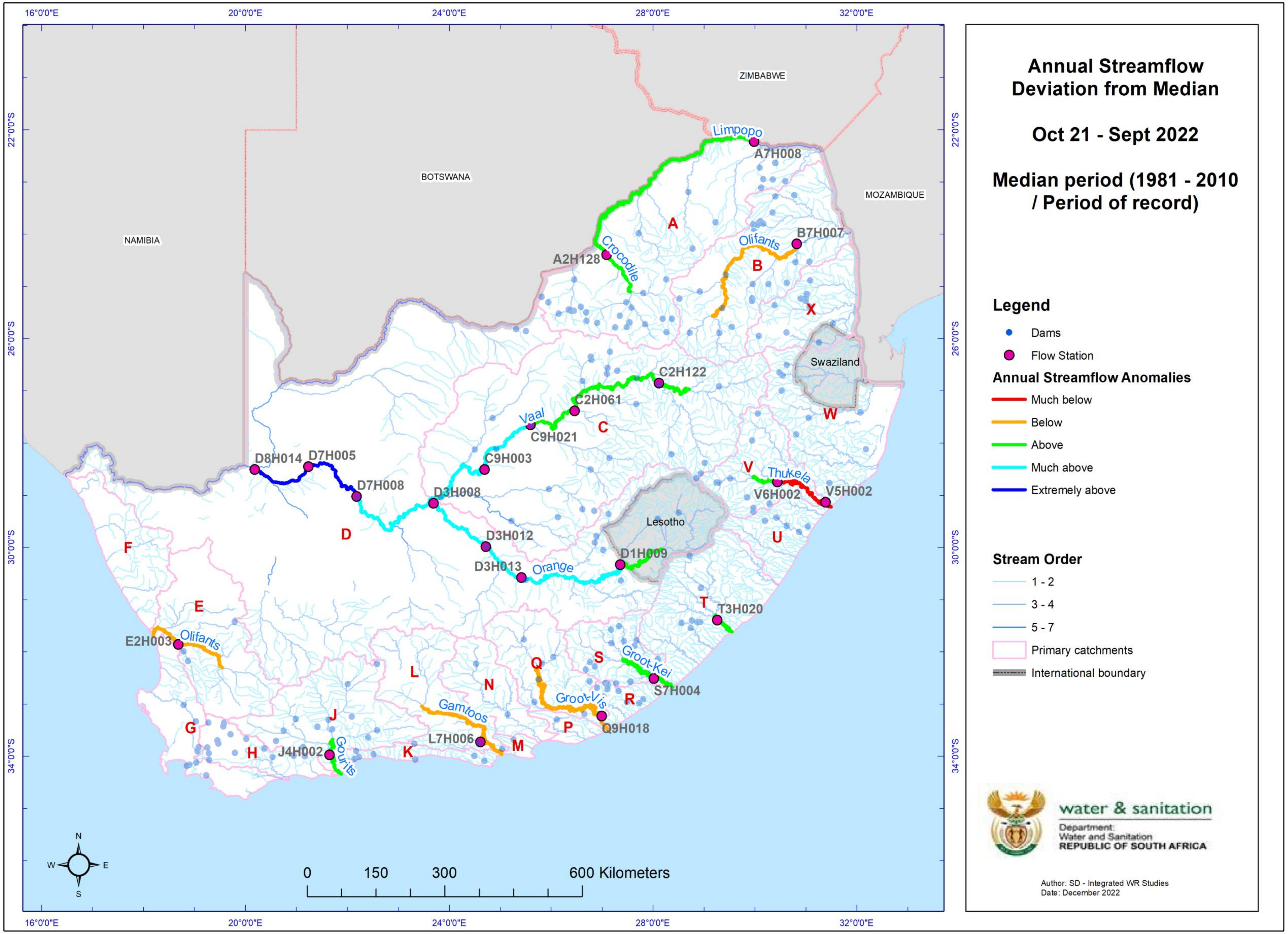


Figure 4.1: Annual Streamflow Anomaly for Strategic River Flow Monitoring Stations as of November 2022.

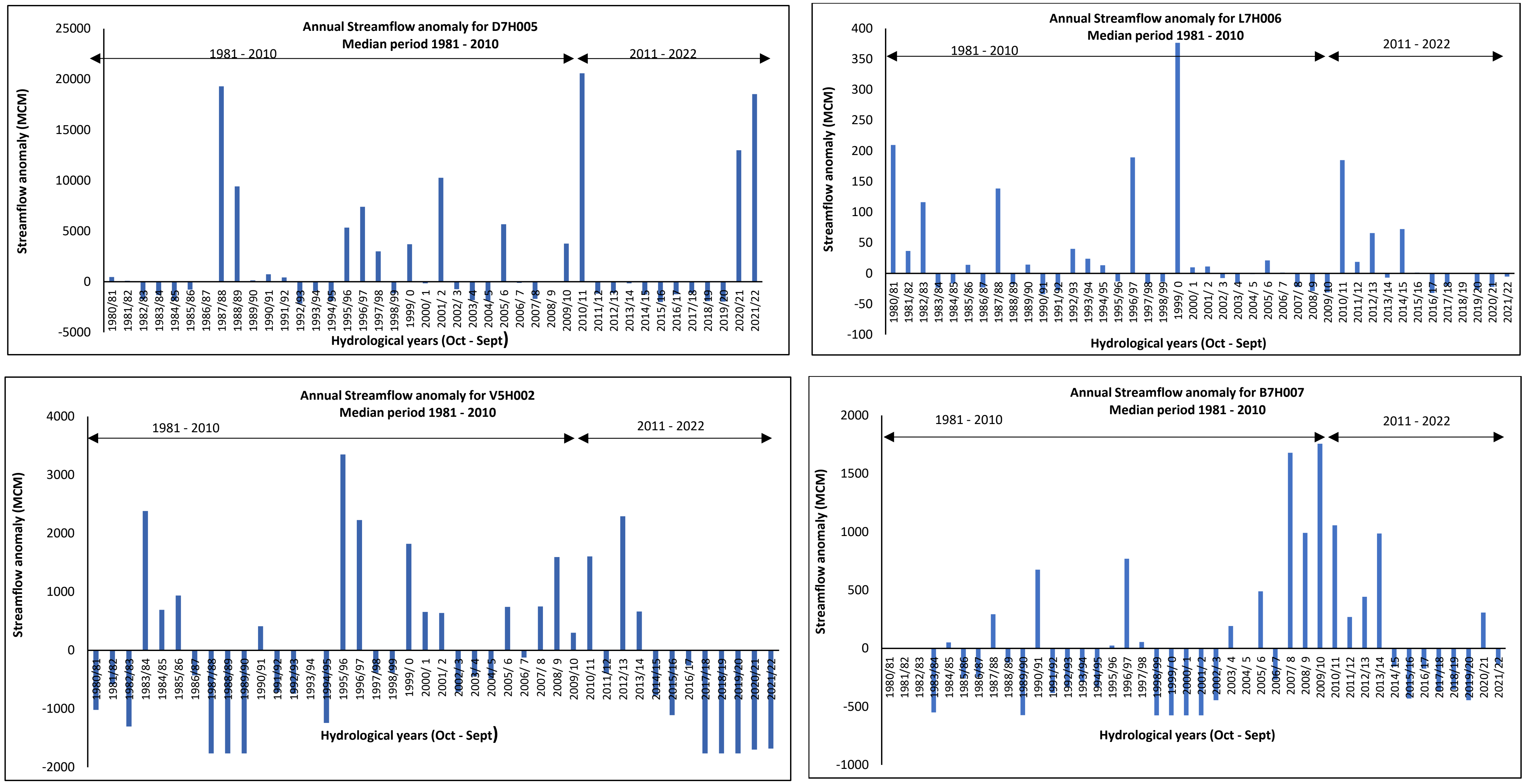


Figure 4.2: Annual streamflow anomaly for some strategic river flow stations using the median period of 1981-2010

Case Study: A focus on the Northern Drakensberg Strategic Water Source Area

Strategic water source areas contribute a disproportionate amount of water relative to their area which makes them crucial for meeting South Africa's water resources needs. However, most of these areas are poorly monitored due to inaccessibility. The South African Environmental Observation Network (SAEON) re-established a dense network of climate, hydrological, biodiversity and carbon monitoring in 2012 in the Cathedral Peak research catchments which form part of the Northern Drakensberg Strategic Water Source Area (SWSA) in the upper uThukela catchment. These catchments were previously monitored from 1949 – 1995. The detailed monitoring in these catchments provide insights into the impacts of global change in this strategic water source area on which there is a heavy dependence on the ecosystem services this landscape provides at national, regional and local scales with the livelihoods of the local population linked to the natural resources and ecosystem integrity.

The landscape includes a vast tract of the protected, near pristine UNESCO World Heritage Ukhahlamba Drakensberg Park which falls under the management of Ezemvelo KZN Wildlife (EKZNW). Further, the complex terrain and high levels of endemism make the landscape sensitive to global change. The high soil carbon stocks and the catchment's substantive contribution to the country's water resources, coupled with trends in land transformation impacting on these ecosystem functions provide a development context of national significance in which to understand global change impacts on ecosystem functioning along a river course from point and plot scale to cumulative downstream impacts.

The long-term annual rainfall records for the hydrological year (October – September) from the catchments are shown as a deviation from the historical mean (1951 – 1980), in Figure 4.3. The rainfall during the 2018/2019 hydrological year was the lowest on record for the catchments, and further the length of the dry period (spanning 8 years) was the longest dry period on record. The annual mean temperature has been greater than the long-term average for the site consistently during the current monitoring period. Although the rainfall for the 2020 and 2021 hydrological years have been wetter than average, the temperatures remain greater meaning a higher evaporation demand.

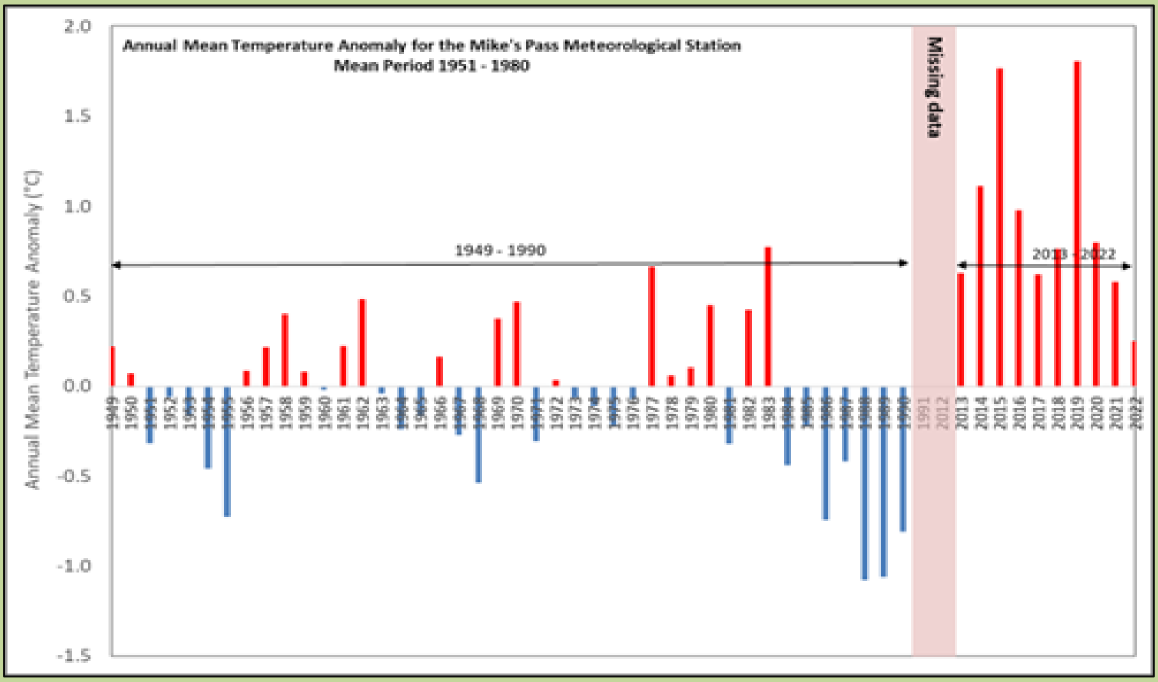


Figure 4.3 Deviations of the (a) annual rainfall and (b) annual mean temperature from the long-term historical means (1951 – 1980

SAEON also investigated the land use and landcover change impacts on water resources in the Cathedral Peak research catchment. The land use and land cover change have significant impacts on the water resources provided by a catchment or area. Any changes in land use or land cover alter the water resources provided by a catchment. The reason for this is that a land use or land cover change alters how the rainfall is partitioned into the different components of the hydrological cycle, such as evaporation, runoff and soil water. With global change, a key concern is how land use and land cover change driven by human impacts such as changes in fire management, CO_2 levels, changes to meet food, fodder and shelter needs will influence the water resources provided by a catchment.

The impacts of land cover change on water resources investigated are the emerging concern of the increase in woody plant species driven by anthropogenic activities. The results demonstrated that the total evaporation from the woody species is significantly higher than the total evaporation from the nearby grassland catchment (Figure 4.4). This implies that the streamflow from the woody encroached catchment is lower than the streamflow from the grassland catchment (Figure 4.5) despite them receiving the same amount of rainfall.

The concern is that should the grasslands in the Northern Drakensberg strategic water source area become encroached with woody species, the water available for downstream communities will be reduced. The decrease in streamflow will affect the immediate local downstream communities but also at a provincial and national scale as this area feeds irrigation schemes in an important agricultural area, supplies water for the uThukela catchment with downstream towns of Richards Bay, and through the Drakensberg pumped storage scheme has national implications.

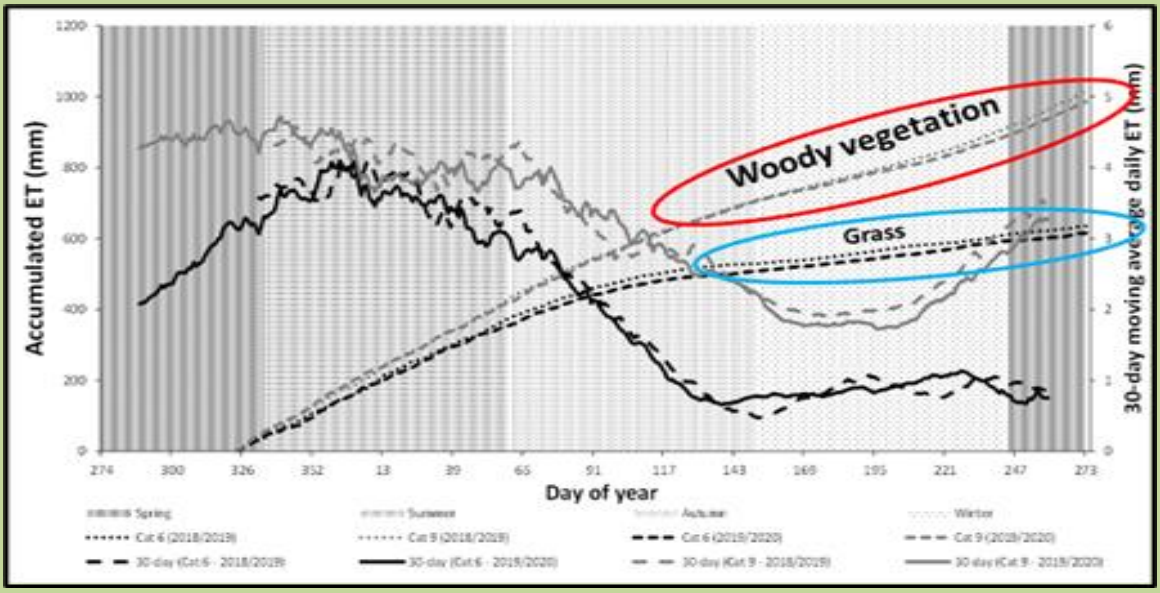


Figure 4.4 Measured total evaporation over a grassland catchment (Catchment 6, black lines) and a woody encroached catchment (Catchment 9, grey lines)

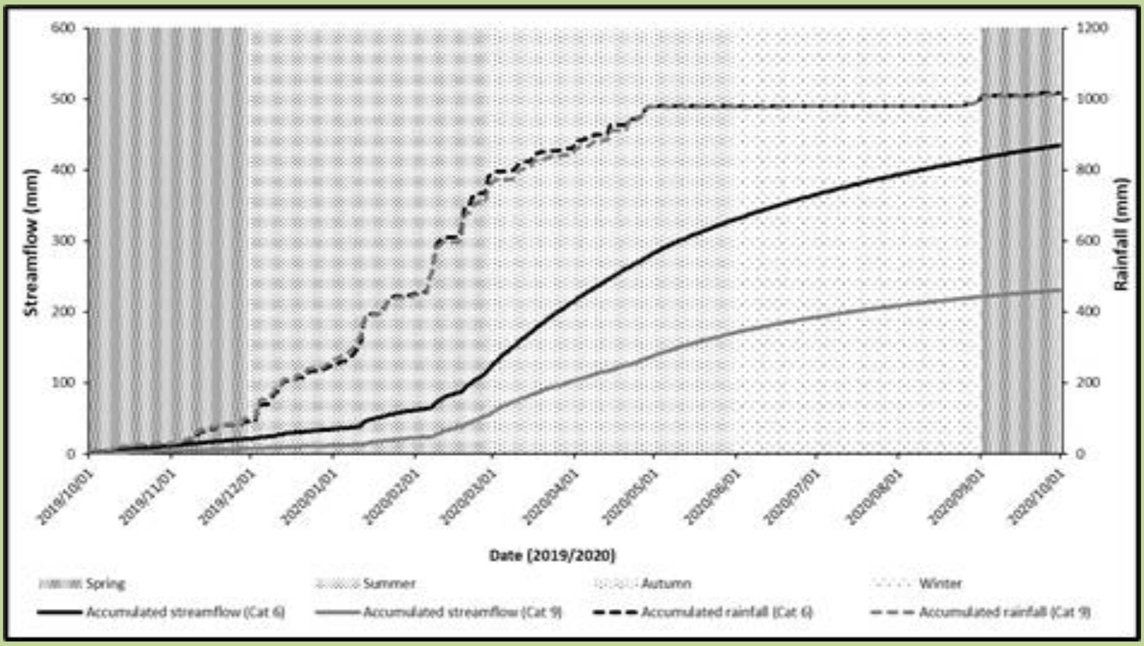


Figure 4.5 Accumulated rainfall (dotted lines) and accumulated streamflow (solid lines) from the grassland catchment (Catchment 6, grey lines) and woody encroached catchment (Catchment 9, black lines) for the hydrological year 2019/2020.

4.3 Surface Water Resource Quality

4.3.1 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, fairly 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

The trophic status and eutrophication potential were calculated for 65 of the 119 sites monitored. The sites with four or more data sets were considered for trophic status and potential eutrophication calculation, as shown in Figure 4.6.

The trophic status calculation demonstrated that fourteen sites were hypertrophic, one eutrophic, nine mesotrophic, and 32 oligotrophic. The other nine sites did not have chlorophyll-*a* data and could not be assigned a trophic status. Eutrophication potential was also calculated (based on total phosphorous (TP) concentration) as serious (26 sites), significant (13 sites), moderate (10 sites), and negligible (14 sites). Two sites did not have TP data.

The hypertrophic sites included the Rietvlei Dam, Hartbeespoort Dam, Roodekopjes Dam, Olifantsnek Dam, Roodeplaat Dam, Bospoort Dam, Klipvoor Dam, Klein-Maricopoort Dam, Lotlamoreng Dam, Modimola Dam, and Florida Lake as shown in Figure 4.6. The Bon Accord Dam was assigned a eutrophic state. The hypertrophic sites and eutrophic sites were characterised by high nutrient levels with serious potential for continued algae and plant productivity. Several sites of concern had significant to seriously high levels of nutrients even though they had mesotrophic to oligotrophic statuses. The trophic status in the sites may change rapidly for the worse should the ideal eutrophication conditions prevail.

In the Eutrophication Management Strategy for South Africa, the challenges of eutrophication are identified as being exacerbated by insufficient wastewater treatment infrastructure maintenance and investment; deteriorating ecological infrastructure; recurrent droughts driven by climatic variation, and an inescapable need for water resource development; inequities in access to safe sanitation, against the backdrop of a growing population; water use regulation that is not consistently and adequately protecting South Africa’s water resources against eutrophication; and a lack of skilled water scientists and engineers. Whilst poor water quality, including eutrophication, is observed to have already significant impacts on economic growth and the well-being of South Africans. This situation, therefore, requires urgent intervention to slow the trend.

The sites characterised by serious eutrophication problems are characterised by catchments hosting densely populated urban developments and poorly functioning sewer networks, and wastewater treatment works.

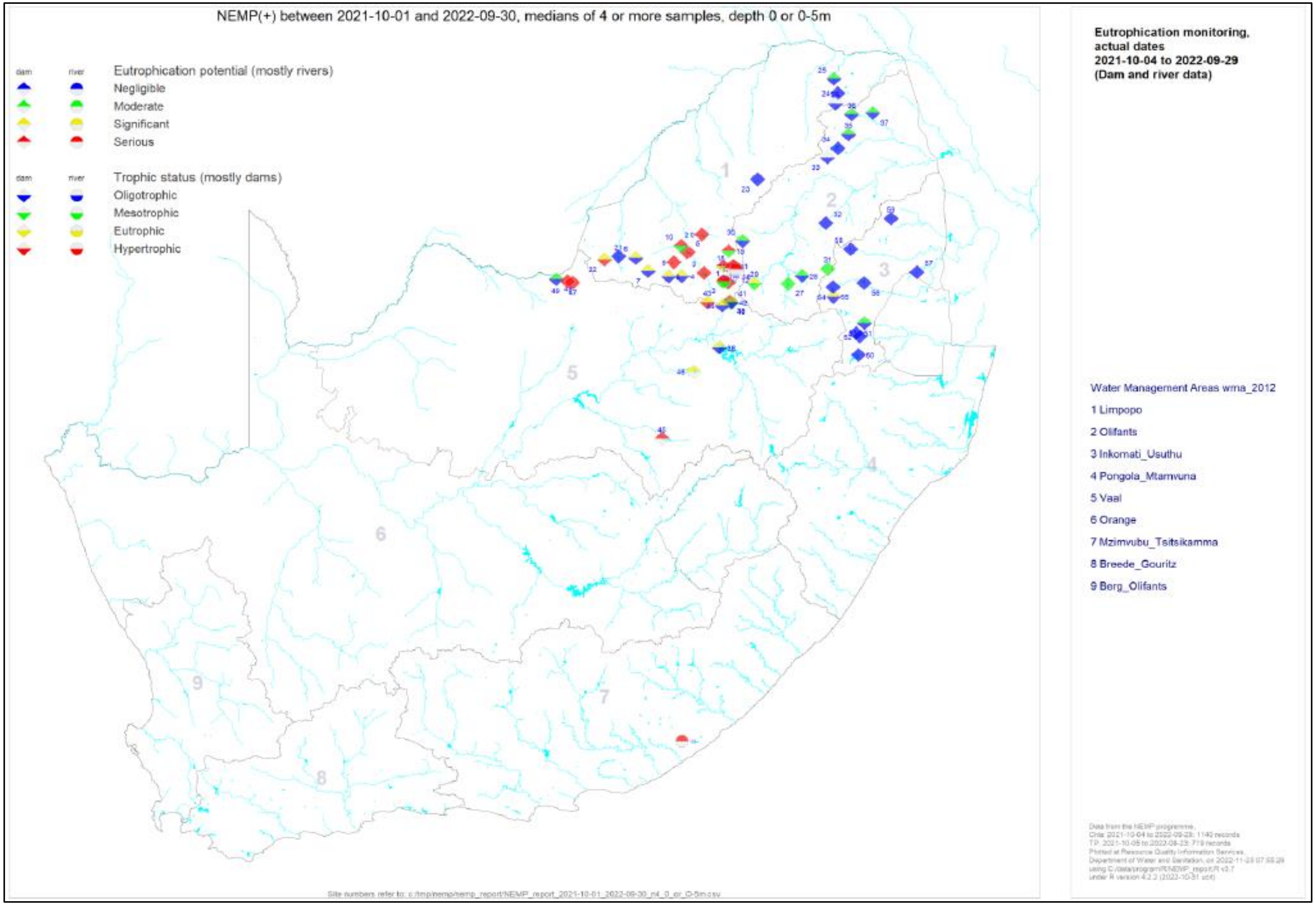


Figure 4.6: Eutrophication monitoring results based on 65 stations that were monitored.

Case Study: Long-term Hartbeespoort Dam versus the Vaal Dam eutrophication data

The graph showing a comparison of the annual chlorophyll-*a* averages of the Hartbeespoort Dam and the Vaal Dam for January 1981 to October 2022 is presented in Figure 4.7. Both dams demonstrated an increasing trend in terms of Chlorophyll-*a* concentration. A significant variation in Chlorophyll-*a* concentrations was noted for the two dams. The Hartbeespoort Dam was hypertrophic for most of the period whilst the Vaal Dam was mostly mesotrophic. A comparison of the nutrient data, particularly total phosphorous and orthophosphate, provided in Figure 4.8 and Figure 4.9 demonstrate that both TP and PO4 were higher at the Hartbeespoort Dam than Vaal Dam, with the high phosphates being the cause for higher biomass at the Hartbeespoort Dam.

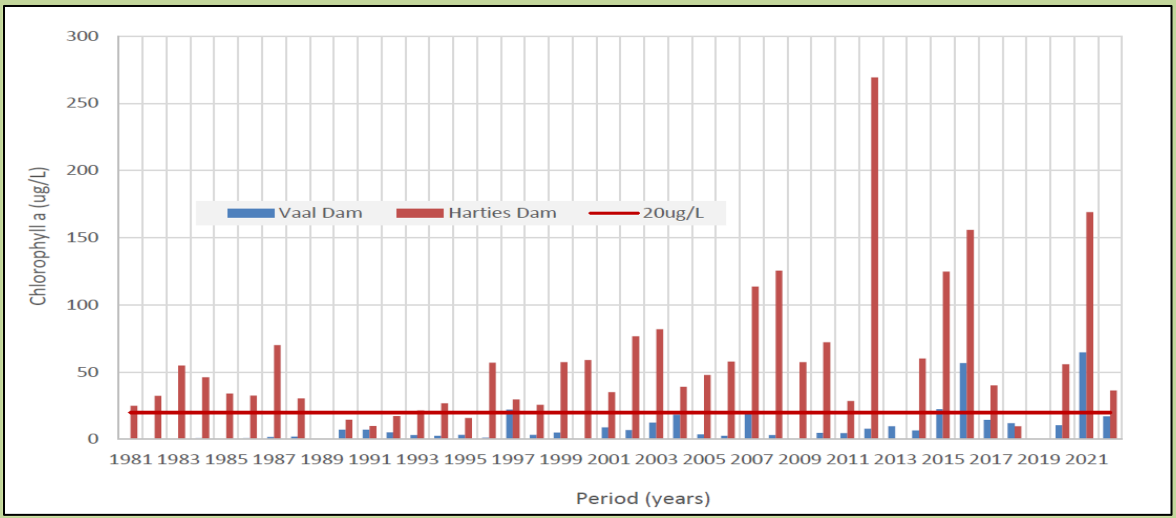


Figure 4.7: Chlorophyll-a data for the Hartbeespoort and Vaal Dams

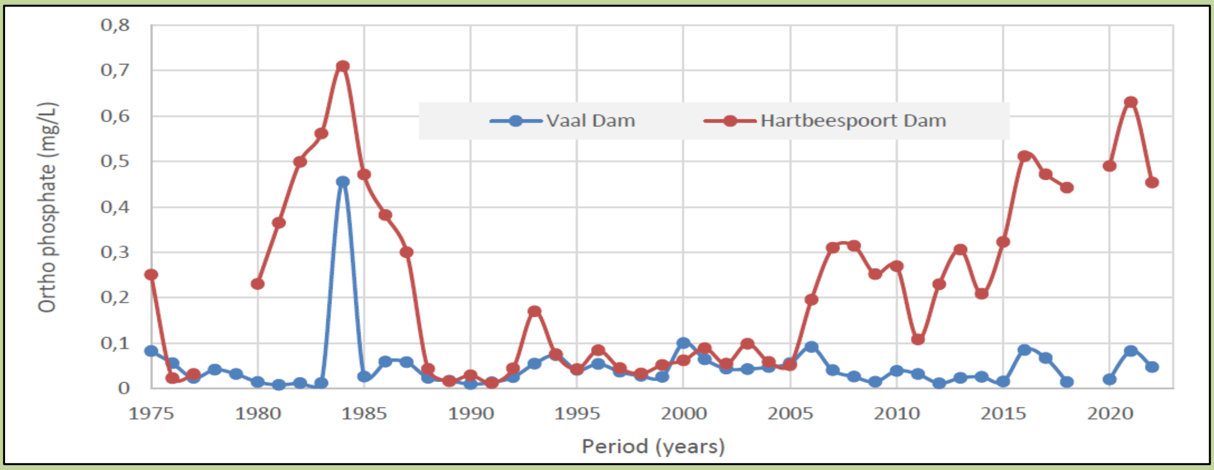


Figure 4.8: PO4 data for the Hartbeespoort and Vaal Dams

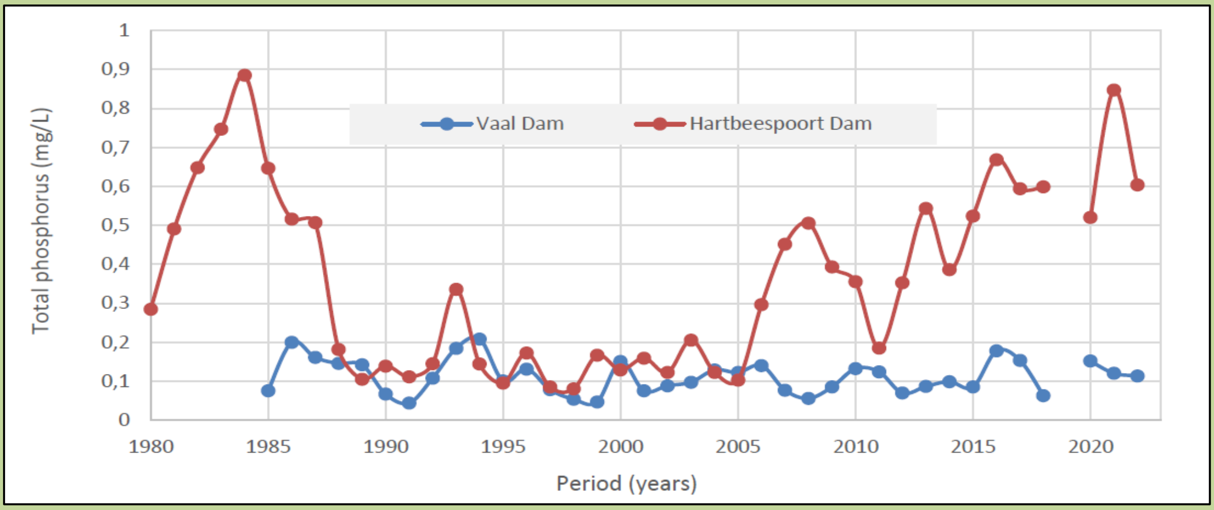


Figure 4.9: TP data for the Hartbeespoort and the Vaal Dams

The TP, PO4, and chlorophyll-*a* data for Hartbeespoort Dam follows an increasing trend for all variables (Notably from 2005 to the present for TP and P04). The chlorophyll-*a* data at the Vaal Dam exceeded the management objective on two occasions, and phosphate data showed variability with time. Chlorophyll -*a* concentrations were high at the Vaal Dam in 2007, 2016, 2017, and 2021. At the Hartbeespoort Dam chlorophyll, *a* was high in all the years except in 1990, 1991, 1992, and 1995. The Hartbeespoort Dam shows an increasing trend for eutrophication, while the Vaal Dam varies over time and does not show a defined trend.

4.3.2 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. Faecal coliform and *E.coli* are measured, and results are compared to the South African Water Quality Guidelines shown in Table 4-3.

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

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

Surface water resources are usually not suitable for domestic activities such as drinking without any sort of treatment, and this is evident in the data represented in Figure 4.10. The microbiological results indicate that all the collected samples had high microbial contamination and the water from that source was not suitable for drinking. This would pose a high risk of infections to human health if water was consumed directly from the source. However, treating the water at the household level can reduce the potential health risk in some cases where water is not severely polluted with faecal contamination.

There was a low risk of infection if water was consumed after limited treatment in 42% of the sampled sites. More than half (53%) of the sampled sites presented a high health risk if water from the source was used for irrigating crops that were eaten raw and only 42% indicated a low risk. Full-contact recreational activities such as swimming, washing laundry, and activities such as baptisms should be discouraged in these water resources that are highly polluted. The results also revealed that 64% of the sampled sites were unsuitable for recreational activities and using these sites for such activities would be associated with a high risk of infections.

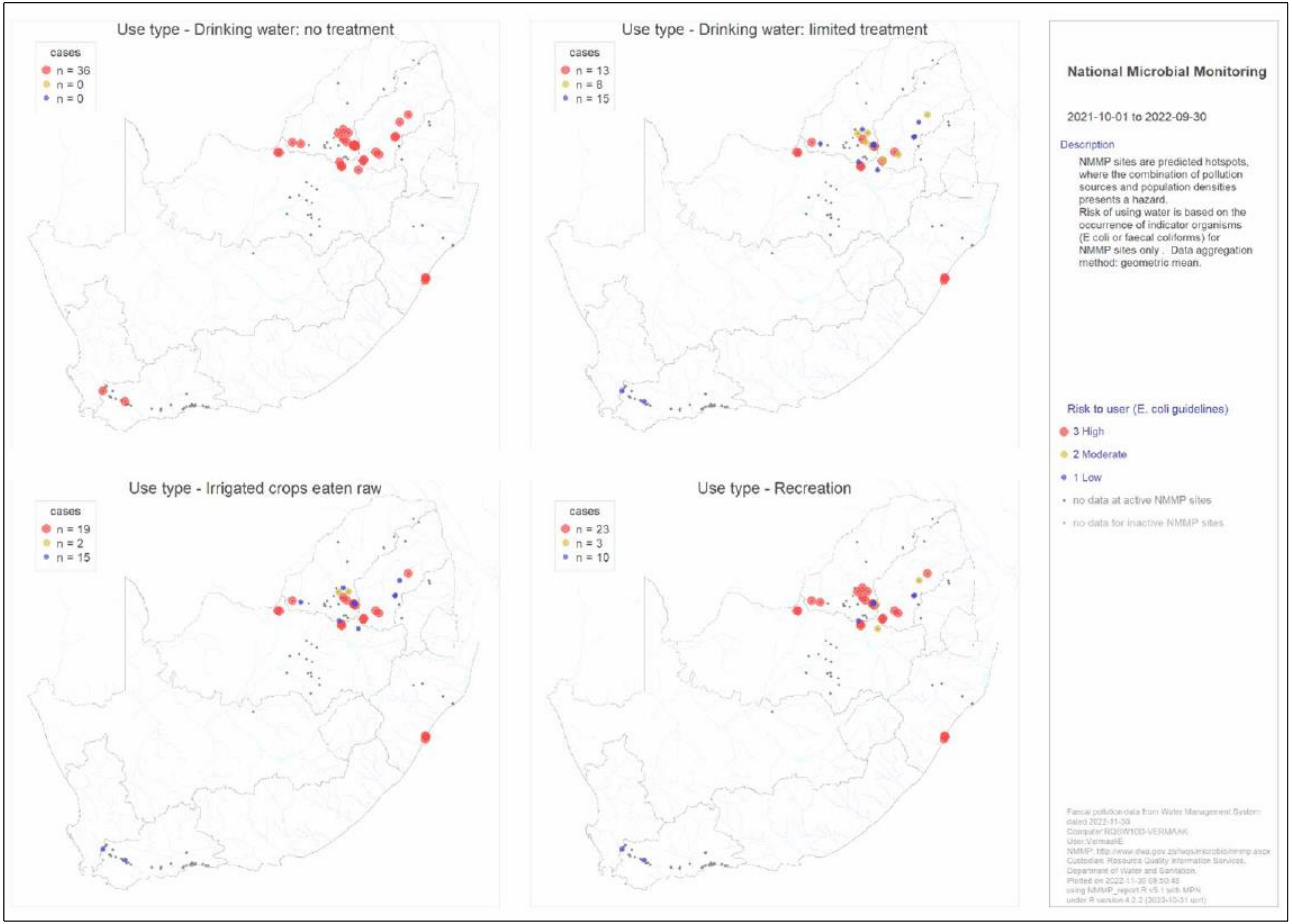


Figure 4.10: representation of Faecal pollution data (October 2021 - September 2022)

4.3.3 Chemical Pollution

The main inorganic water quality issues of concern on a country-wide basis include elevated salinity, the perception of failing wastewater treatment works in some municipalities, and acid mine drainage. However, high salinity may also be the result of natural processes due to the geological formations in the catchment and the dissolution of rocks and is also influenced by surface water and groundwater that also contains salts. These levels can also be elevated due to urban and agricultural run-off, domestic wastewater effluents, and mining or industrial effluent discharges.

The National Chemical Monitoring Programme (NCMP) provides data for interpretation into information on the inorganic chemical quality of the country's surface water. Since the NCMP is a national-scale programme, issues that are known and experienced at a local (fine-scale) level may not be reflected at the sites selected to show the overall situation in South Africa. This finer scale is beyond the scope of a national programme and needs to be reported on in catchment and situation-specific assessments, that is, at regional and site-specific water quality management levels. The location of the programme's sampling sites is depicted in Figure 4.11.

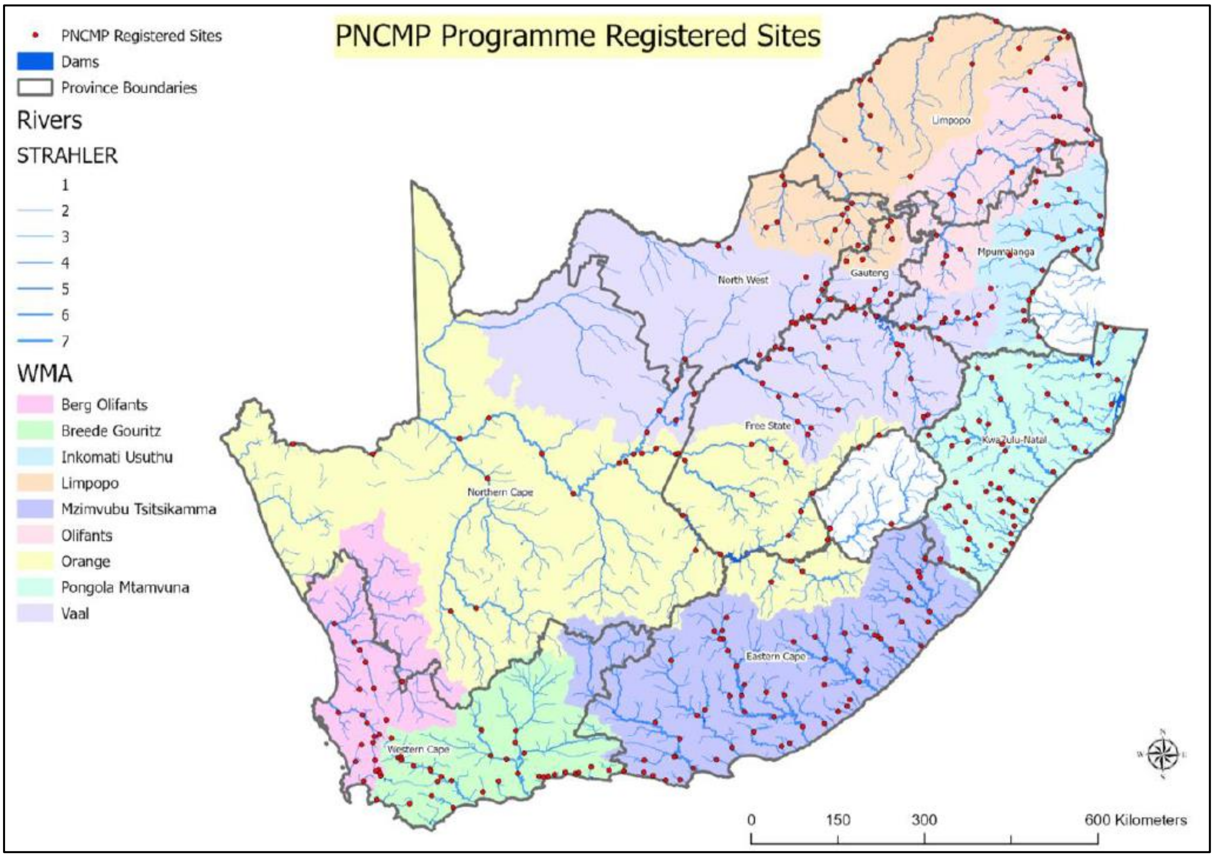


Figure 4.11: The location of priority NCMP sampling sites is situated across South Africa.

Due to various constraints, the water quality picture able to be represented is currently lacking in many areas of the country. Figure 4.12 represents the chemical water quality condition of **2017-2018** as the most recent period for which there was adequate data to provide a water quality depiction of the situation across South Africa. To show any water quality fitness-for-use on the presented map, a less stringent requirement of data points per site for the entire year had to be implemented in the assessment, as mentioned above.

- *Salinity*

The salinity level of water resources is calculated as Total Dissolved Solids (TDS, also termed Dissolved Major Salts or DMS) or is measured as electrical conductivity (EC) and is also gauged from the concentrations of individual ions such as sodium, chloride, and magnesium, potassium and sulfate, amongst others. Elevated salinity may be the result of natural processes due to the geological structure of the catchment and the dissolution of rocks. It is also influenced by surface water and groundwater, which also contains salts. The levels of these can, however, also be elevated due to urban and agricultural run-off, domestic wastewater effluents, mining (*i.e.* sulfate ions from acid mine drainage) or industrial effluent discharges, and others.

Increased salinity affects the taste and perceived *freshness* of water. When salt levels are high and the water is used for domestic purposes, such as drinking, it can lead to serious health risks in infants under the age of one year (Blue Baby Syndrome); individuals with heart or kidney disease who have been put on a salt-restricted diet; and those with chronic diarrhoea. Excessively high levels of salts in water can also affect water infrastructure by corroding water distribution pipes leading to increased maintenance and replacement costs.

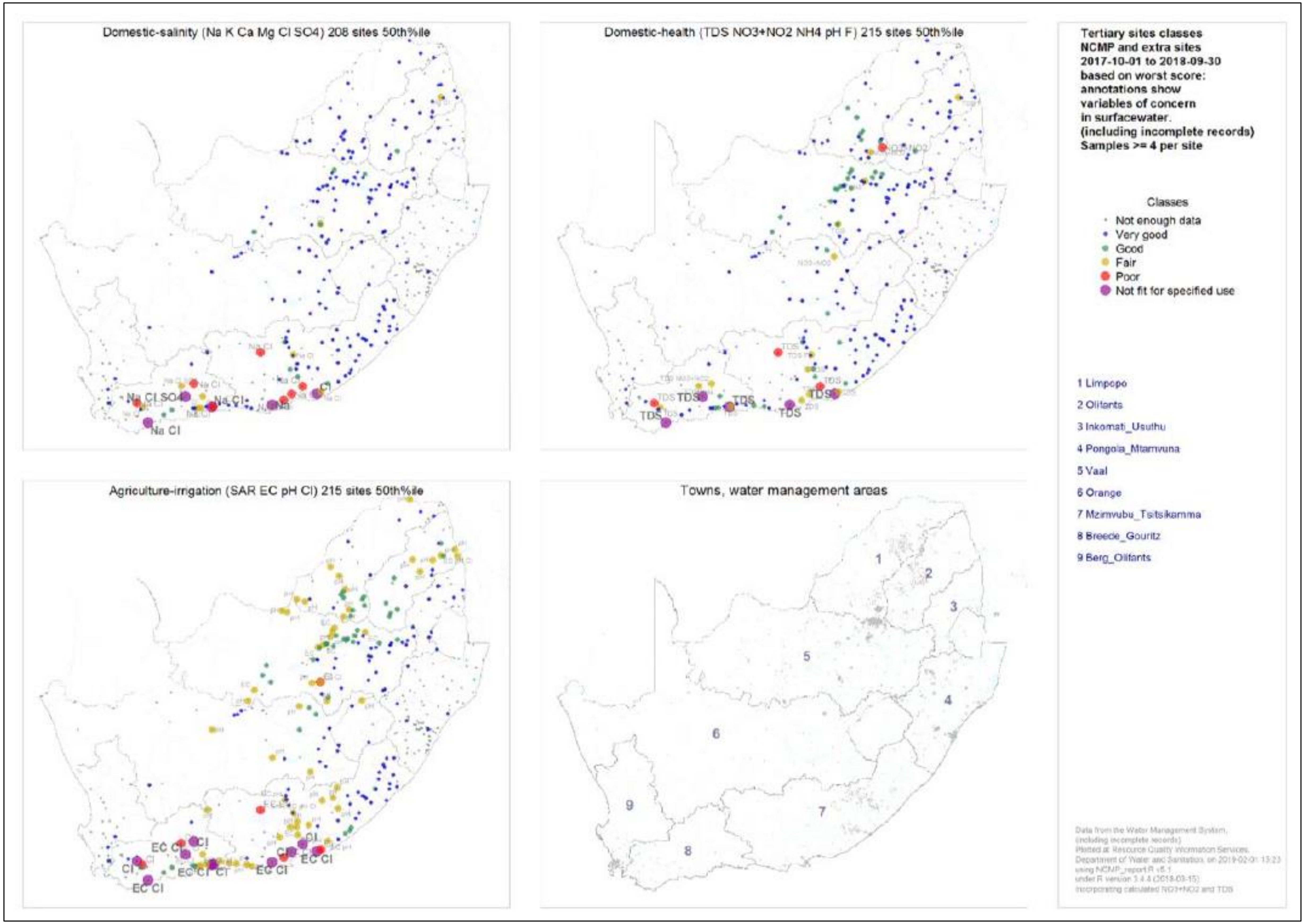


Figure 4.12: The inorganic chemical water quality situation in South Africa during the 2017/2018 period is an example that is still likely to be broadly true of the current situation for conservative water quality attributes.

Figure 4.12 reflects the situation evident in 2017-2018, high salinity levels are concentrated around the Southern and Western Cape regions of the country due most likely to marine geology, with a limited occurrence of elevated chloride in the Vaal WMA. There was an isolated pocket of elevated magnesium, chloride, and fluoride in the Olifants Water Management Area (WMA) in the Ga-Selati River at Google-Foskor (at a Fair level for Domestic Use), and elevated sulphate levels at selected sites within the Breede-Gouritz WMA.

For irrigated agricultural use, high levels of salts (chloride, EC, and the irrigation suitability indicator, the Sodium Adsorption Ratio –SAR) in water can have an impact on sensitive crops resulting in reduced crop yields and hence negatively affect profitability. The result clearly showed poor to non-acceptable levels of variables impacting irrigated agricultural use in the Southern and Western Cape. There were many instances of elevated EC throughout the Vaal River WMA and Lower Olifants River WMA, where EC and chloride were seen to be within the Fair range. Throughout the rest of the country, there were also incidences of pH levels that were not ideal for irrigated agriculture. In practical terms, though, the real-life situation may not be as severe as the water quality guidelines would suggest, and this is due to the abruptness of the transition between the Very Good and the Not Very Good water quality ranges that is not realistic. There should be a more gradual transition for it to be meaningful and realistic.

- *Potential Problems with Wastewater Treatment Works*

Elevated ammonium (NH_4^+) and nitrate-nitrite (NO_3+NO_2) levels could be indicative of poorly achieving wastewater treatment works (WWTW), or direct discharge of untreated or minimally treated human or animal waste or agricultural return flows entering the water resource. Two sites within the upper Crocodile-Marico WMA had elevated nitrate-nitrite levels, as well as a site in the Upper, reaches of the Orange River WMA and a site in the Breede-Gouritz WMA. A site in the Upper reaches of the Vaal River WMA had ammonium (NH_4^+) elevated into the Fair range for domestic use purposes. Instances of poorly functioning or non-functional WWTW have been reported in the media, including the contamination of the Vaal River in the vicinity of Parys. This affects all classes of water use and has significant negative impacts. Ammonium was also elevated in a site in the Breede-Gouritz WMA.

- *Acid Mine Drainage Hotspots and mitigation strategies*

Acid Mine Drainage (AMD) is a consequence of mining activities and is not unique to South Africa. In the past, it was common practice to abandon mines without implementing adequate pollution control measures after mineral extraction was no longer financially viable. There was little concern for the environment since mine closures before the promulgation of the Water Act of 1956 were not subject to legislative closure requirements. The possible risks of AMD include contamination of shallow groundwater and surface water if mines decant contaminated water. This can affect the suitability of the water resources required for domestic, agricultural, and other uses. Sulphate in combination with low pH (acidic) conditions, can be an indicator of Acid Mine Drainage (AMD).

In 2002 the South African government realised the extent of the negative impact that mine effluent has on the environment and the threat that it poses to our natural resources such as water, especially with concerns about mines in the Western, Central, and Eastern Basins largely within the Vaal River catchment. There are also initiatives in the KwaZulu-Natal Province to rehabilitate numerous coal mine discard dumps and defunct or ownerless opencast coal mine sites in the Klip River coalfields. The aim is to mitigate the impacts of post-coal mining activities and improve water quality in the affected catchments.

AMD occurs when abandoned mines are exposed to water, especially due to inundation by groundwater that then fills up the voids left by mining operations and liberates sulphate and metals from the exposed rock into the water. Suppose the water levels rise and reach the surface. In that case, the polluted water can be decant into the surface water resources, reducing the pH levels of the receiving water and contaminating it with high levels of sulphate and metals. This can represent a risk to downstream users and can impact very negatively on the environment.

On a national scale, reduced pH levels are not necessarily seen to coincide with those areas (the Breede-Gouritz WMA) indicated in Figure 4.12 that have elevated sulphate (SO4) levels. A finer scale and more rigorous sampling can reveal a different picture. The isolated elevated salinity (as depicted by chloride) levels within the Vaal River may be partially due to AMD, together with irrigation return flows and the effects of discharge from urban areas. It must be borne in mind that due to the limited number of samples in many cases across the country, water quality problems are revealed due to data limitations.

4.3.4 Sampling for SDG Reporting

The need to provide data to service national and international commitments, such as for SDG (Sustainable Development Goals) reporting where monitoring had come to a halt, has resulted in a major effort to rejuvenate sample collection. The potential sites to represent GEMS/SDG sampling shown in Figure 4.13 were flagged for consideration by the respective programme coordinators. They were then workshopped to arrive at the desired list to report on inorganic water quality in South Africa at an international level. The samplers of those sites were communicated with to attempt to obtain assurance that those samples at least would be collected on no less than a quarterly basis and maintained frozen or chilled. A programme for the GEMS/SDG sampling has been registered on the WMS, and it has been consolidated. Sampling materials are being couriered to samplers.

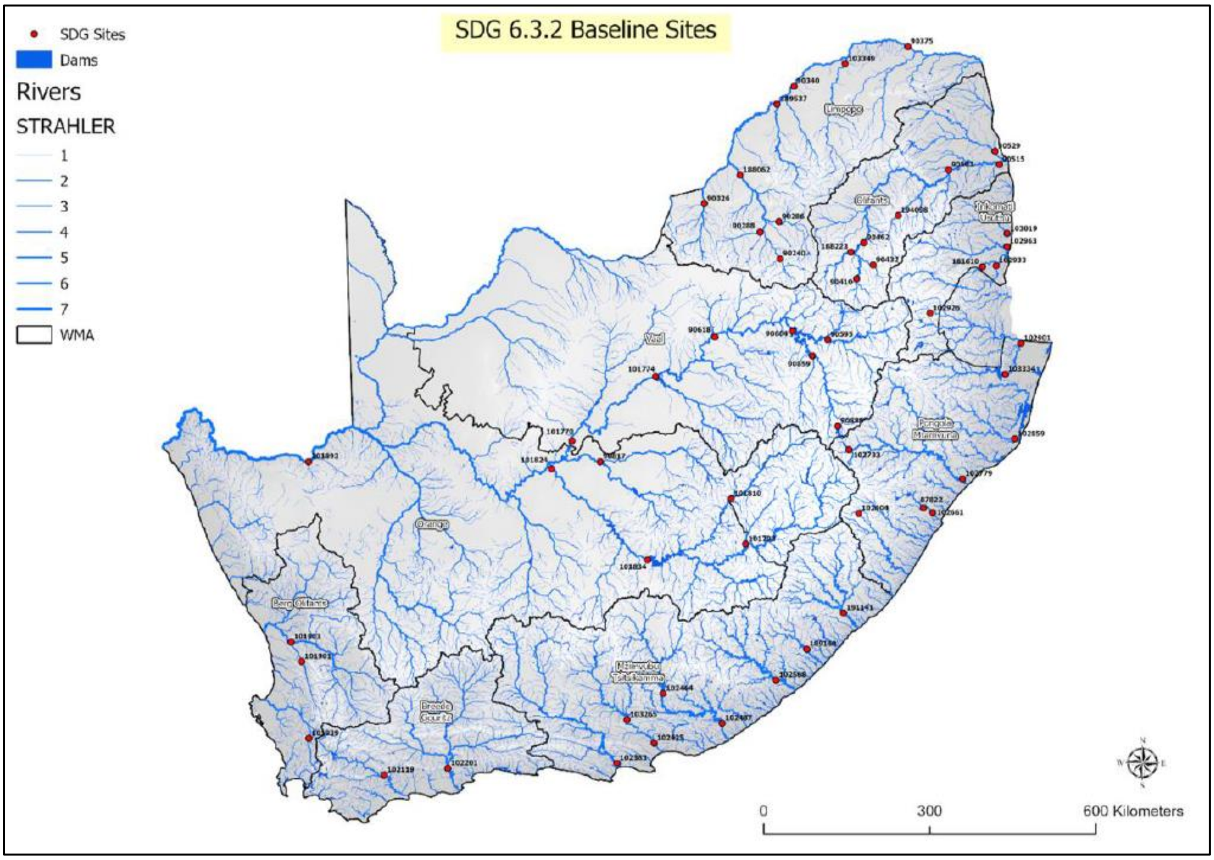


Figure 4.13: The distribution of GEMS/SDG sites – also referred to as the SDG 6.3.2 Baseline Sites - across South Africa. The number accompanying each site is its WMS reference number.

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.

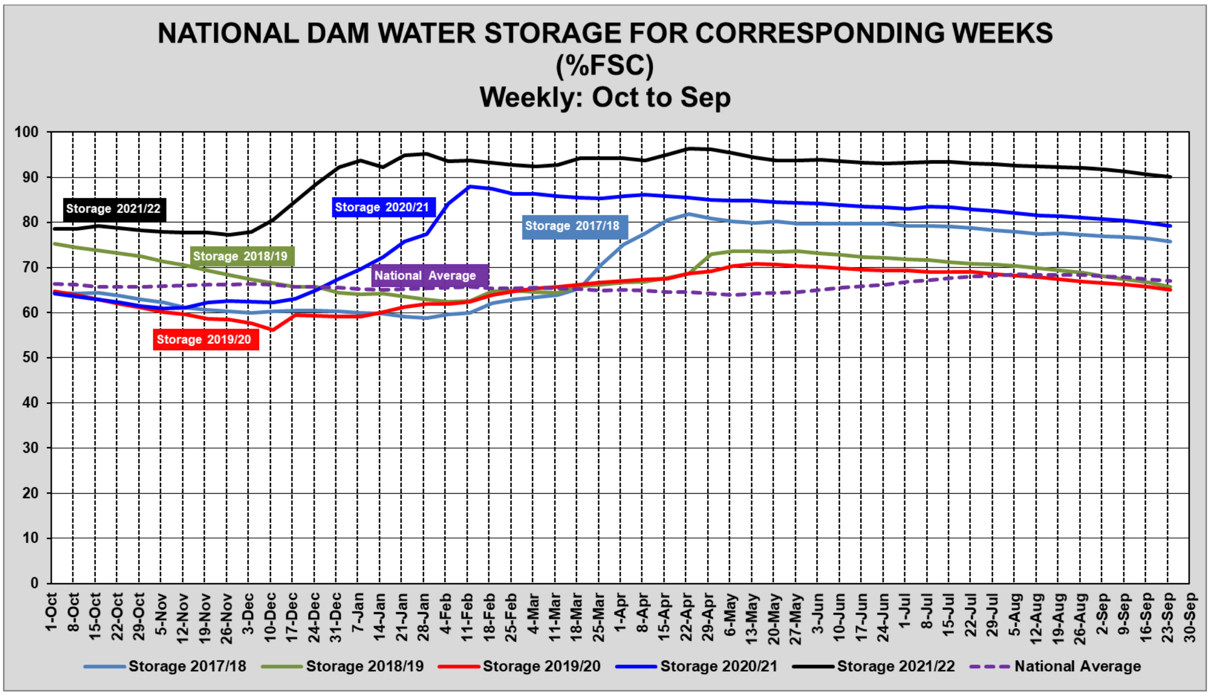


Figure 5.1 National Dam storage levels for the past five years compared to a national average

The national dam storage levels for the past two hydrological years - 2020/21 and 2021/22, have been the highest for most of the months in the past five hydrological years. This is true, especially after the beginning of summer rainfalls received between December and April 2022 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 2022), approximately **4%** of the dams were at critical storage levels, **11%** were at risk, and over **85%** were either spilling or at optimal storage levels.

Table 5-1 Surface storage at the end of September 2022

PROVINCES/COUNTRIES SHARING WATER RESOURCES WITH RSA	FSC MILLION M³	TOTAL	NUMBER OF DAMS PER PROVINCE/COUNTRY			
			<10%	>=10% <50%	>=50% <100%	>=100
Kingdom of Eswatini	334	1			1	
Eastern Cape	1729	46	2	7	21	16
Free State	15657	21		1	20	
Gauteng	128	5			2	3
KwaZulu-Natal	4910	19		1	15	3
Kingdom of Lesotho	2363	2			2	
Limpopo	1480	28	1	2	16	9
Mpumalanga	2539	22		2	20	
Northern Cape	146	5		1	2	2
North West	867	28		6	15	7
Western Cape - Other Rainfall	269	22	4	3	12	3
Western Cape - Winter Rainfall	1597	22	1	2	15	4
Western Cape - Total	1866	44	5	5	27	7
Grand Total:	**32019**	**221**	**8**	**25**	**141**	**47**

Most of the dams that were at critical storage conditions at the end of the reporting period were in the Eastern Cape, Limpopo, and Western Cape – all-year rainfall region/winter rainfall region. 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, Limpopo, North West, and Western Cape.

Table 5-2 Dams below 10% of FSC September 2022

Reservoir	**River**	**Province/Country**	**2022/09/26 (% FSC)**
Middel-Letaba Dam	Middel-Letaba River	Limpopo	0.7
Nuwejaars Dam	Nuwejaarspruit River	Eastern Cape	3.6
Poortjieskloof Dam	Groot River	Western Cape - Winter Rainfall	9
Bellair Dam	Brak River	Western Cape - Other Rainfall	4.2
Oukloof Dam	Cordiers River	Western Cape - Other Rainfall	4.7
Nqweba Dam	Sondags River	Eastern Cape	5.5
Hartebeestkuil Dam	Hartenbos River	Western Cape - Other Rainfall	6
Kammanassie Dam	Kammanassie River	Western Cape - Other Rainfall	5

The spatial layout of dam storage levels in four storage level categories depicted with colour codes integrated with the SPI is presented in (Figure 5.2). In contrast, the presentation of dam storage levels in relation to the key water supply systems is presented in (Figure 5.3).

Areas experiencing moderate to severe drought are still prevalent in the Sekhukhune District in Limpopo, West Coast District, Sarah Baartman, Central Karoo, and the Garden Route District in the Western Cape. This is further confirmed by dams at critical dam levels (<10% of FSC) within these districts. An expectation is the Middle Letaba Dam which is on the boundary of Vhembe and Mopani District, although with no drought mapped out from the SPI, the land use changes, and water use activities within the catchment of the Middle-Letaba Dam are likely the cause of reduced streamflow and affecting the water resource yield at this dam over the years. The river catchment of the Middle-Letaba Dam requires further assessments.

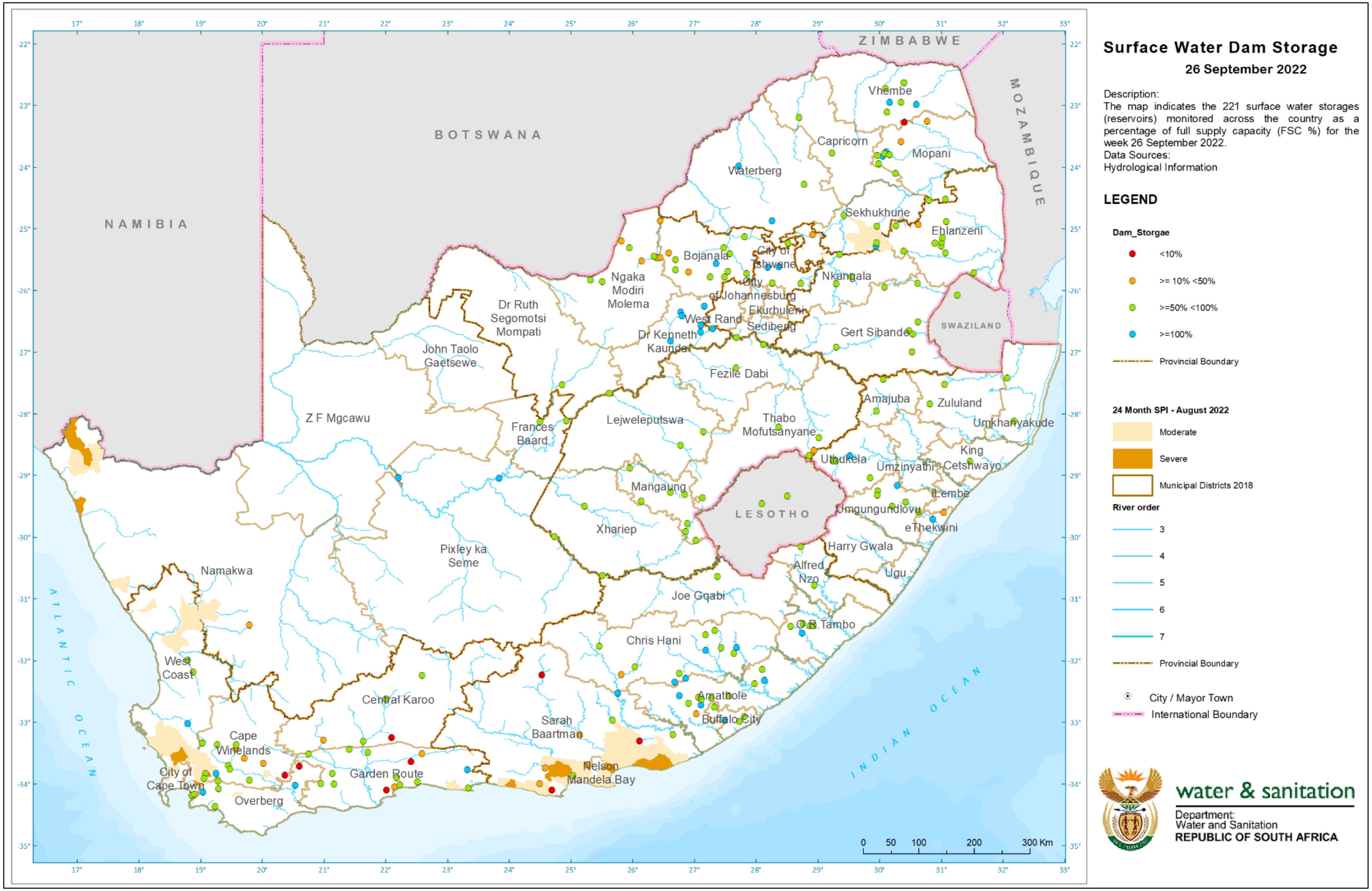


Figure 5.2 Dam Storage Levels at the end of September 2022

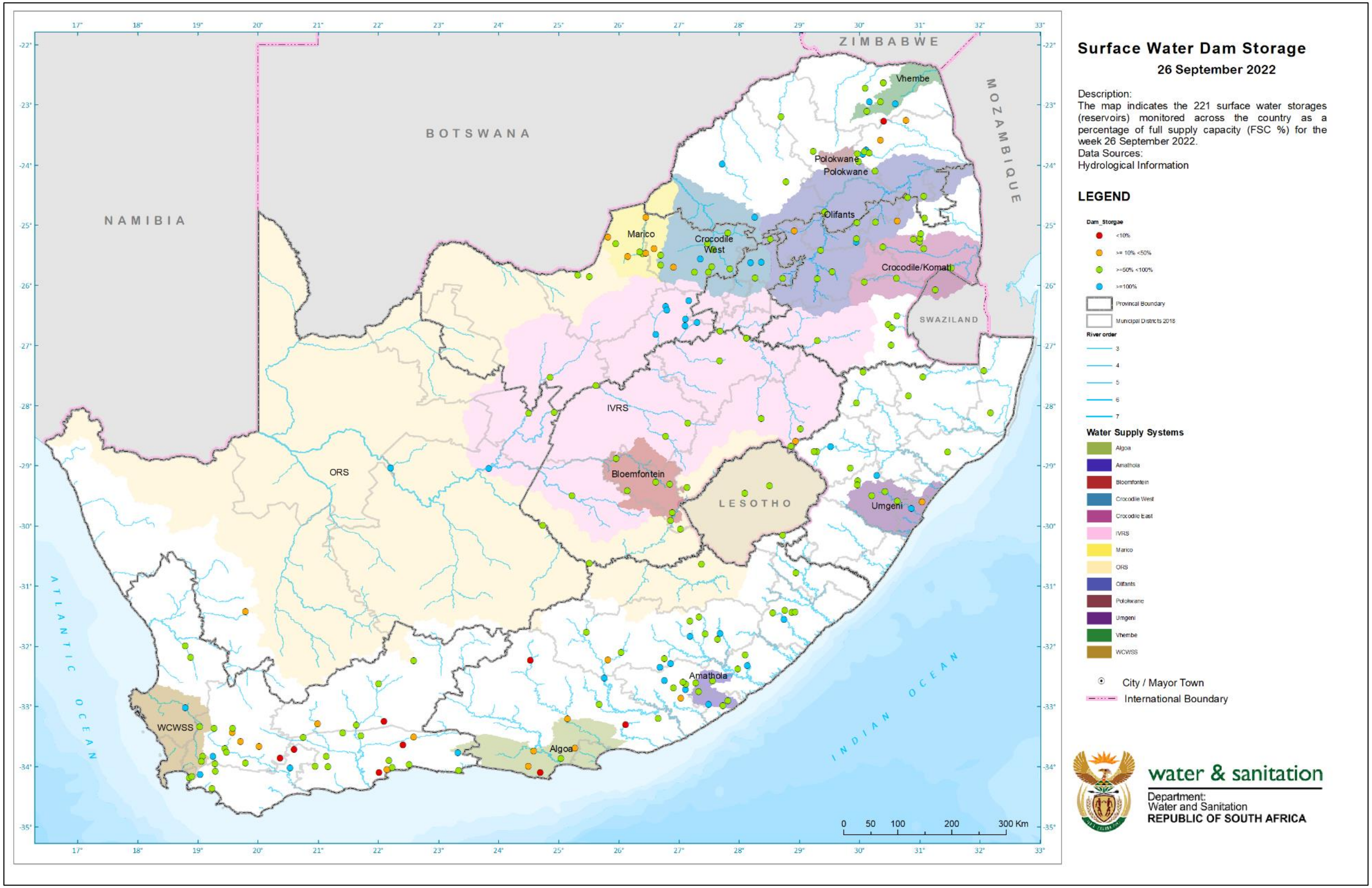


Figure 5.3 Water Supply System and dam storage – end September 2022

The Storage comparison for 2020/21 & 2021/22 of the ten largest dams, as of the end of September 2022, versus their full supply capacities is presented in Figure 5.4. Most of these large dams had storage levels higher than last year at the same time of reporting, apart from Sterkfontein Dam (Reservoir to augment water levels in the Vaal Dam), Bloemhof Dam, and Theewaterskloof Dam. The most significant improvement in storage levels from last year was for the Gariep, Pongolapoort, and Mohale Dams.

5.2 Provincial Storage

The long-term median storage (1978 – 2022) for each Province compared to the last two hydrological years is presented in Figure 5.5. For the hydrological year 2021/22, 50% of the time, the dam levels for all Provinces were above the long-term median storage levels. An increase or recovery to above the long-term median from last year is notable for the Eastern Cape and KwaZulu-Natal Provinces.

5.3 Water Management area storage

The comparison of the long-term historical median storage levels (2016-2022) of water management areas and the past two hydrological years' median storage is presented in Figure 5.6.

The 2021/22 storages have been above the historical median for all water management areas. A similar pattern is observed for the past year (2020/21) for all WMAs except for the Mzimvubu-Tsitsikamma WMA.

Notably, all median storages for the 2021/22 hydrological year are higher than the past year for all WMAs, apart from the Berg Olifants and Breede Gourits WMAs. However, the dam storage levels in these two WMAs remained higher than the long-term median dam levels.

5.4 District Municipality Storage

The water storage level comparison for the end of HY 2020/21 and 2021/22 for District Municipalities is presented in Figure 5.7. The central Karoo DM, Amathole DM, and Buffalo City DM have experienced a significant increase compared to last year. In contrast, the Cape Winelands DM, West Coast DM, Lejweleputswa DM, Overberg DM, OR Tambo DM, Mopani DM, and Ngaka Modiri Molema DM have experienced the worst decline in dam levels compared to last year.

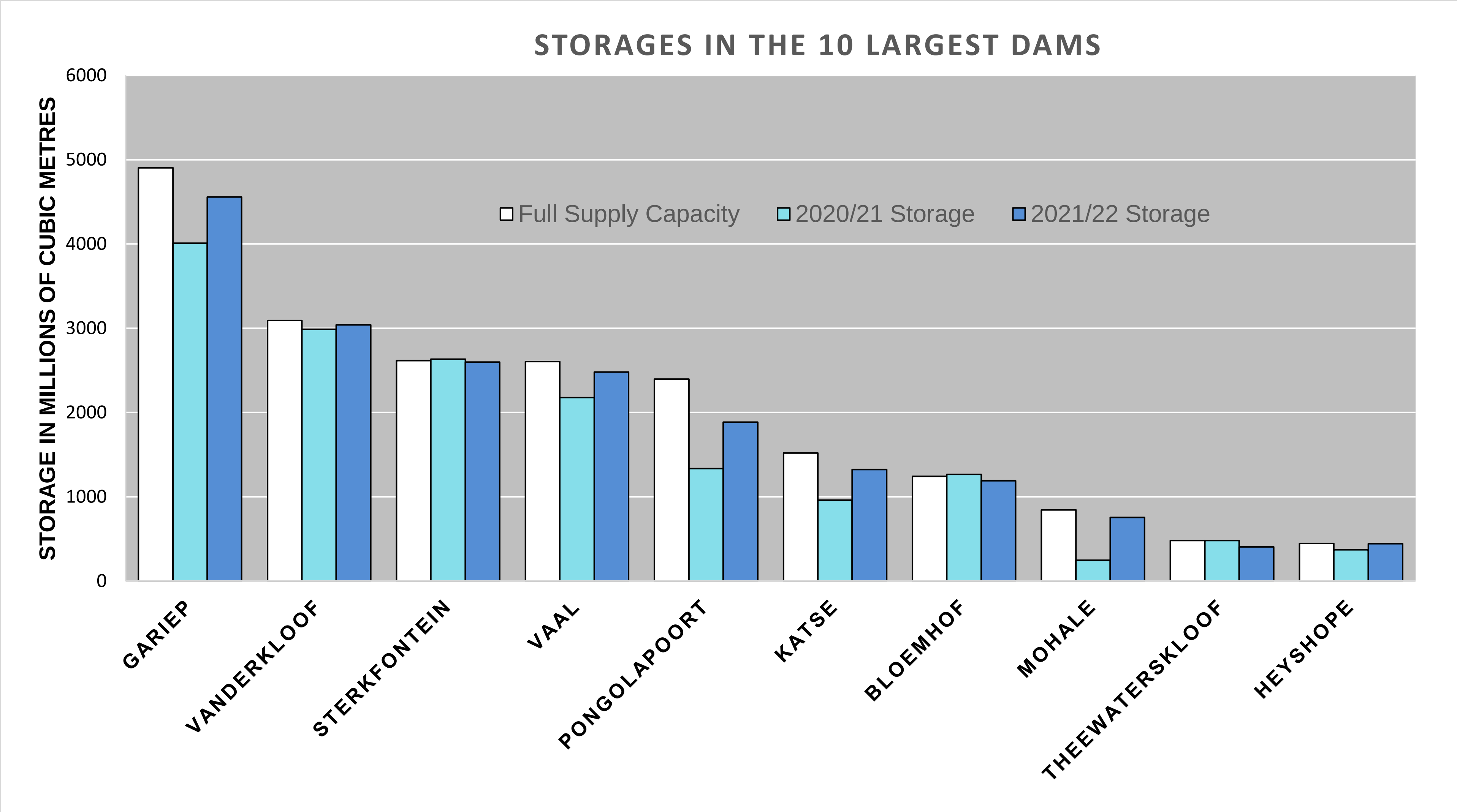


Figure 5.4 Storage volume comparison 2020/21 & 2021/22 of the ten largest dams, as at the end of September

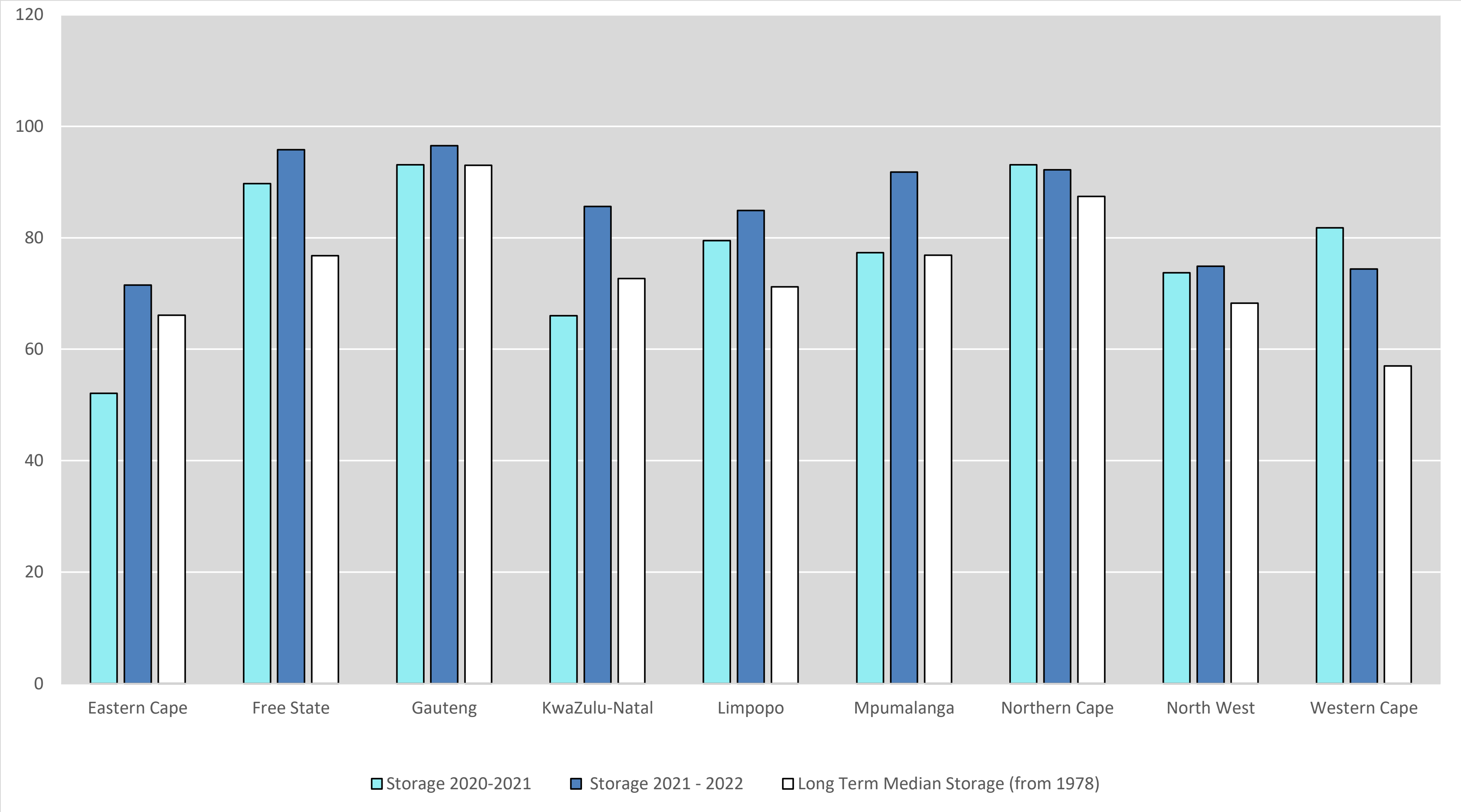


Figure 5.5 The storage situation in each Province during 2021-2022, compared with the previous hydrological year and the media

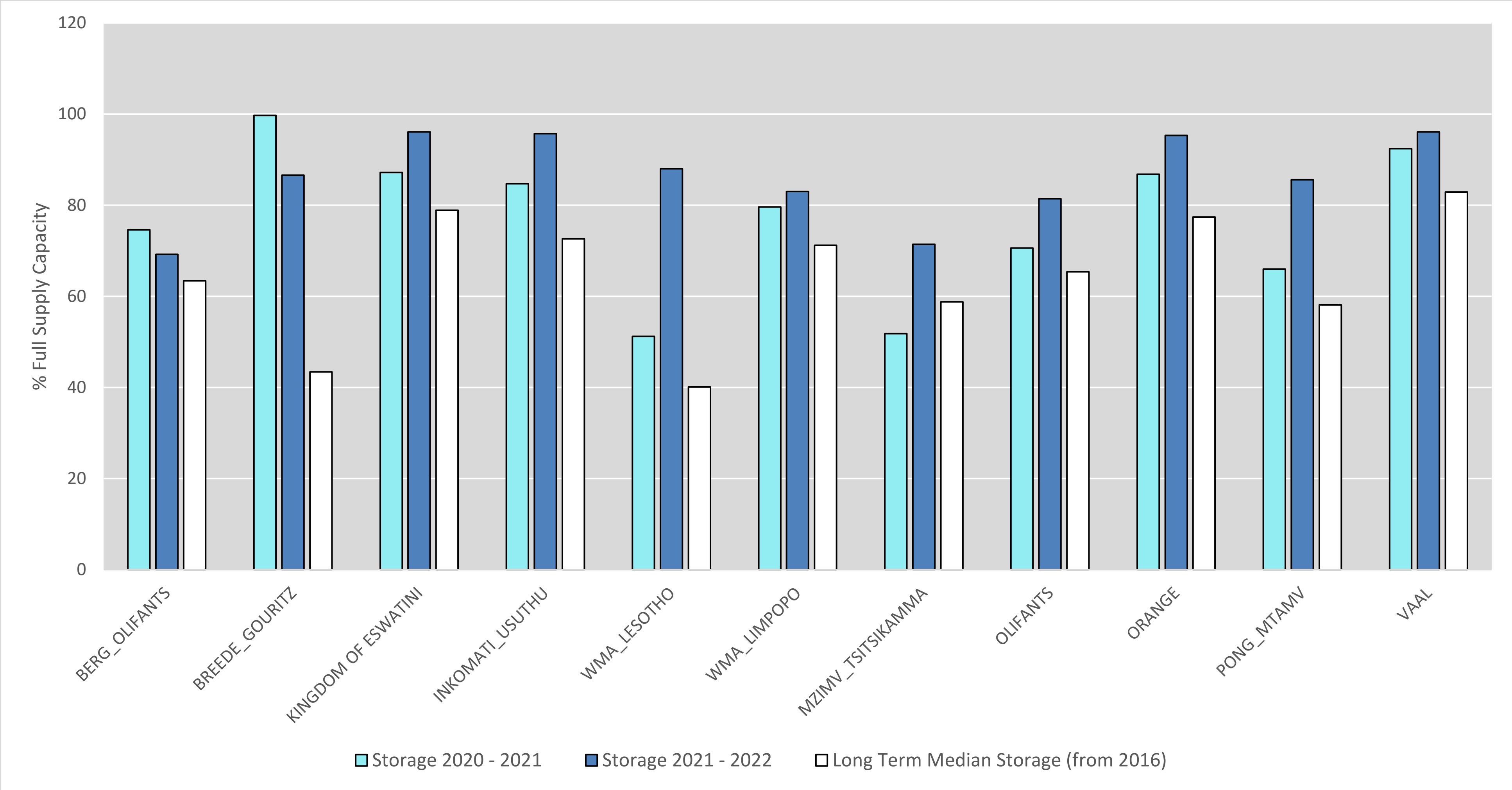


Figure 5.6 The storage situation in each WMA during 2021-2022, compared with the previous hydrological year and the median

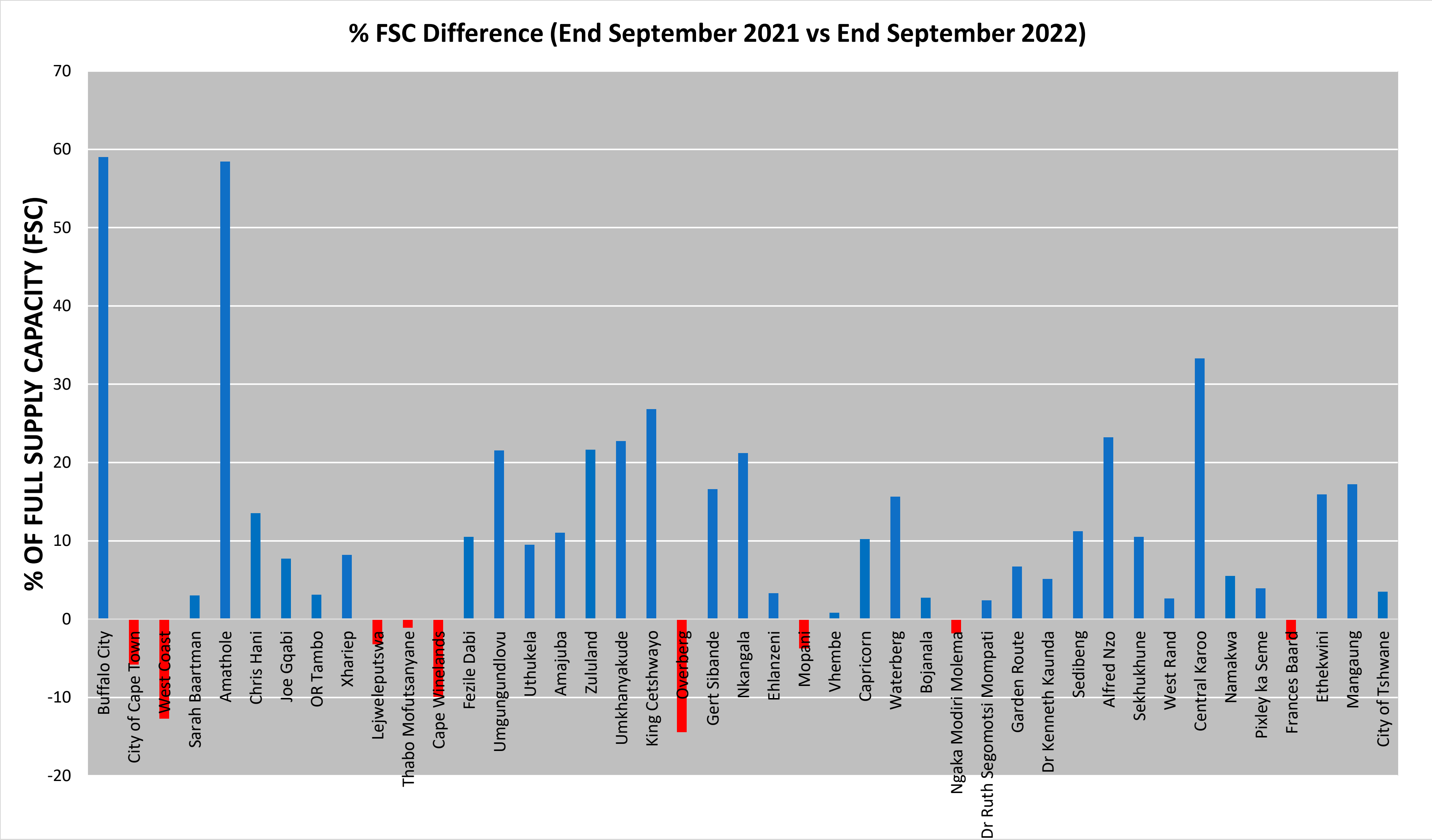


Figure 5.7 Difference in Water Storage Levels per District Municipality September 2021 vs September 2022

5.5 Water Supply Systems and restrictions

The Dam storage levels in water supply systems (WSSs) at the end of the HY 2020/21 and 2021/22 and the applicable restrictions are given in Table 5-3. A recovery or an increase in dam levels in water supply systems is observed for all water supply systems from last year at the same time of reporting. This is true except for the Cape Town WSS, which has experienced a decline from the previous year by **15%** of FSC.

Areas experiencing moderate to severe drought are still prevalent in the Sekhukhune District in Limpopo, West Coast District, Sarah Baartman, and Central Karoo, and the Garden Route District in the Western Cape.

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 standalone dams or dams within a water supply system 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 Water supply systems (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 reasonably well since the February/March flooding events. Due to infrastructure limitations, permanent restrictions are still applicable for the Polokwane in Limpopo and Bloemfontein systems in the Free State Province.

Table 5-3 Water restrictions applicable at end of September 2021

Water Supply Systems/clusters	Cap in 10^6m^3 (% FSC)	27 September 2021 (% FSC)	26 September 2022 (% FSC)	Comments (systems below 50% in red)
Algoa System	282	12.1	19.1	System of 5 dams for Nelson Mandela Bay Metro, Sarah Baartman (SB) DM, Kouga LM and Gamtoos Irrigation: 40% domestic & industrial restrictions (no compliance), 85% irrigation restrictions (Good compliance by Gamtoos IB); Varying levels of restrictions were also recommended for groundwater abstractions – restrictions are generally accepted by water users and gazetted in the Government Gazette Notice no. 1626 on December 17 2021
Amatole System	241	26.2	84.2	System of 6 dams for Bisho & Buffalo City, East London: No restrictions, the system recovered reasonably well since the February/March flooding event. Notice yet to be gazetted.
Klipplaat System	57	22.4	100.4	System of 3 dams for Queenstown (Chris Hani DM, Enoch Ngijima LM): 10% for domestic and 50% for irrigation use. Restrictions were gazetted on December 17 2021

Water Supply Systems/clusters	Cap in 10^6m^3 (% FSC)	27 September 2021 (% FSC)	26 September 2022 (% FSC)	Comments (systems below 50% in red)
Butterworth System	14	6.9	100	Xilinxa Dam and Gcuwa weirs for Butterworth: Domestic restrictions of 20% still in place (Covid and community frustration occurring, further interventions like augmenting river flows from upstream Dams)
Integrated Vaal River System	10 546	81.8	94.5	System of 14 dams serving Gauteng, Sasol, and ESKOM: No restrictions, and the system recovered reasonably well since the February/March flooding event
Polokwane	254	82.5	97.3	System of 7 dams serving Polokwane and surroundings: 20% restrictions on Domestic and Industries
Crocodile West	444	89.7	91.4	6 dams for Tshwane up to Rustenburg: No restrictions
Luvuvhu	225	98.7	100.3	System of 3 dams for Thohoyandou etc: No restrictions
Umgeni System	923	74.5	95.2	System of 5 dams serving Ethekwini, iLembe & Msunduzi: No restrictions
Cape Town System	889	100.1	85.4	System of 6 dams for the City of Cape Town:

Water Supply Systems/clusters	Cap in $10^6 m^3$ (% FSC)	27 September 2021 (% FSC)	26 September 2022 (% FSC)	Comments (systems below 50% in red)
				No restrictions
Bloemfontein	219	74	95.6	System of 3 dams serving Bloemfontein, Botshabelo and Thaba Nchu: A 15% restriction has been recommended on Domestic and Industrial water supply when the system drops below 95%, notice yet to be gazetted.
Crocodile East	159	88.4	93.4	Kwena Dam supplies Nelspruit, Kanyamazane, Matsulu, Malelane and Komatipoort areas & Surroundings: No Restrictions
Orange	7 996	87.7	95	Two dams serving parts of the Freestate, Northern and Eastern Cape Provinces: No restrictions
uMhlathuze	301	71	97.8	Goedertrouw Dam supplies Richards Bay, Empangeni Towns, small towns, surrounding rural areas, industries and irrigators, supported by lakes and transfer from Thukela River: No restrictions

5

GROUNDWATER

6 GROUNDWATER

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 using water from dams and piped surface water to supply the 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.

Groundwater systems are dynamic and adjust continually to short-term and long-term changes in climate, groundwater withdrawal, and land use. Water level and quality measurements from observation wells are the principal sources of information about the hydrologic stresses acting on aquifers and how these stresses affect groundwater recharge, storage, and discharge. Monitoring information makes it possible for unseen groundwater resources to be seen so that it is sustainably managed. This chapter will look at the groundwater status for the hydrological year 2022.

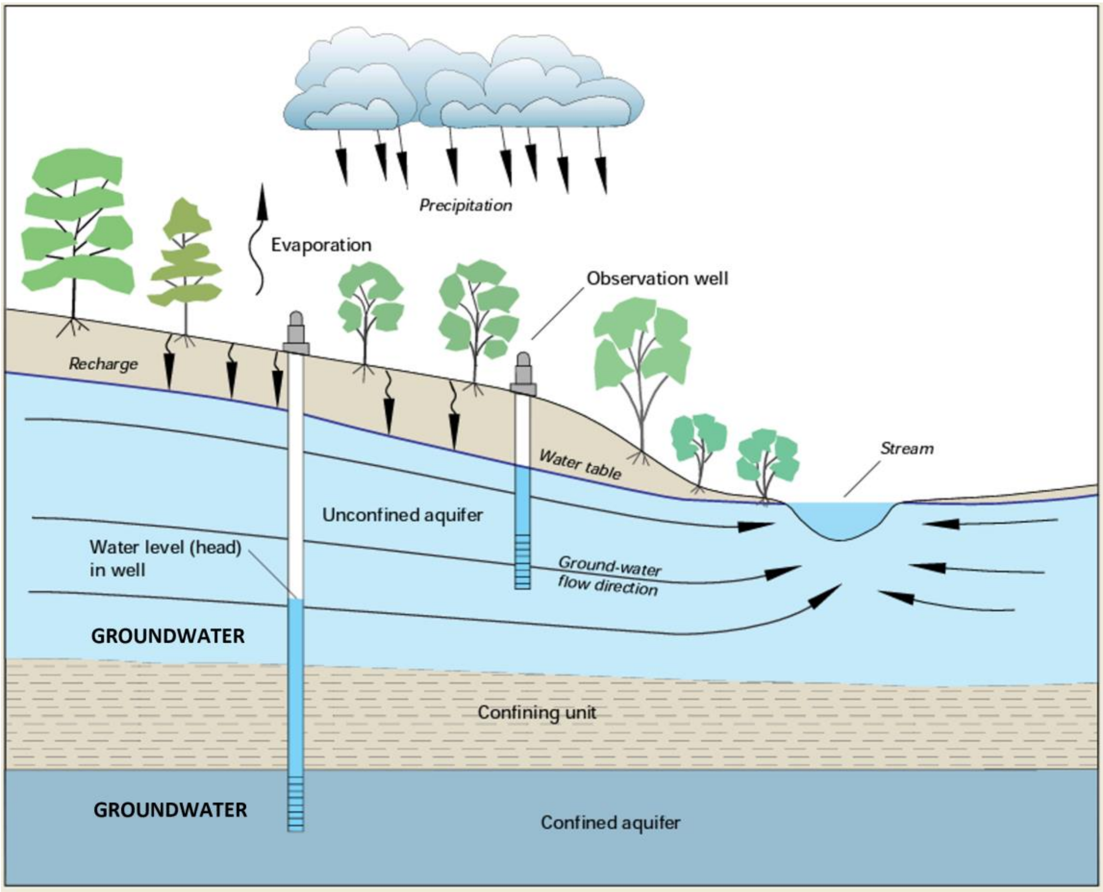


Figure 6.1 Cross Section sketch of a typical groundwater flow system showing water table and other hydrologic elements (Modified from Taylor and Charles, 2001).

6.1 Groundwater Level Status

The Department of Water and Sanitation monitors over 1 800 groundwater levels monthly, bi-monthly, quarterly, and at some geosites bi-annual basis throughout the country. Groundwater fluctuations can be a result of human-induced recharge, groundwater abstractions, or the reflection of climate variation and indicate the stress placed on the resource (Fourie, 2022).

The groundwater level value is presented as a percentage of the groundwater level status (GwLS). The historical groundwater level monitoring record is assessed per borehole to ensure significant results and understanding. The groundwater level status 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 water level.

The Groundwater Level Status approach allows the comparison of groundwater level data of any geosite/borehole on the same scale. Figure 6.2 presents the groundwater level status for the month of September 2022 and the available data at the time of reporting. The two consecutive above-normal rainfall years, 2021 and 2022, have improved groundwater level recovery at most places and good aquifer recharge.

Figure 6.3 depicts the groundwater level status over the years from September 2019 to 2022. September 2021 and 2022 have water levels recovering, showing more geosites with above 50% GwLS, particularly in the Northern Cape Province and interior of the country. This corresponds with the increase in rainfall percentage anomalies over the past two hydrological years (see Figure 3.3 in Chapter 3), and the prevalence of above 75% GwLS in the interior can be attributed to the above-normal rainfall trends in the past two years.

Due to the localised nature of groundwater aquifers, there is an increasing need to understand better the groundwater data monitored at a local level, such as by local municipalities or villages and by other water sector institutions such as SAEON in conjunction with the national monitoring database.

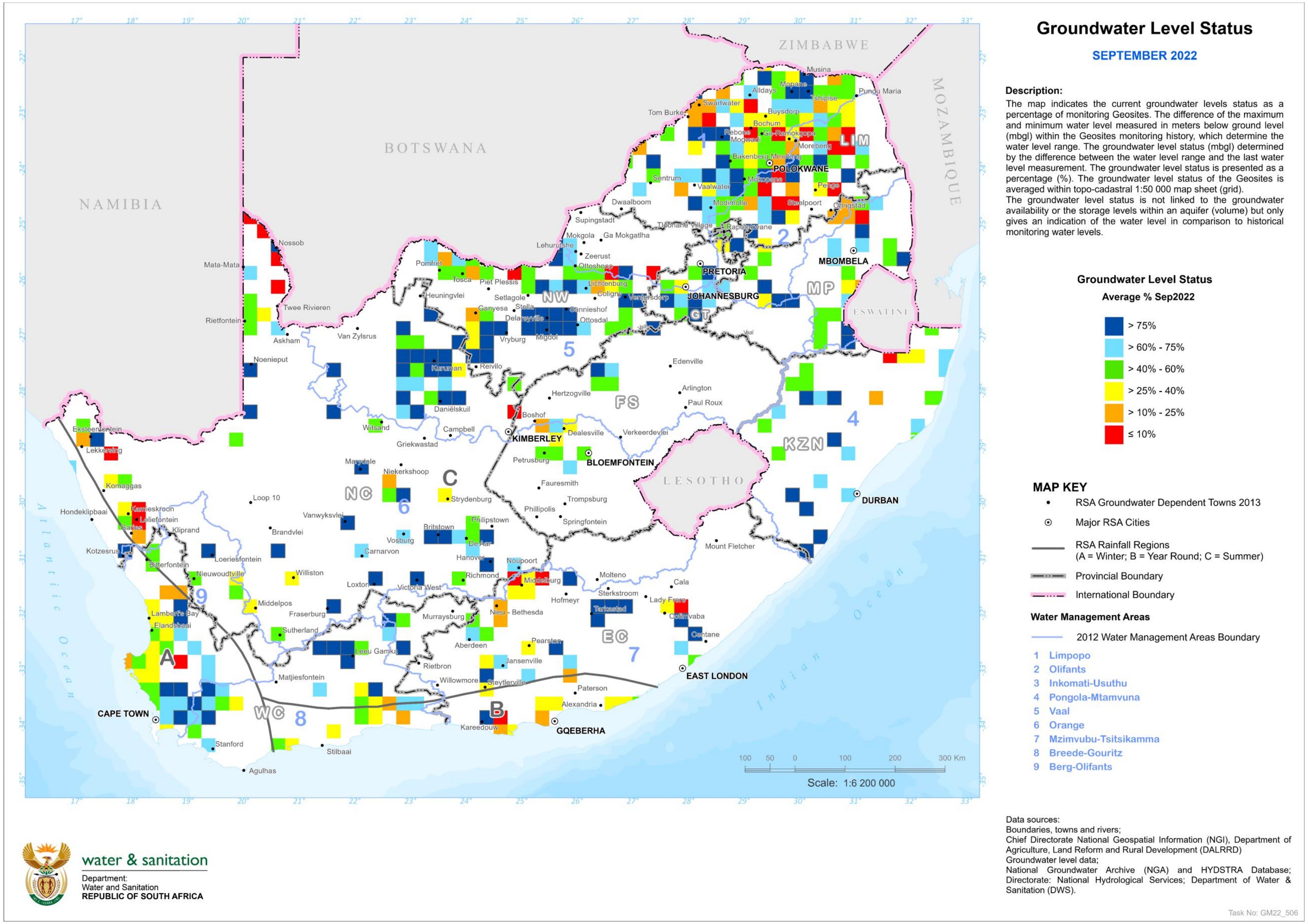


Figure 6.2 Groundwater Level Status Map – September 2022

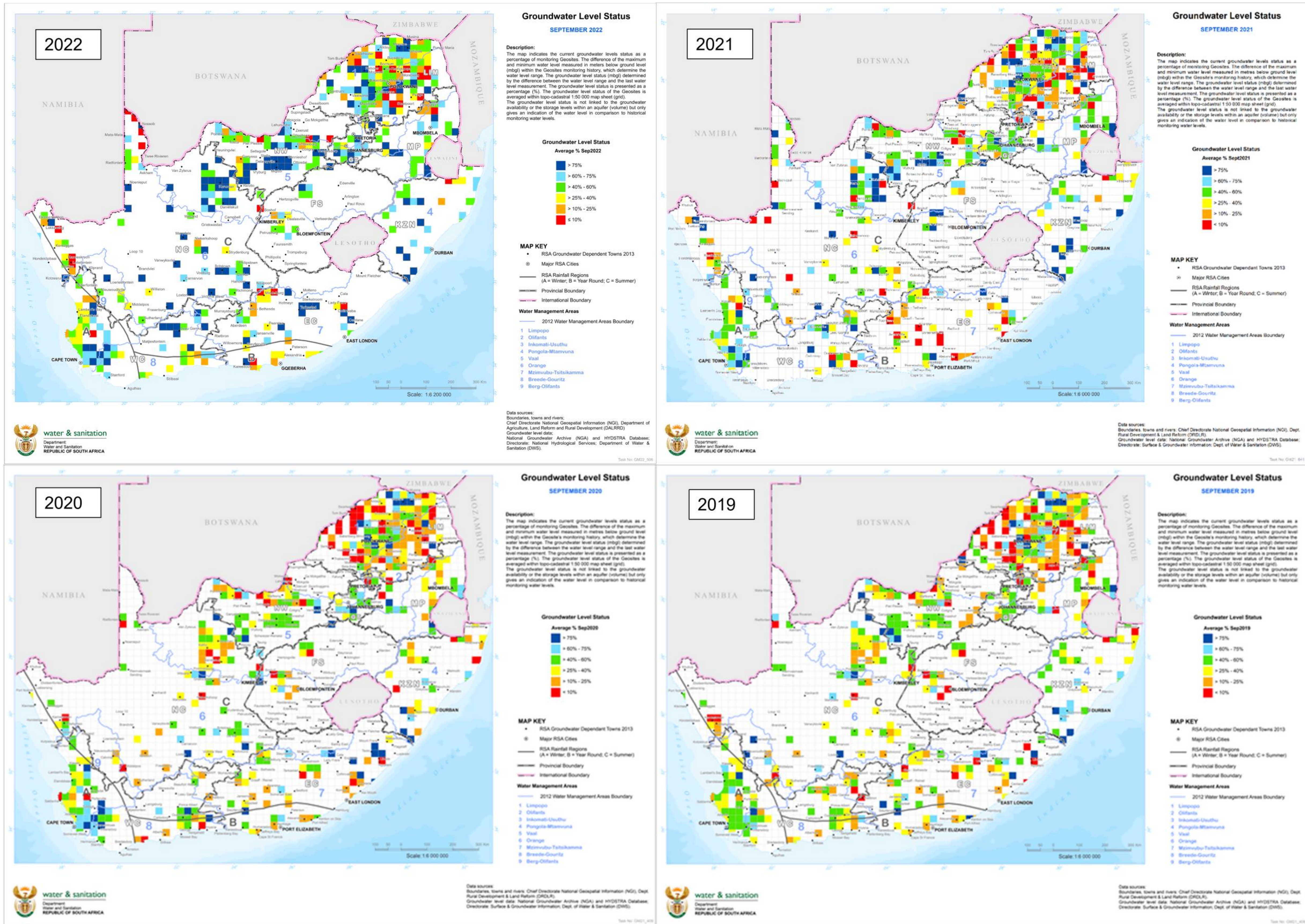


Figure 6.3 Groundwater Level Status Comparison for September month for the year 2019. 2020. 2021, 2022

6.2 Groundwater Level Risk Status

The impact of drought or over-abstraction on groundwater levels can be presented by its severity on the groundwater resource (average groundwater level status). The exact reasons for the primary stress driver can only be determined if the assessment is done on individual boreholes and grouping the boreholes according to hydrogeological characteristics.

The average GwLS is presented against the percentiles of the historical groundwater levels (Figure 6.4). The graph provides a visual presentation to indicate 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 - seven percentile ranges.

The groundwater level value is a percentage of the groundwater level status (GwLS). 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 geosites entire historical groundwater level monitoring record.

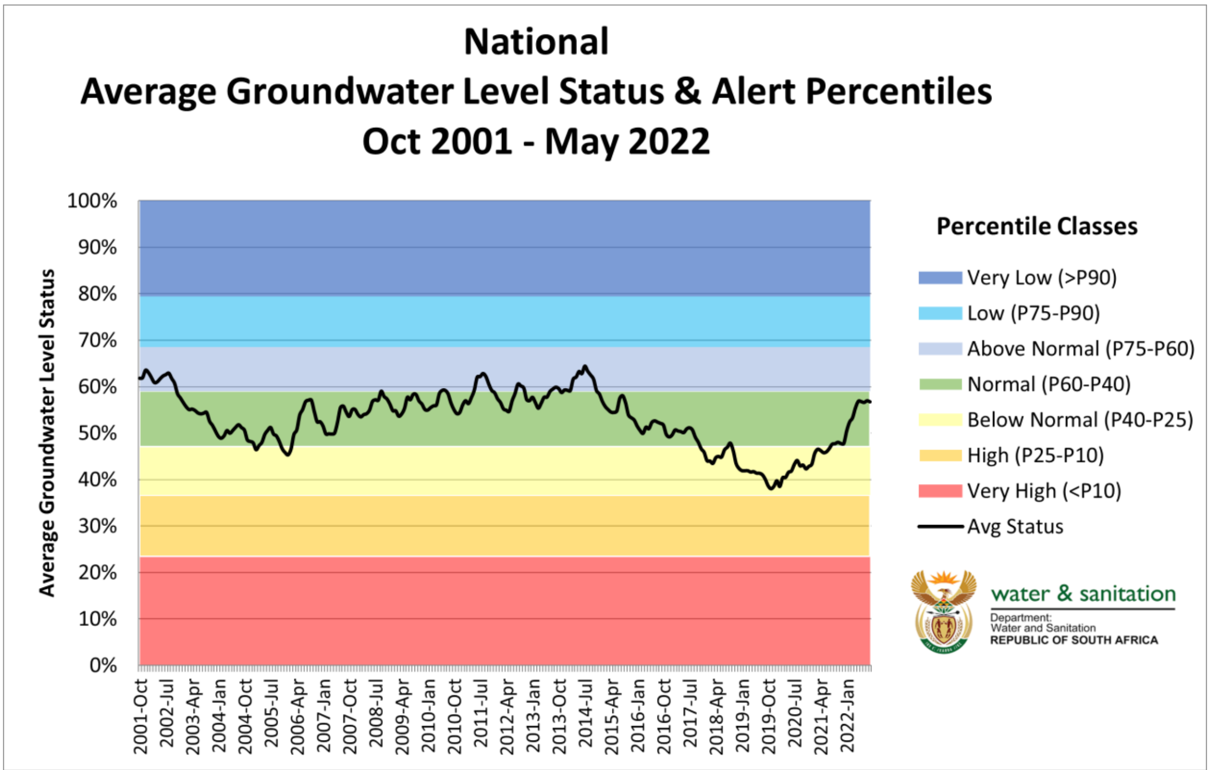


Figure 6.4 Average Groundwater Level Status Severity Graph

The national average GwLS indicated a recovery trend from below normal in 2019 to normal in September 2022. This can be attributed to the above-normal rainfall received in the current and previous years, which has recharged aquifers. There has been a decline in the number of monitoring stations with data available to put together the average groundwater level status. The decline in the number of geosites used to derive the national average GwLS in 2022 influences the average GwLS graph. Even though the average groundwater level status graph gives us an estimation of the groundwater levels across the country, it should be used with caution as it depends on the input number or geosites used to derive the average.

Timely data capturing groundwater level data on the central database by regions is still a challenge resulting in data lag. Investment in digitising the groundwater level monitoring process (collection, transmission, processing, and dissemination) can work hand in hand with manual data collection to aid in prompt data capturing to improve decision-making.

6.3 Strategic Groundwater Resource Areas and Groundwater Pollution

Strategic Water Source Areas (SWSAs) are areas of land that either (a) supply a disproportionate amount of mean annual surface water runoff in relation to their size and are considered nationally important; or (b) have high groundwater recharge and are locations where groundwater forms important national resource; or (c) are areas that meet both criteria. Water source areas are critical because they produce large volumes of water that sustain people and ecosystems. In the case of groundwater, they are the only sustainable and reliable water source (Le Maitre *et al.*2018).

Groundwater SWSAs provide water to 126 towns and rural supply schemes. Key regional centers that are highly dependent on groundwater are: Mafikeng with 75% of its water from groundwater, Lichtenburg >50%, Giyani >26% and Polokwane >11% (Le Maitre *et al.*2018).

Figure 6.5 presents the nitrate/ nitrite groundwater quality in mg/l classes according to the SANS 241 drinking water quality guidelines. Nitrate has a limit of 11 mg/l; anything above this limit is indicated in red in the map in Figure 6.5. The Strategic Water Source Areas with groundwater quality exceeding the limit are in the Free State and Limpopo Regions. The Central Pan belt (SWASA) in the Free State has a harmonic mean of 13 mg/l for nitrate. In Limpopo, the affected SWSA is Nyl and Dorps River Valley with a harmonic mean of 14 mg/l nitrate/nitrite; Giyani with 62 mg/l ; Letaba Escarpment with a harmonic mean of 21 mg/l; Vivo Dendron with a harmonic mean of 30 mg/l; Soutpansberg with 20 mg/l. All the exceedances within the SWSAs have nitrate/nitrite concentrations ranging from 13 mg/l to 62 mg/l indicative of impacts of land use activities that can still be arrested before significant groundwater pollution is allowed to take place.

The current water situation in South Africa provides strong motivation for protecting SWSAs to ensure a sustainable and equitable water supply. According to Le Maitre *et al.* (2018) there is currently no specific policy, legislation, or regulation that specifically protects Strategic Water Source Areas, including their groundwater counterparts. The legal measures available for protecting water sources include but are not limited to the National Water Act, National Environmental Management Act (NEMA), and Spatial

Planning and Land Use Management Act, to name a few. Some of the effective ways identified by Le Maitre *et al* (2018) to protect Strategic Water Source Areas are: (1) Under NEMA Section 24(2A), which allows the minister to prohibit granting of environmental authorisations in certain geographical areas; (2) Adding a chapter on Water Source Area protection to the new Water and Sanitation Act, prohibiting activities in certain geographical areas affecting water quality and quantity.

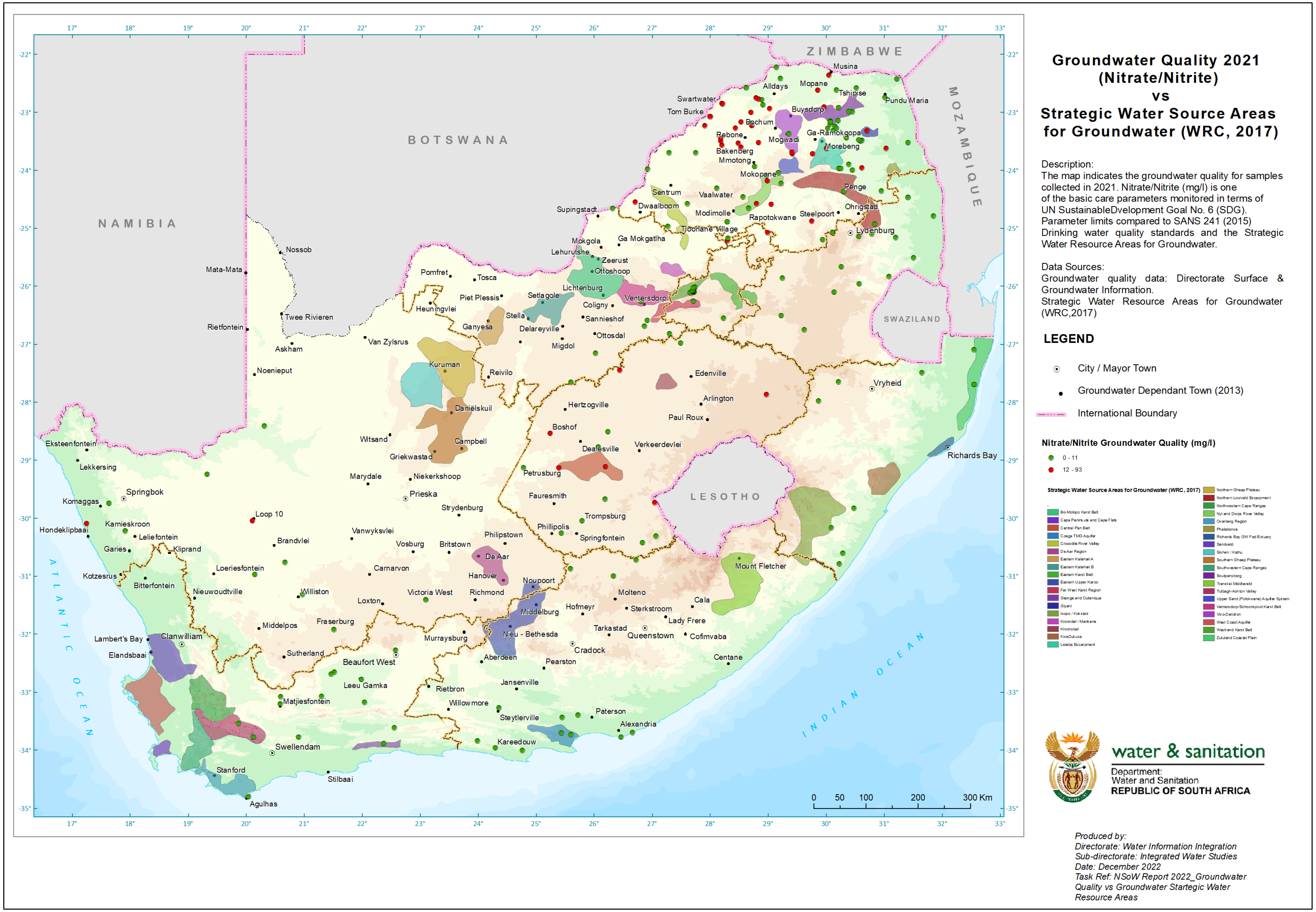


Figure 6.5 2021 Groundwater Quality within Strategic Water Source Areas for Groundwater

The consequences of contaminated groundwater for health, agriculture, the environment, and the economy can be massive. Anthropogenic pollution can be prevented and should be remediated at the cost of the polluter. Furthermore, because groundwater, as baseflow, is a major contributor to the dry season flow of most rivers, its quality and quantity greatly influence their ecological states. When unaffected by human activity, most groundwater is of good quality.

Remediating anthropogenic pollution of groundwater sources objectives will be to prevent contamination of drinking water sources and to restore the aquifer to a natural or “safe” state. According to Lytton and Ravenscroft (2022), remediation should be (a) preceded by a detailed characterisation of the source area and (b) guided by quantitative risk assessment.

6.4 Groundwater Use Per Economic Sector

Groundwater is registered in terms of the provisions in the National Water Act, of 1998. This information is available on the Departments WARMS database (https://www.dws.gov.za/Projects/WARMS/default.aspx), from which the Provincial figures of the currently registered water use per sector have been derived for up to September 2022. The economic sectors compared for groundwater use in the nine provinces are Agriculture irrigation, agriculture watering livestock, mining, schedule 1, water supply service, and others (aquaculture + industry + power generation + recreation).

A minimum of a third and more of groundwater is used in most provinces for agricultural irrigation. The Free State and Northern Cape Provinces have about two-thirds of groundwater used for agriculture irrigation. Limpopo and the Eastern Cape Provinces use groundwater predominately for agriculture, irrigation, and water supply service. In Limpopo, about half of the groundwater used is for water supply services. The Eastern Cape Province is the second largest user of groundwater for water supply service. Mpumalanga Province has two-thirds of its groundwater used in the mining sector. Most of South Africa’s coal mining activities are situated in Mpumalanga Province. Figure 6.6 illustrates pie charts for groundwater use per economic sector of the nine provinces.

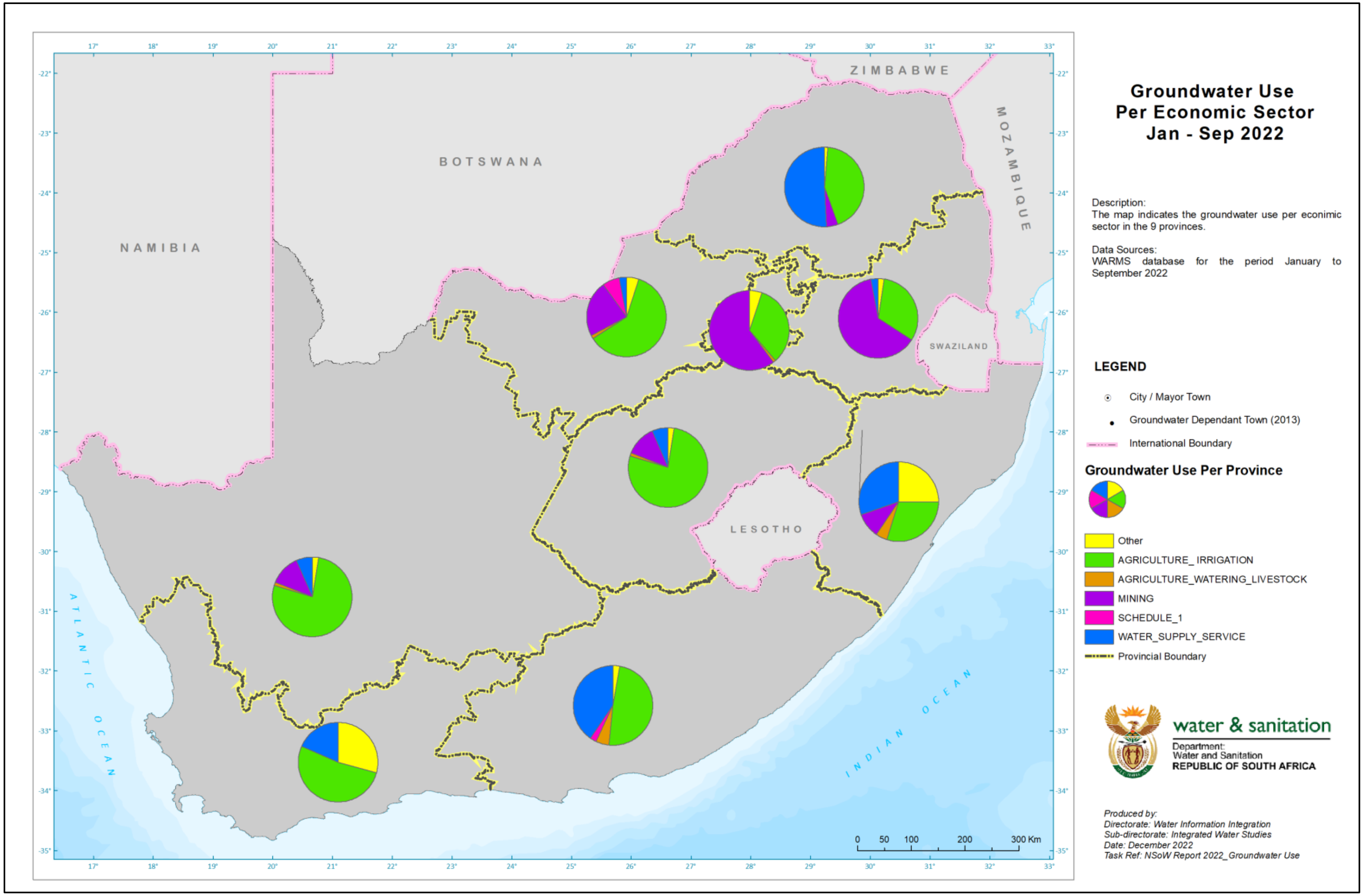
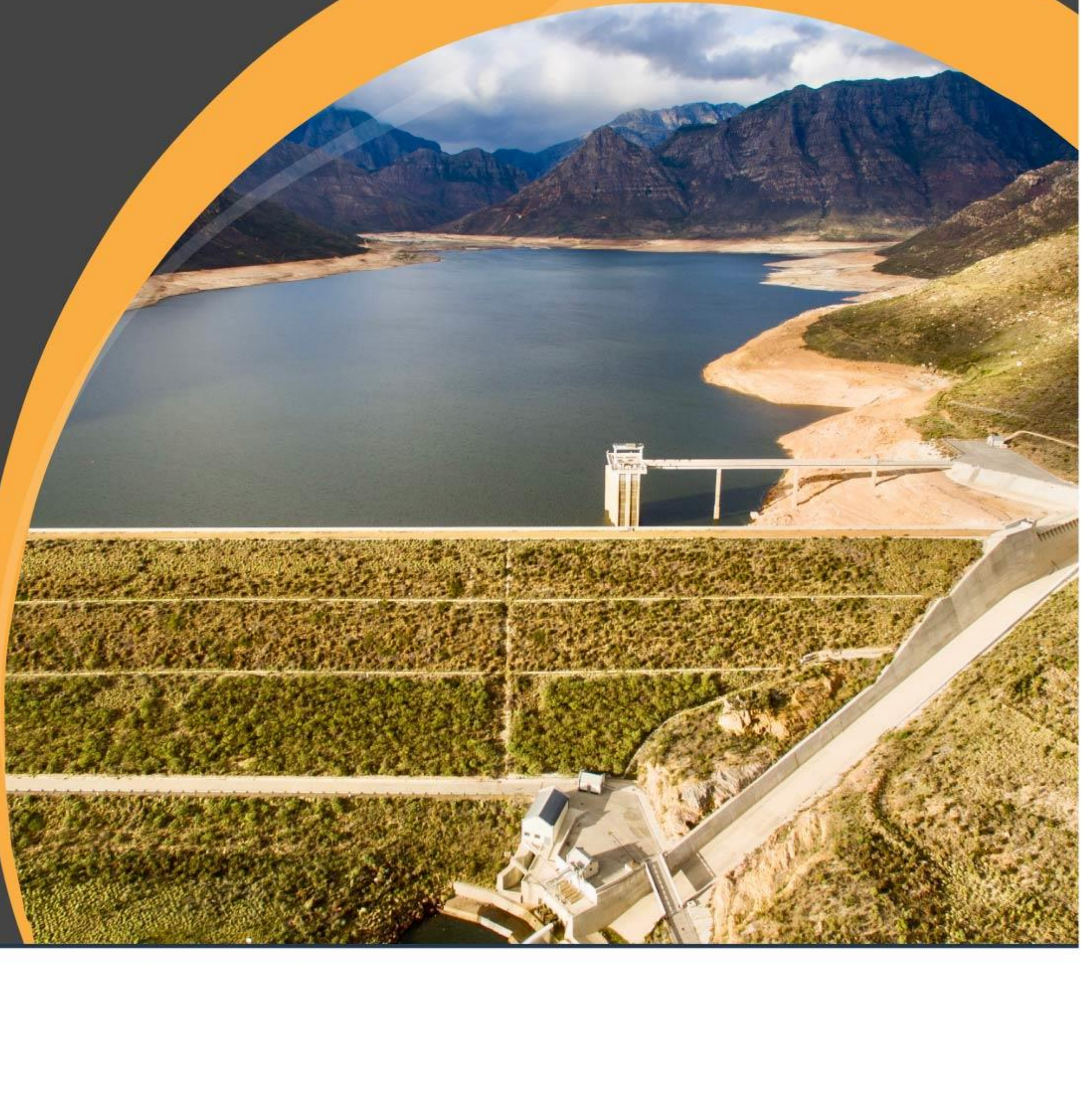


Figure 6.6 Groundwater Use Per Economic Sector - 2022

7

WATER SECURITY



7 WATER SECURITY

7.1 Water availability and demand

Water supply in South Africa is mostly through water supply systems, consisting of dams or standalone (surface water storage). Therefore, water availability has been estimated at a water supply system (WSS) scale.

Ideally, the water balance is to be made available for each WMA. However, there is no latest available data on the water balances of WMAs. From a strategic planning and/or operation perspective, water balance data is made available for WSS. Key water resource systems are presented in Figure 7.1 below.

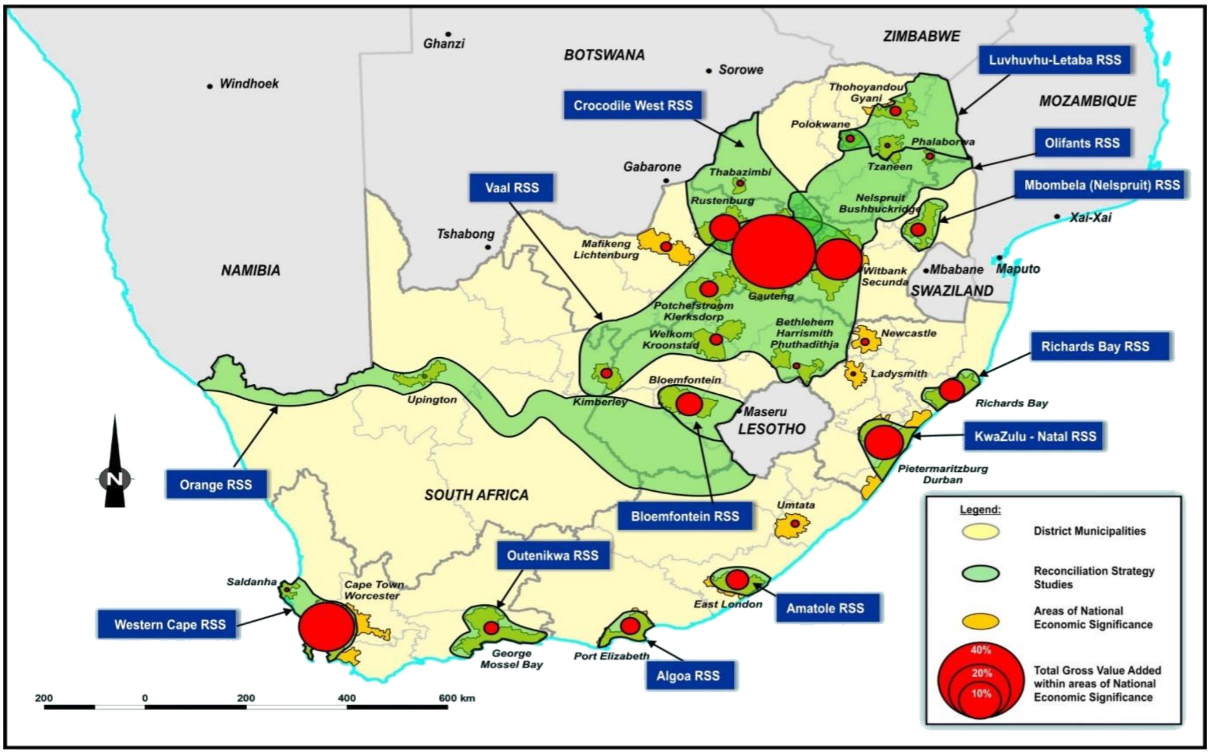


Figure 7.1 Key water resource systems

Based on data from 2019, as given in Table 7-1, large systems where water requirements exceed water available are:

- Outeniqua in WC (-6 M m³/year)
- Amathole in EC (-11 M m³/year)
- Olifants in Limpopo (-33 M m³/year)
- Orange in NC, FS, EC (-147 M m³/year)
- Umgeni – KZN (-62 M m³/year)

Nationally, the water supply systems are at a deficit of 96 M m³/year (1%), predicted to be 3.4 % by 2040 (see Figure 7.2).

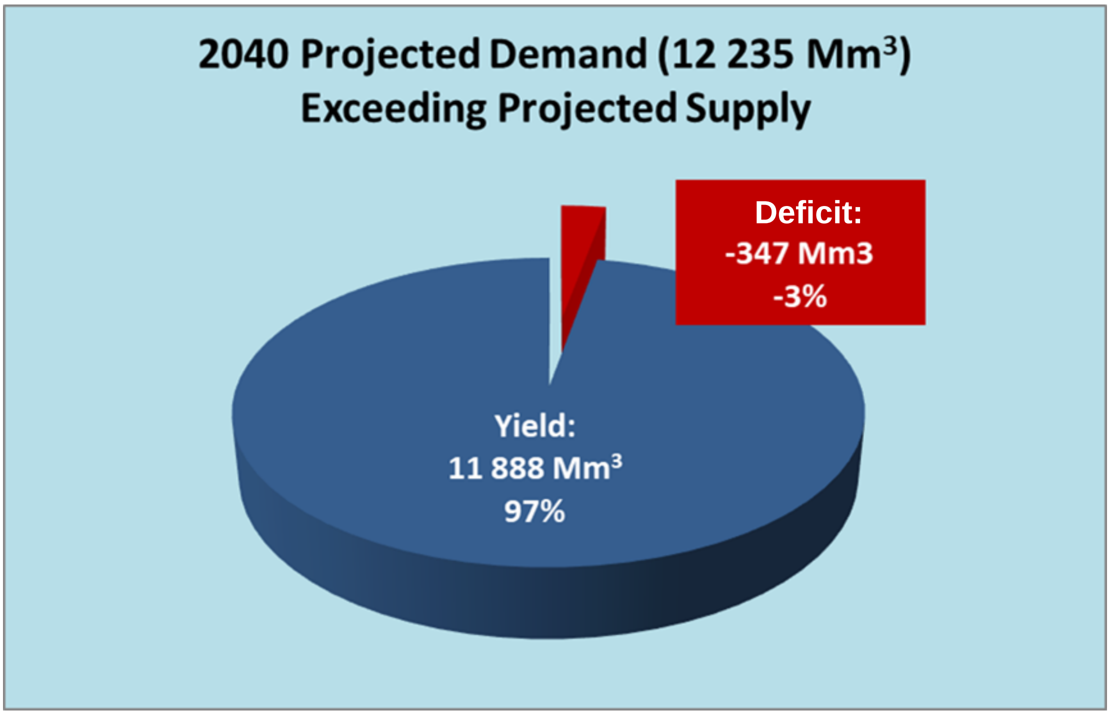


Figure 7.2 Projected demand in comparison to the yield in large water supply systems

Table 7-1 Water availability and requirement in large systems

System	Province	Systems in Mm³	Current in Mm³ /Year, the base year 2019			Future in Mm³ /Year, projected for 2040		
		Total Storage capacity	Availability (integrated system yield)/ scheme yield	Demands (estimated requirements)	Deficit (-) / Surplus (+)	Availability (integrated system yield)/ scheme yield	Demands (estimated requirements)	Deficit (-) / Surplus (+)
Western Cape	WC	895	590	590	0	1 160	1 125	35
Outeniqua	WC	49	62	68	-6	62	90	-28
Algoa	EC	281	195	182	13	225	258	-33
Amathole	EC	241	104	115	-11	124	125	-1
Other Dams in EC	EC	989	36	5	31	36	7	29
Crocodile West	L, NW	495	1 200	1 170	30	1 460	1 365	95
Polokwane	L	254	268	261	7	433	408	25
Luvuvhu/Letaba	L	472	243	215	28	276	277	-1
Olifants	L	1 859	425	458	-33	442	566	-124
Crocodile East	Mp	340	208	361	-153	208	387	-179
IVRS	Mp, NW, GP, FS	10 566	3 154	3 120	34	3 640	3 600	40
Orange	NC, FS, EC	7 996	2 950	3 097	-147	2 766	3 150	-384
Umgeni and Coasts	KZN	978	499	561	-62	736	705	31
Richards Bay	KZN	413	239	225	14	290	292	-2
Bloemfontein	FS	84	105	104	1	162	191	-29
TOTAL		**25 912**	**10 278**	**10 532**	**-254**	**12 020**	**12 546**	**-526**

The water use per sector projections is given in Table 7-2 below. Irrigation and Municipal (urban water supply) remain the largest water use sectors. It is expected that relative to other use sectors, by 2040, the municipal and afforestation sectors will see an increase of 36% and 3%, respectively (see Figure 7.3).

Table 7-2 Water use per sector projections

User sector*	**Water requirements (million m³/annum)**				
	2015	**2020**	**2025**	**2030**	**2040**
Municipal (industries, commerce, urban and rural domestic)	4 447	4 900	5 400	5 800	6 600
Agriculture (irrigation and livestock watering)	9 000	9 500	9 600	9 700	9 800
Strategic/Power generation	362	390	410	430	450
Mining and bulk industrial	876	921	968	1 017	1 124
International obligations	178	178	178	178	178
Afforestation	431	432	433	434	434
Total	**15 294**	**16 321**	**16 989**	**17 559**	**18 586**

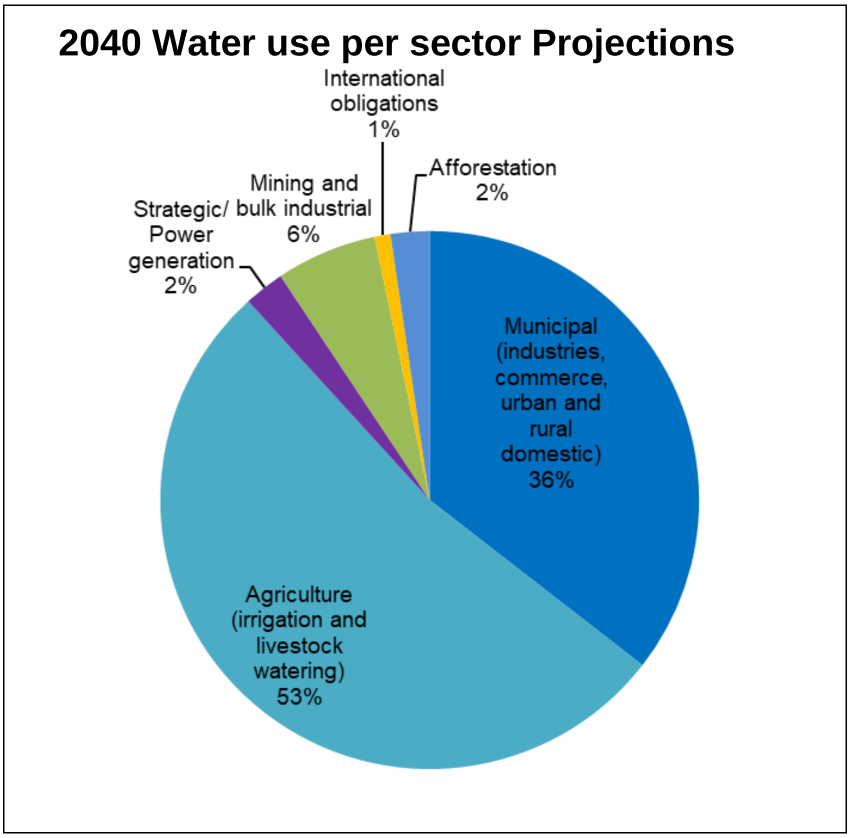


Figure 7.3 Water Use per sector 2040 Projections

7.2 Water Reconciliation Strategies

The objective of the reconciliation strategy within a water supply system is to reconcile or find a balance between the current and future water requirements by implementing appropriate intervention measures to increase the available water, conserve water through water conservation and demand management measures, as well as improve the water quality in the river systems.

The Department has recently completed the reconciliation strategies for the Integrated Vaal River System, Mbombela water supply system, Algoa water supply system, and the Richards Bay water supply system. The interventions in these areas have been based on the recommended reconciliation options.

i. The Integrated Vaal River System Reconciliation Strategy

The Vaal Catchment consists of the Upper, Middle, and Lower Vaal River WMAs. Due to numerous inter-basin transfers that link the major Vaal WMA with other WMAs, the reconciliation planning is done in the context of the integrated Vaal River System, which includes portions of the Komati, Usuthu, Thukela, and Senqu River (located in Lesotho) catchments. Significant water transfers also occur to water users in Olifants and Crocodile (West) River Catchments, of which most are dependent on water resources of the Integrated Vaal River System.

The main users of the IVRS water resources are bulk industrial users (Eskom and Sasol), urban users (Rand Water and Sedibeng water), and irrigators (predominantly the Vaalharts Scheme).

The following options are recommended:

- **Water Conservation and Demand Management** - Water loss reduction to reduce water requirement growth.
- **Removal of unlawful irrigation** - Finalise Verification and Validation of lawful water use.
- **Reuse** - Carry out a Regional Reuse investigation. Implement reuse where feasible.
- **Lesotho Highlands Water Project Phase 2** - Implement project, finalise completion of Polihali Dam and other associated infrastructure construction.
- **Yield Replacement: Orange River** - Finalise feasibility to determine a suitable option (Noordoewer/Vioolsdrift, Verbeeldingskraal). Implement a project to construct the scheme.

The status of the implementation of some of the interventions is summarised in Table 7-3.

Table 7-3 Status of implementation of the intervention plans

Intervention	Summary of implementation progress
WCWDM	Limited progress made, some successes of Rand Water Project 1600, Impacts not yet seen on water balance, greater attention required, Municipalities to improve commitment of financial resources.
Removal of unlawful Irrigation	Initially, some progress was made—successfully removing 80 million m3 of unlawful irrigation. Recent years have seen a slowdown of progress. Validation and Verification completion delaying further implementation. Northern Cape continuing with efforts, Free State and Gauteng committed to restarting process. Target to remove additional 75 million m3.
Reuse of treated effluent and other discharges	Short Term AMD solution implemented. Long Term AMD solution requires further investigation. CoT reuse plans slowed down due to budget constraints. Overall Regional reuse feasibility investigation is required. Ongoing links to Crocodile (West) Reconciliation Strategy implementation plans.
New Infrastructure construction	Implementation of LHWP Phase 2 has been delayed till the earliest date of April 2027 for delivery. Yield replacement Dam in Orange River Feasibility Study started, but still to be completed before the best option is determined. Earliest

Intervention	Summary of implementation progress
	data for yield replacement is set at 2028. Improved maintenance of existing transfer infrastructure is required.

ii. Mbombela Reconciliation Strategy

The major water requirements within the Mbombela Water Supply System are for irrigation, making up 54% of the total Crocodile and Sabie catchment requirements. Sugarcane is the predominant crop in these two catchments. Cross-border flows for the Crocodile and Sabie Rivers have a minimum requirement of 37 million m^3/annum, according to the InoMaputo Water Use Agreement to cross the border from South Africa into Mozambique.

The Crocodile system provides water to several users along the stretch of the river and downstream of the main dam for the system - Kwena Dam. The yield of the Crocodile River System is influenced directly by the abstraction volumes and location of the water users within the system. The main water resource infrastructure in the Sabie River is the Inyaka Dam which supplies the Sabie and Sand catchments via the Bushbuckridge Transfer Pipeline.

Options for reconciliation and/or intervention measures for the Crocodile System include:

- WCWDM
- Removal of Invasive Alien Plants
- Surrender Irrigation allocations
- Strict restriction rules on low-priority users
- Releases from the Ngodwana Dam

Reconciliation options and or intervention measures for the Sabie System include:

- WCWDM
- Removal of Invasive Alien Plants
- Development of groundwater
- Additional return flows from treated effluent

iii. Algoa Reconciliation Strategy

The Algoa WSS currently comprises three major dams in the west, several smaller dams, a spring situated near NMBM, and an inter-basin transfer scheme from the Orange River via the Fish and Sunday Rivers to the east. Five water user categories included domestic/industrial, Gamtoos irrigation, other irrigation, environmental, and losses.

Urban water use from the Algoa Water Supply System is more than 60% of the total use of the system and is expected to increase. Water use within the Kouga

Municipality is 10.0 million m3/a (27.3 Mℓ/d), with an estimated bulk water requirement of 13.0 million m3/a (35.5 Mℓ/d). Of this, 5.85 million m3/a was supplied from the Algoa WSS in 2016/17. The Municipality plans to develop a long-term Water Provision Master Plan to upgrade and rehabilitate bulk infrastructure. In the future, Groundwater from the Humansdorp area will be used by Kouga LM. There is a possibility of the supply of additional Orange River water to the NMBM, instead of more water from the Kromme River sub-system to the Kouga LM and the proposed power plant.

The following interventions are recommended:

- **Further allocation of Orange River water to NMBM**

The concept of the further phasing of the NCLLS (post Phase 4) of transferred Orange River water has been added, termed Phase 5. The assumed yield of the Nooitgedagt Phase 5 Scheme has been assumed to be 18.25 million m3/a (50 Mℓ/d). Conveyance to NMBM could be by either of the two-bulk supply (high-level and low-level) pipelines. Should the capacity of these pipelines be exceeded (assuming that supply cannot be boosted), a further bulk supply pipeline would be required.

- **Groundwater supply**

The yields of the Coega Fault, Moregrove Fault, and Jeffreys Arch aquifers have been revised, while in some areas, the original yield estimates have not been changed. The total long-term yield of the eight potential groundwater interventions has been updated from 29.5 million m3/a to 36.0 million m3/a.

- **Large seawater desalination scheme**

A potential large seawater desalination scheme, with a capacity of 87.6 million m3/a (240 Mℓ/d) has been added as a potential intervention to consider for implementation should the allocation of transferred Orange River water be revoked.

iv. Richards Bay Reconciliation Strategy

Intervention options in the Richards Bay system comprise the implementation of combinations of various reconciliation options over time and can be divided into two main categories, namely:

- Reconciliation options are used to reduce the water requirements; and
- Reconciliation options will increase the yield available from the existing water resources.

The following interventions are recommended:

- **Reducing water demand by introducing WCWDM** – King Cetshwayo DM recently (May 2020) started a WCWDM project aiming to reduce water losses in their water supply schemes.
- **Remove alien vegetation** - removing alien vegetation is a standard intervention measure for saving water in all Reconciliation Strategies and is very important in severely water-stressed catchments.

- **Water Reuse** - Indirect effluent reuse, whereby treated effluent could be discharged to Lake Mzingazi for indirect potable and industrial reuse. Also, consider the blending of treated effluent at the Mzingazi WTW or artificial recharge to create a barrier to prevent seawater intrusion. Potential uptake of treated effluent by bulk industrial water users close to the Arboretum macerator. Potential users would need to be identified.
- **Transfers from Neighboring Catchments -** an increase in the Thukela transfer from Middeldrift be compared with other transfer options (Lower Thukela Coastal pipeline and Umfolozi off-channel storage Dam) at a pre-feasibility level, after which a decision can be made as to the preferred option. However, drought hit the catchment shortly after the completion of the Strategy (2015), and the upgraded Thukela transfer was then selected as an emergency scheme. Construction of the upgrade began, which would increase the size of the existing transfer from 1.2 m^3/s to 2.4 m^3/sd.
- **New Dam Construction -** a new dam on the Nseleni River. The proposed dam will be located on the Nseleni River, a tributary of the Mhlathuze River just upstream of the Bhejane township, from where water can be released downstream to Lake Nsezi for abstraction.
- **The raising of Goedertrouw Dam** - the dam can be raised by 2.8 meters which will result in an increase in storage capacity from the existing volume of 301 million m^3 to 336 million m^3. The corresponding increase in yield to the system would be 5.8 million m^3/annum.

7.3 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 development 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**.** A schematic illustration of the phases for various projects is presented below.

Furthermore, the list of prioritised water resource development per water supply system is given in Table 7-4.

Table 7-4 Current Prioritized 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 Crocodile (West) Water Augmentation Project (MCWAP) by 2024 (R15 Billion)	Re-Use of Effluent	Re-Use of Effluent
Olifants River System	Olifants 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)
Umgeni Water Supply System	Phase 1 of uMkhomazi Water Project by 2026 (Dam at Smithfield, 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)	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

7.3.1 Augmentation Projects

Water infrastructure is aging 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 7-5 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 7-5 reports on a portfolio of projects, including a status update on those projects that are on hold due to funding and other constraints. In addition, TCTA oversees the Operation and Maintenance of several other projects.

Table 7-5 Progress of augmentation projects across the provinces

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	A BOQ for repairs to the Buffelskloof houses, water supply, and sewage network, and Tshehla Trust furrow has been compiled and is being finalised	
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	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	

	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		Upgrade of Greater Brandvlei Dam Scheme
Gauteng	Lesotho Highlands Phase 2	Lesotho Highlands Phase 2 is in progress	
KZN	uMkomazi Water Project 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	To date, 73 anchors have been installed and stressed. 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	

The project summary in Table 7-5 presents and overview the various TCTA projects at various stages and the status of the projects. Climate change, increasing population growth, and urbanisation continue to exert pressure on the timely delivery of traditional water infrastructure projects to meet the needs of our time. Figure 7.4 presents illustrations of some of the TCTA augmentation projects at various locations across South Africa.

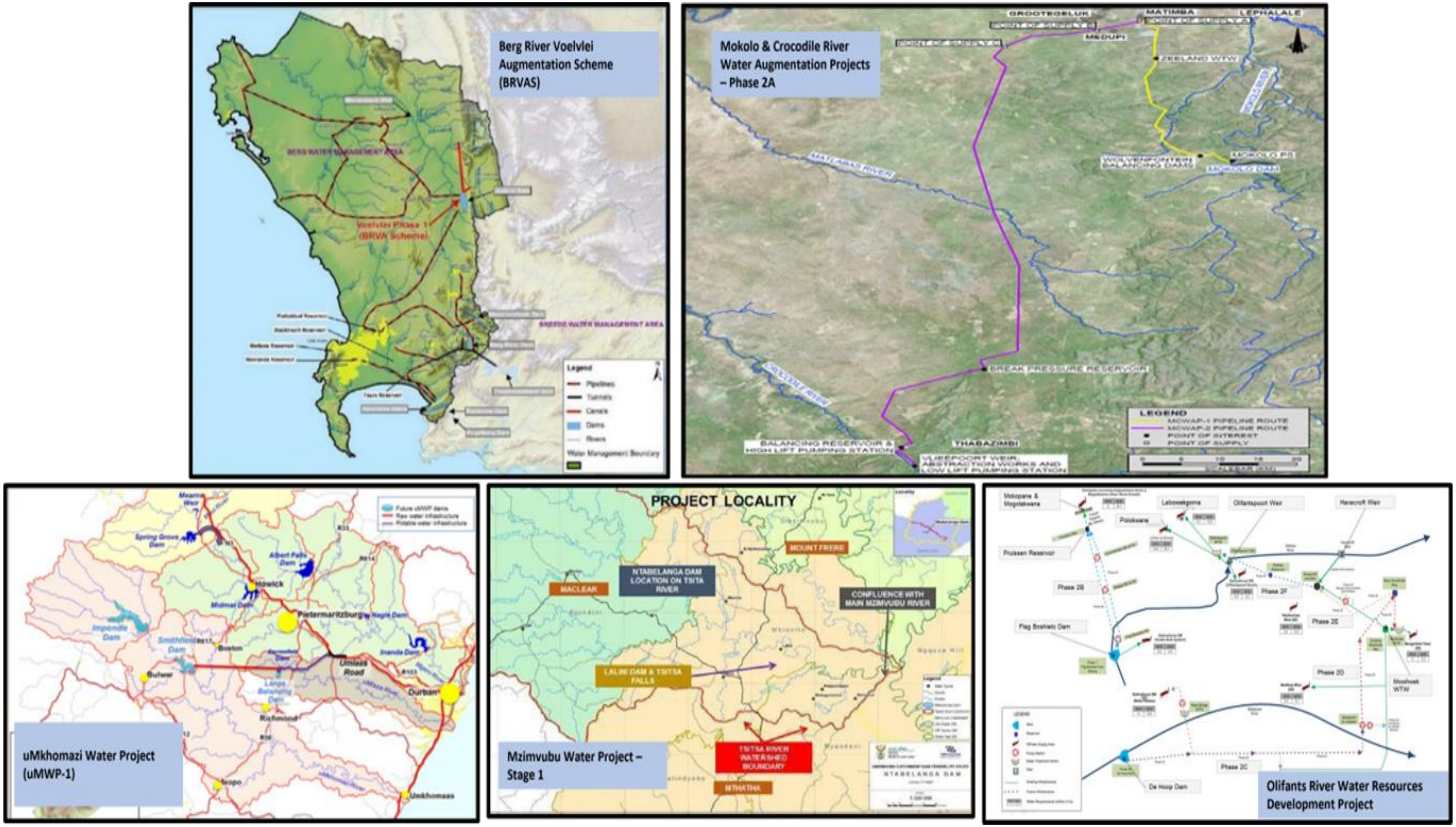


Figure 7.4 Illustration of some of the TCTA augumentation projects (modified from DWS 2022 report)

Table 7-6 TCTA Projects Progress end of September 2022

No.	Project Name	Start Date	End Date	Project description	Status
PROJECTS AT PREPARATION PHASE					
1.1	uMkhomazi Water Projects – Phase 1	February 2019	2031	Water requirement projection indicates that the Umgeni System is experiencing a deficit since 2016 and therefore there is a need for new water resources, hence uMWP-1. uMWP-1 consists of Bulk raw water implementation by TCTA and Bulk Potable Water Implementation by Umgeni Water. The Bulk Raw Water portion consists of: • 81m high dam and appurtenant works at Smithfield on the uMkhomazi River near Bulwer. • Conveyance infrastructure (32km 3.5m diameter tunnel and 5km 2.6m diameter raw water pipeline) to the proposed Umgeni Water's Water Treatment Works (WTW) in the uMlazi River valley. Cost at Completion: R 23.243 billion Percentage Actual Spend to Date: 0%	Design Complete: N/A
1.2	Berg River Voelvlei Augmentation Scheme (BRVAS)	May 2017	February 2028	The Water Reconciliation Strategy for the Western Cape Water Supply System (WCWSS) indicates that the system is projected to be in deficit soon and should have been augmented by at least 2019/20 to avert a serious shortfall. The urgent need for augmenting the WCWSS has become evident by the system's inability to cope with the current drought situation. BRVAS is conceptualised to abstract winter flows from the Berg River and pump it to the existing	Design Complete: 100% (conceptual design)

				Voëlvlei Dam, increasing the yield by 23 million m^3 per annum and consists of: • abstraction works in the Berg River - diversion weir, sediment traps, 5MW pump station; • canoe chute-fish way; and • a 6.3 km long pipeline to deliver the water to the Voëlvlei Dam Revised Cost at Completion: R 1 746 242 452 Percentage Actual Spend to Date: 3%	
1.3	Mokolo and Crocodile River Water Augmentation Project- Phase 2A (MCWAP-2A)	April 2019	April 2030	Additional water from MCWAP-2A is required to provide Eskom with a second water source to run their two Waterberg power stations, Medupi and Matimba. This water is to further provide Medupi Power Station with enough water to operate the additional three Flue Gas Desulphurisation (FGD) units and Matimba Power station to operate their 6 FGD units could not be supplied from the MCWAP-1 pipeline. It will also provide the Lephalale Local Municipality with water and provide Exxaro with the required additional water to increase its mining capacity. The Industrial Development of the Waterberg area is one of the objects of the PICC SIP-01 programme, and the project will also aim to provide water to aid that industrialisation. MCWAP-2A consists of an abstraction weir, a River Management System and implementation of a 160 km water transfer infrastructure with a capacity of 75 million m3/annum with associated ancillary infrastructure. Design Complete: 99% Cost at Completion: R12.36 million	Design Complete: 99%

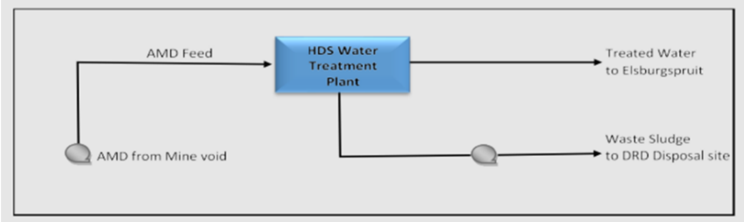
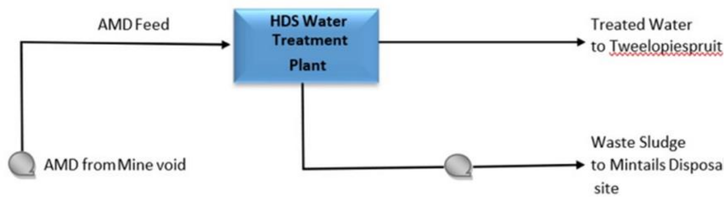
ADVISORY SERVICES					
2.1	Mzimvubu Water Project (MWP): Stage 1	2019	2025	Two multi-purpose dams and associated infrastructure, Ntabelanga and Lalini dams, on the Tsitsa river, which is a tributary of the Mzimvubu river, will be developed to provide for potable water supply, irrigation, hydropower, and tourism. Government has classified the project as a Strategic Integrated Project under SIP-3. The project aims to develop the water resources in the Mzimvubu river catchment to provide a stimulus for the regional economy, in terms of domestic water supply, irrigation, hydropower generation and job creation. The project was envisaged to be implemented in 4 stages (2018/19). Stage 1 is Advanced Infrastructure, mainly access road. Stage 2 is the Implementation of Ntabelanga Dam and Water Treatment Works. Stage 3 involves the bulk distribution system. Stage 4 is the Irrigation and Hydropower components – roads, staff housing. TCTA is only providing Project Management advisory services for implementation of Stage 1. Cost at Completion: R 15 billion construction cost Percentage Actual Spend to Date: 29% of construction cost.	Design Complete: 0%
PROJECTS AT CLOSE OUT PHASE					
3.1	Olifants River Water Resources Development project –Phase 2C	March 2012	2020	The ORWRDP-2 bulk distribution system (BDS) transfers water from the De Hoop and Flag Boshielo dams for municipal and mining needs in the middle Olifants river catchment area, unlocking significant social and economic development.	Construction Status: 100% Complete

				Phase 2C will improve water supply to Jane Furse/Nebo Plateau and for mining activities in the Steelpoort-Burgersfort area. Phase 2C has been implemented by TCTA as per revised Ministerial Directive Construction Complete: 100% Cost at Completion: R2 544 million	

PROJECTS ON HOLD

	Project	Directive	Strategic Impact	Status
4.1	Olifants River Water Resources Development Project – Phase 2B (ORWRDP-2B)	To source funding and implement commercial portion of Phase 2B. Augment water supply to Mogalakwena Local Municipality by 50 million m^3 per year. DWS signed MOI with Mines for the implementation of the outstanding phases on a JV basis with shared responsibility.	Augment water supply to Mogalakwena Local Municipality by 50 million m^3 per year	DWS signed MOI with Mines for the implementation of the outstanding phases on a JV basis with shared responsibility. TCTA awaits DWS guidance on what role TCTA will play within the new institutional framework. TCTA also placed this on agenda with the Minister.
4.2	Acid Mine Drainage – Long Term Solution (AMD-LTS)		Desalination of partially treated acid mine drainage	TCTA Board raised the way forward on the implementation of the Long-Term solution

		To fund and implement the AMD Long-term solution.	water from the Short-term Intervention to a potable or industrial standard.	during the meeting with the Minister, feedback from DWS is awaited.
POTENTIAL PROJECTS				
Project		Directive	Strategic Impact	Status
5.1	Olifants River Water Resources Development Project (ORWRDP - 2D, 2E and 2F) – Phase 2B	Possible directive for TCTA to implement social phases related to Phases 2D, 2E and 2F withdrawn.	Development of additional water resource infrastructure.	See ORWRDP-2B above
5.2	Nwamitwa Dam	Possible directive to TCTA to implement the project.	Increase in water supply for commercial and social use in the Tzaneen area.	Proposal made to DWS and awaiting response.
OPERATIONS AND MAINTENECE				
6.1	Acid Mine Drainage Treatment Plants in the Western, Central and Eastern Basins	**Objectives:** To draw down the AMD Central Basin water level to be at or below the level recorded on 31 March 2021. To operate and maintain the Central Basin – High Density Sludge (HDS) Water Treatment Plant in a cost effective and environmentally sustainable manner.		

		 Winze 18 Shaft. During the year 1 April 2021 - 31 March 2022, the water level not to exceed 1m below shaft collar to operate and maintain the Western Basin - High Density Sludge (HDS) Water Treatment Plant in a cost effective and environmentally sustainable manner. 
6.2	Delivery Tunnel North (DTN) of the Lesotho Highlands Water Project (LHWP)	**Objectives:** • To transfer water as per LHWP Treaty, protocol VI. • To operate and maintain the Delivery Tunnel North transfer scheme in a cost effective and environmentally sustainable manner. Operator: As from 1 January 2021, Nafasi Water (Pty) Ltd was appointed to operate the plant for duration of 60 months.

7.4 Water Use Efficiency

7.4.1 Legislation addressing water use efficiency

The National Water Act, 36 of 1998 (NWA), provides the legal framework for the effective and sustainable management of the country's water resources. The Act requires that the nation's water resources are used efficiently and equitably in a sustainable manner for the benefit of all South Africans. Moreover, Section 22 of the NWA states that a person who uses water may not waste that water.

The Water Services Act, 108 of 1997 (WSA) aims to promote 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 states in Section 73 that the Minister may prescribe measures to conserve water. The 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 Directorate: Water Use Efficiency (D: WUE) is responsible for facilitating the national scale development and promotion of water conservation and water demand management aimed at efficiently using the nation's limited water resources.

7.4.2 Why is addressing water use efficiency a concern?

South Africa is the 30th driest country in the world, and many parts of the country are approaching a scenario where the demand outstrips the supply. That is, most of the freshwater resources are fully utilised. A high level of water stress can negatively affect economic development, increasing competition and potential conflict among users, which calls for effective supply and demand management policies and an increase in water-use efficiency. Therefore, Water Use Efficiency is critical in ensuring the sustainability of the freshwater resources.

7.4.3 Stakeholders involved in addressing water use efficiency

Governments are increasingly collaborating with other stakeholders, including the private sector, to ensure that Water Governance is genuinely inclusive. The fundamental components of good water governance include effective, flexible, and accountable state institutions that can respond to change, along with openness and transparency. Citizens and communities should also be able to voice their opinions and be involved in decision-making. Policy processes must involve participation and multistakeholder engagement.

- *<u>South African Local Government Association (SALGA)</u>:* Ensures the provision of services to communities in a non-exploitative manner. SALGA promotes a safe and healthy environment in local government, promotes social and economic development, and encourages the involvement of communities and community organisations in matters of local government. SALGA provides support to Water Services Authorities (WSAs) to ensure the implementation and reporting of Water Use Efficiency.

● *Sector Bodies such as Business Unity South Africa (BUSA), Minerals Council South Africa, and Agricultural Sector bodies*: Provide support to their members to ensure the implementation and reporting of WUE information.

● *Water Services Authorities (WSAs)*: Implementation of WUE programmes and report progress to the Department.

● *Industry, Mining, and Power Generation Sector*: Implementation of WUE programmes and report progress to DWS.

● *Civil Society*: Advocating the importance of saving water within their communities.

● *Water Research Commission (WRC)*: Provide Research and Development of tools relating to WUE.

7.4.4 South African Citizens' Role in Managing Water Use Efficiency

All South African Citizens need to be mindful of the amount of water they are consuming in their households and use water sparingly. Figure 7.5 presents the water numbers every South African should be familiar with to aid in water use efficiency and behavioral change. Each household can formulate its water-savvy practices and be guided by water-wise tips communicated by the Department. An enormous amount of water is wasted daily due to household water leaks and excessive water use behaviour. SA Citizens need to ensure leaking pipes in their yards and toilets are fixed quickly. Communities need to support their Water Services Authorities by reporting leaking and burst pipes and hold the authorities accountable to the by-laws. Water users should also be aware of their responsibility and take ownership of the water services and resource management in their area of residence.

Figure 7.5 Water use efficiency campaign- 50 litres of water per day

7.5 Consumption Trends

i. Integrated Vaal River System

The per capita consumption is shown in Figure 7.6 and has been reducing since 2015 because of some WCWDM interventions and imposed water restrictions. The current consumption is still high compared to the national benchmark of 236 ℓ/c/d, but the study area includes the country's largest number of wet industries. The ℓ/c/d is expected to reduce to 251 ℓ/c/d if the 2022 target is achieved, and further improved efficiencies and water loss reduction could reduce this figure to an expected international benchmark of 180 ℓ/c/d.

Municipalities in the IVRS exceeded their December 2020 target by 106 million m^3. Ekurhuleni, Mogale City, Govan Mbeki, and Midvaal surpassed their 2019 water demand targets. The City of Johannesburg, City of Tshwane, Emfuleni, and Rustenburg, the major contributors to water losses in the IVRS, have not achieved their targets and seem unlikely to do so within the next two years unless significant effort and funds are dedicated to water loss reduction.

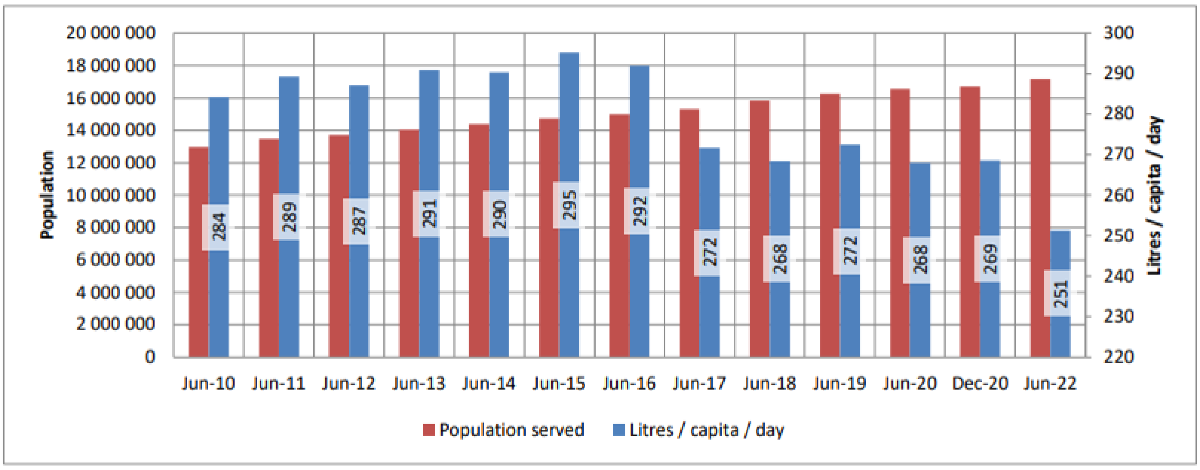


Figure 7.6 IVRS per capita consumption trend

ii. Crocodile West River Water Supply (CWRWSS)

The per capita consumption is presented in Figure 7.7. In December 2019, the consumption was estimated at 170 ℓ/c/d, which is in line with the level of service. The results indicate that progress has been made with the reduction of water losses within these municipalities, although the data had a very low confidence level.

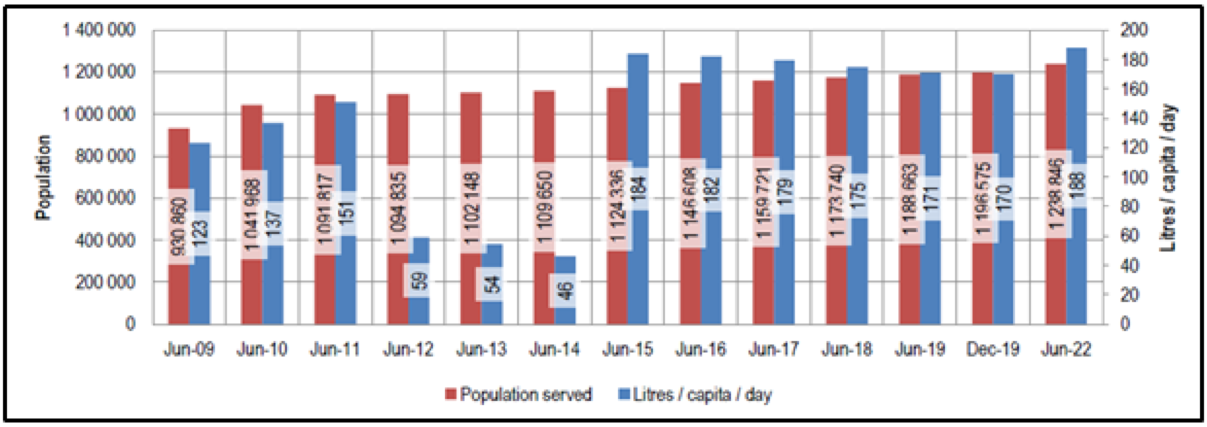


Figure 7.7 CWRWSS per capita consumption trend

iii. KwaZulu-Natal Coastal Metropolitan Water Supply System (KZNCMWSS)

The per capita consumption is presented in Figure 7.8, which has been consistently increasing since 2017 when water restrictions were lifted.

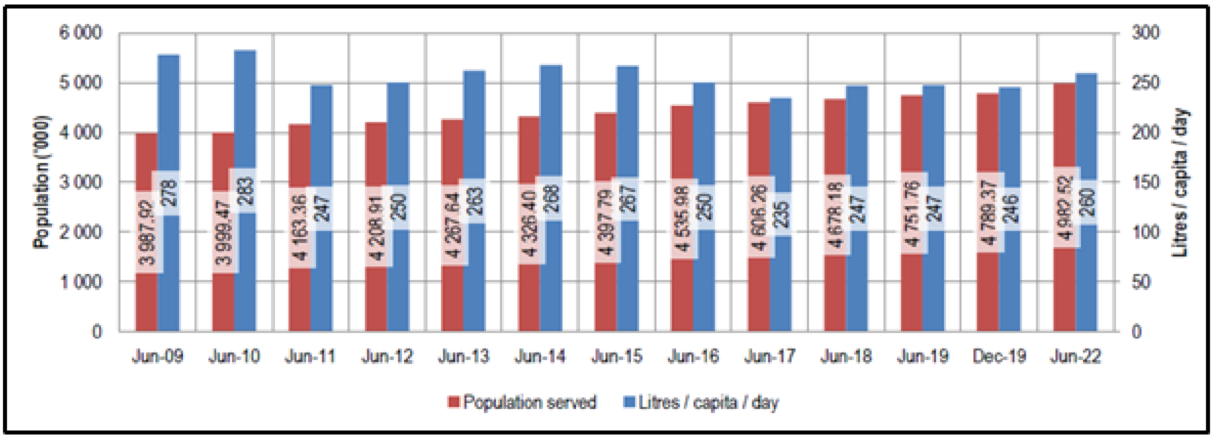


Figure 7.8 Coastal Metro WSS per capita consumption trend

iv. Western Cape Water Supply System (WCWSS)

The per capita consumption is presented in Figure , which has been consistently decreasing over the past ten years. The average consumption of 127 ℓ/c/d is well below the national benchmark of 236 ℓ/c/d.

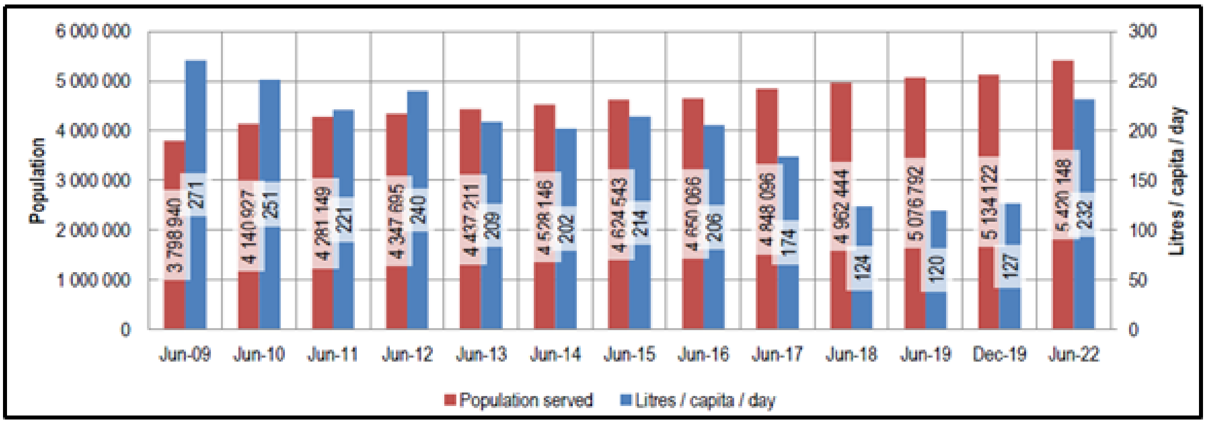


Figure 7.9 Western Cape WSS per capita consumption trend

v. *Algoa Water Supply System*

The results indicate that NRW has been relatively constant over the last six years, at approximately 45%. The AWSS per capita consumption is shown in Figure which has been between 199 and 277 ℓ/c/d over the past ten years. The average consumption is expected to reach 226 ℓ/c/d if the 2022 target can be achieved.

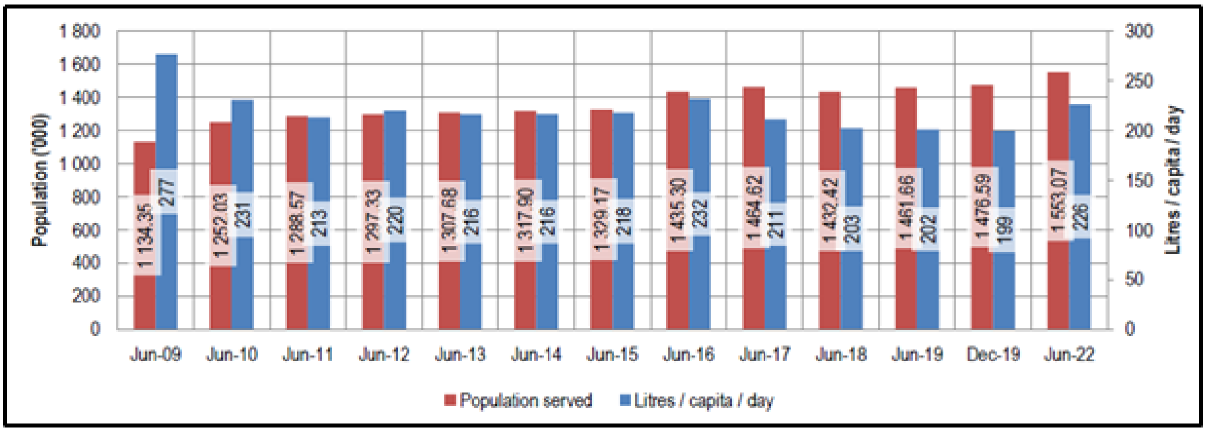


Figure 7.10 Algoa WSS per capita consumption trend

vi. *Amatole Water Supply System*

The per capita consumption for AmWSS is presented in Figure 7.11. The average per capita consumption has been stable over the past few years.

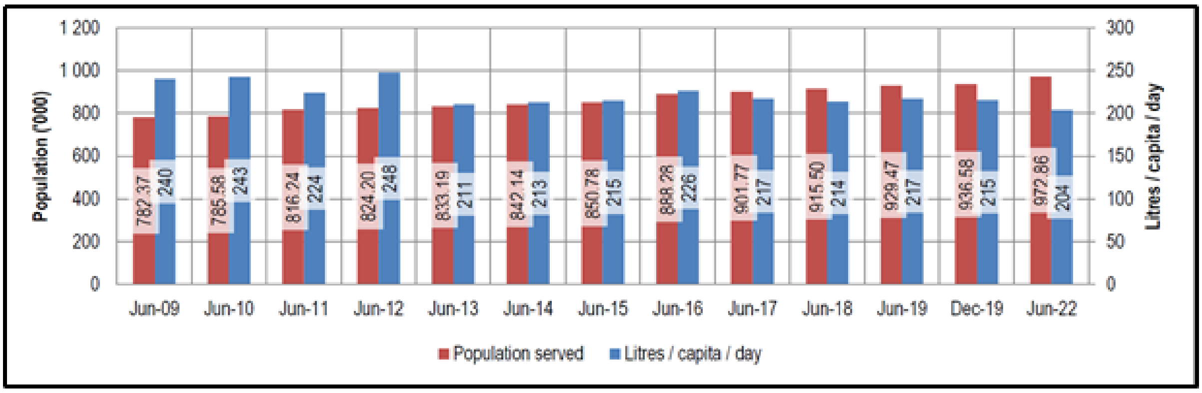


Figure 7.11 AmWSS per capita consumption trend

vii. Greater Bloemfontein Water Supply System

The per capita consumption for MMM is shown in Figure 7.12. The average per capita consumption has been improving over the past few years. However, it can improve considering the level of service. Restrictions of 15% were implemented in MMM during July 2015, which was increased to 20% in July 2016 due to resources being under stress.

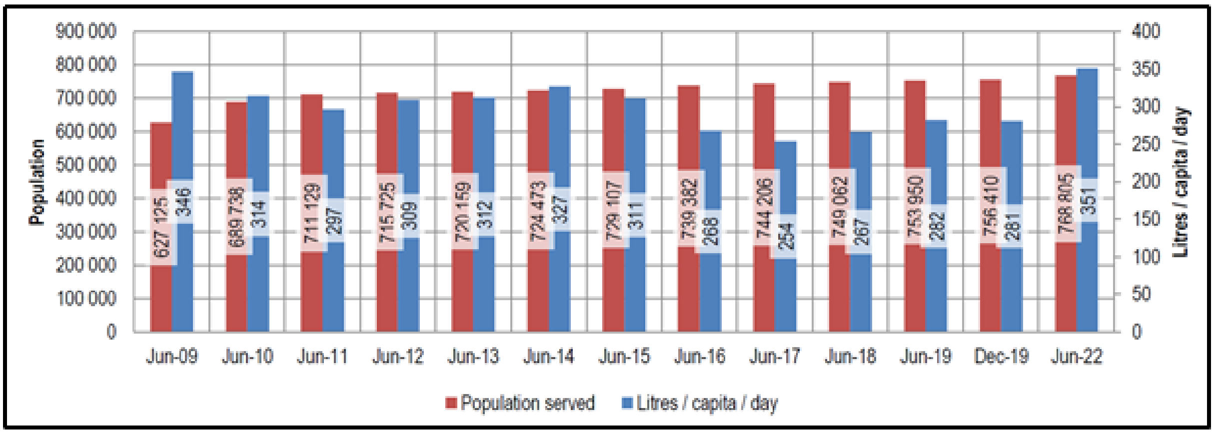


Figure 7.12 MMM per capita consumption trend

viii. Olifants River Water Supply System

The per capita consumption is shown in Figure 7.13. However, there is a very low confidence level in the unit consumption decrease over the past five years. The current estimated average consumption is 184 ℓ/c/d.

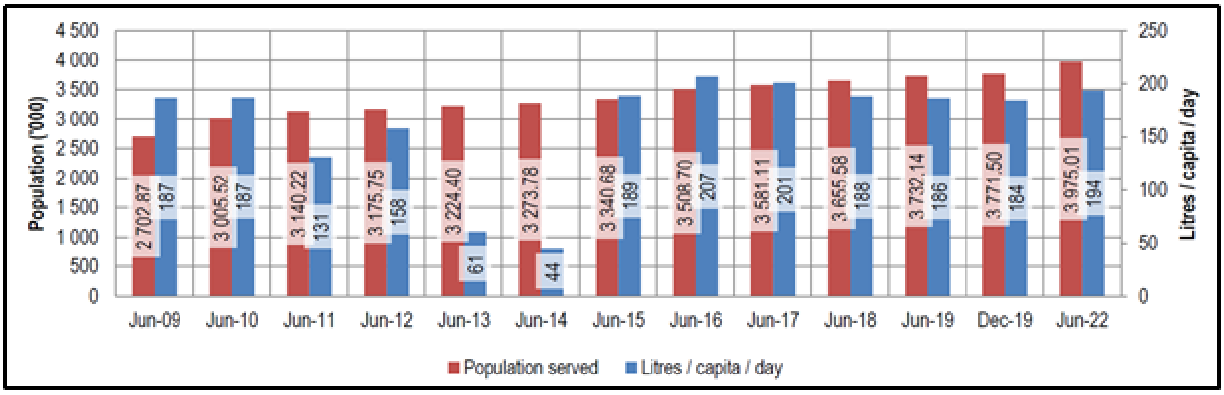


Figure 7.13 ORWSS per capita consumption trend

8

WATER RESOURCE PROTECTION

8 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 decline in water quality limits ecosystem goods and services such as water quality improvement, streamflow regulation, and flood attenuation operations. The maintenance of ecosystem goods and services has an economic value as water ecosystems can buffer human settlements and build infrastructure against extreme events that are likely with climate change, playing a crucial and cost-effective role in the disaster-risk reduction. Therefore, water resource quality must be effectively managed to achieve sustainable water use for the benefit of all users.

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.

8.1 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 8.1, 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 8.2.

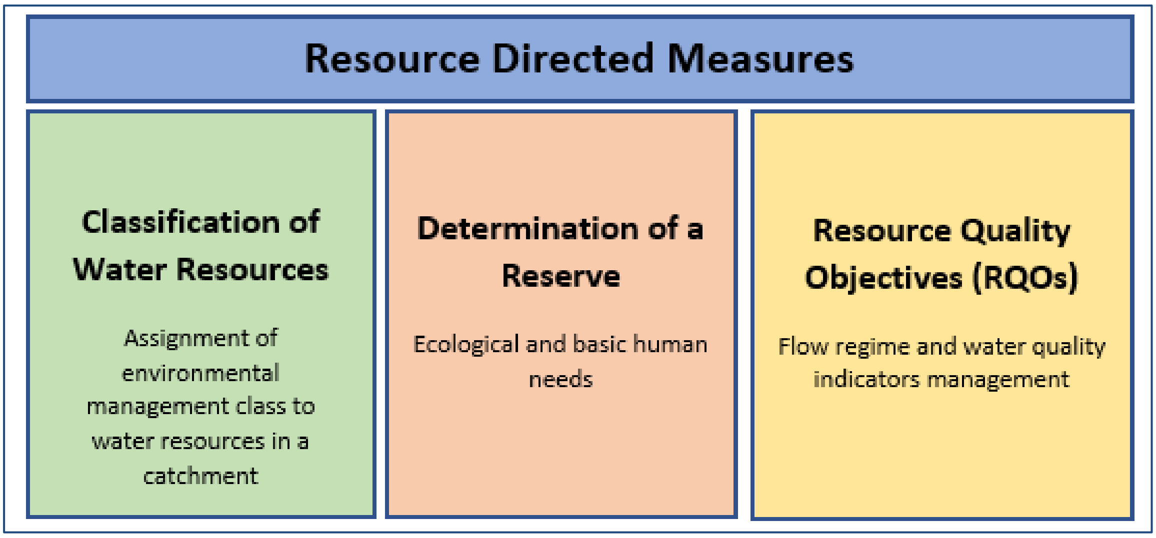


Figure 8.1: Three-stages processes of RDMs

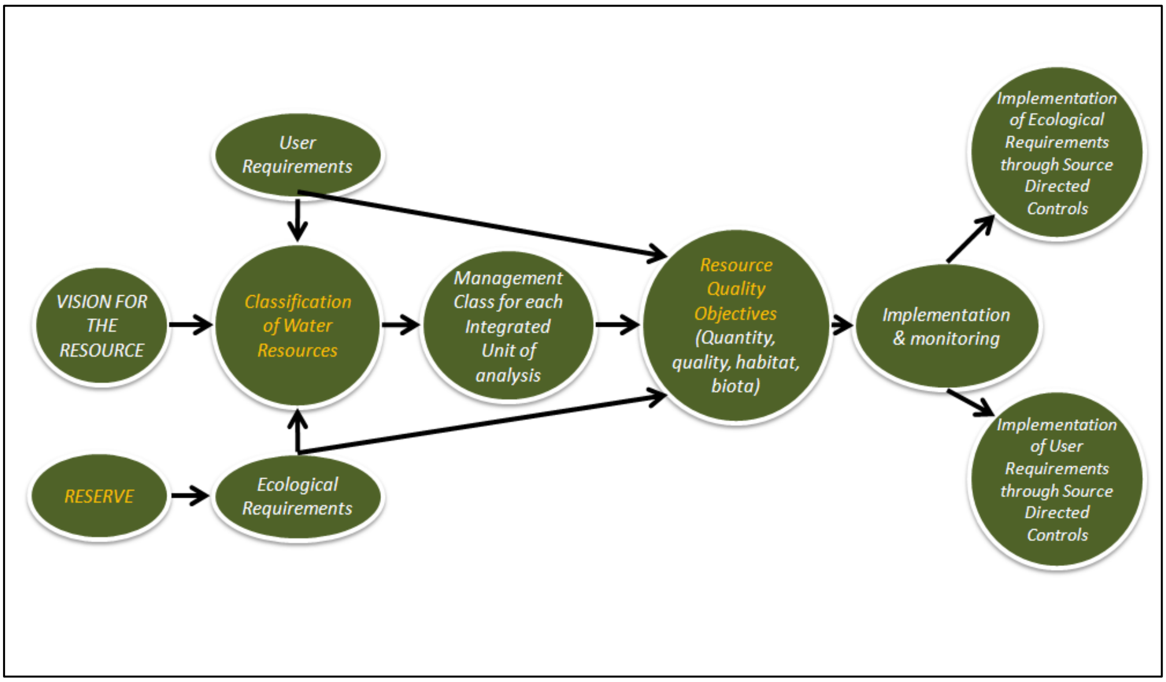


Figure 8.2: The Linkages between the RDMs processes.

8.1.1 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. This system 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 a 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 8-1, 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 8-1: 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.*

8.1.2 Resource Quality Objectives (RQOs)

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, condition, and distribution of the aquatic biota.

In 2011, the Department developed a procedure for the determination of RQOs. The RQO determination procedure 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 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*.

8.1.2.1 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

DWS has completed and gazetted the Water Resources Classes (WRCs) and the determination of associated RQOs in several WMAs, as shown in Figure 8.3 and in Table 8-2. In some catchments, including Inkomati and Olifants-Doorn, the final WRCs and RQOs have been implemented and are currently being monitored through the surface water resources monitoring programmes.

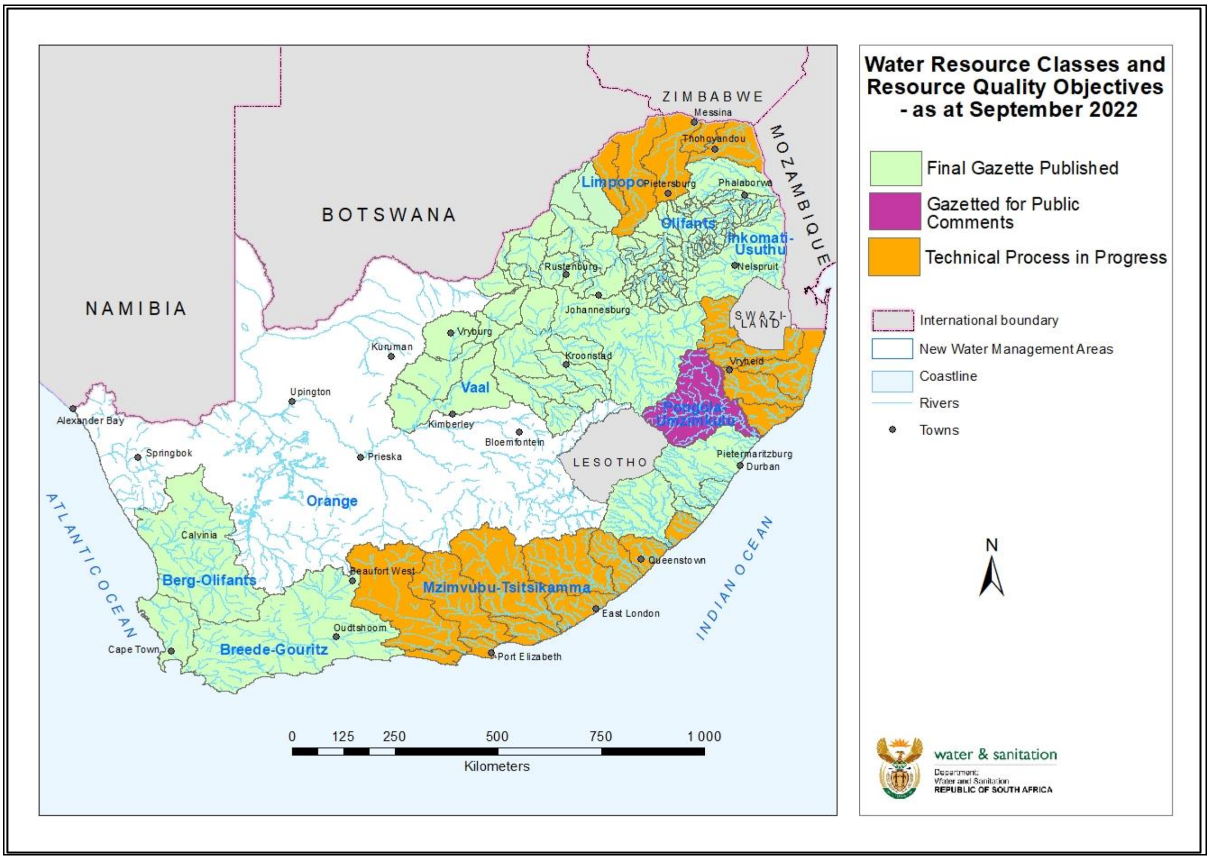


Figure 8.3: Overview status of WRC and RQO determination progress post-2010 to September 2022.

Table 8-2: 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	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 39943 of 22 April 2016
Letaba and Inkomati	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 40531 of 30 December 2016
Mvoti to Mzimkhulu	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 41306 of 08 December 2017
Crocodile (West) and Marico, Mokolo, and Matlabas	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 42775 of 18 October 2019
Breede-Gouritz	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 43726 of 18 September 2020
Mzimvubu	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 43015 of 14 February 2020
Berg	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 43872 of 06 November 2020

(ii) WRCs and RQOs Determination in Progress

The determination of WRCs and RQOs is still in progress in some study areas shown in Figure 8.3 and detailed in Table 8-3. In the uThukela Catchment, the finalised WRCs and the associated RQOs are scheduled for publication in March 2023, while the rest of the study areas are currently completing the technical processes.

It should be noted that after the completion of the technical processes in a particular river system, a legal notice for the proposed water resource classes and the associated proposed RQOs is published in the Government Gazette for a 60 day's public commenting period.

The public comments received are considered in order to finalise the WRCs and the associated RQOs. Once the Minister of Water and Sanitation approves the final WRCs and the associated RQOs for the respective river systems, these are published in the Government Gazette, and they become binding on all institutions and authorities.

Table 8-3: Overview of WRCs and RQOs determination processes as of September 2022.

Study Areas	Status	Government Gazette No.
Thukela	The Department published the notice containing the proposed water resource classes together with the associated proposed resource quality objectives for public comments on **11 March 2022**. The closing date for receiving comments was **10 May 2022.** Preparations for publishing the final gazette is currently underway and the final gazette is scheduled to be published by **March 2023**.	GG 46032 of 11 March 2022
Fish to Tsitsikamma	The technical process for the determination of WRCs and associated RQOs commenced in **September 2021** and is scheduled to complete in **September 2024.**	Not yet gazetted
Luvuvhu	The technical process for the determination of WRCs and associated RQOs commenced in **October 2021** and is scheduled to complete in **September 2025**.	Not yet gazetted
Usuthu to Malthouse	The technical process for the determination of WRCs and associated RQOs commenced in **December 2021** and is scheduled to complete in **May 2024**.	Not yet gazetted

(iii) Outstanding Water Resource Classifications and RQOs studies

The Department is, as of September 2022, only left with the Orange River System, which has outstanding water resource classes and Resource Quality Objectives determination studies, as shown in Figure 8.4. The Classification process in the Upper and Lower Orange is anticipated to commence in the 2023/24 financial year.

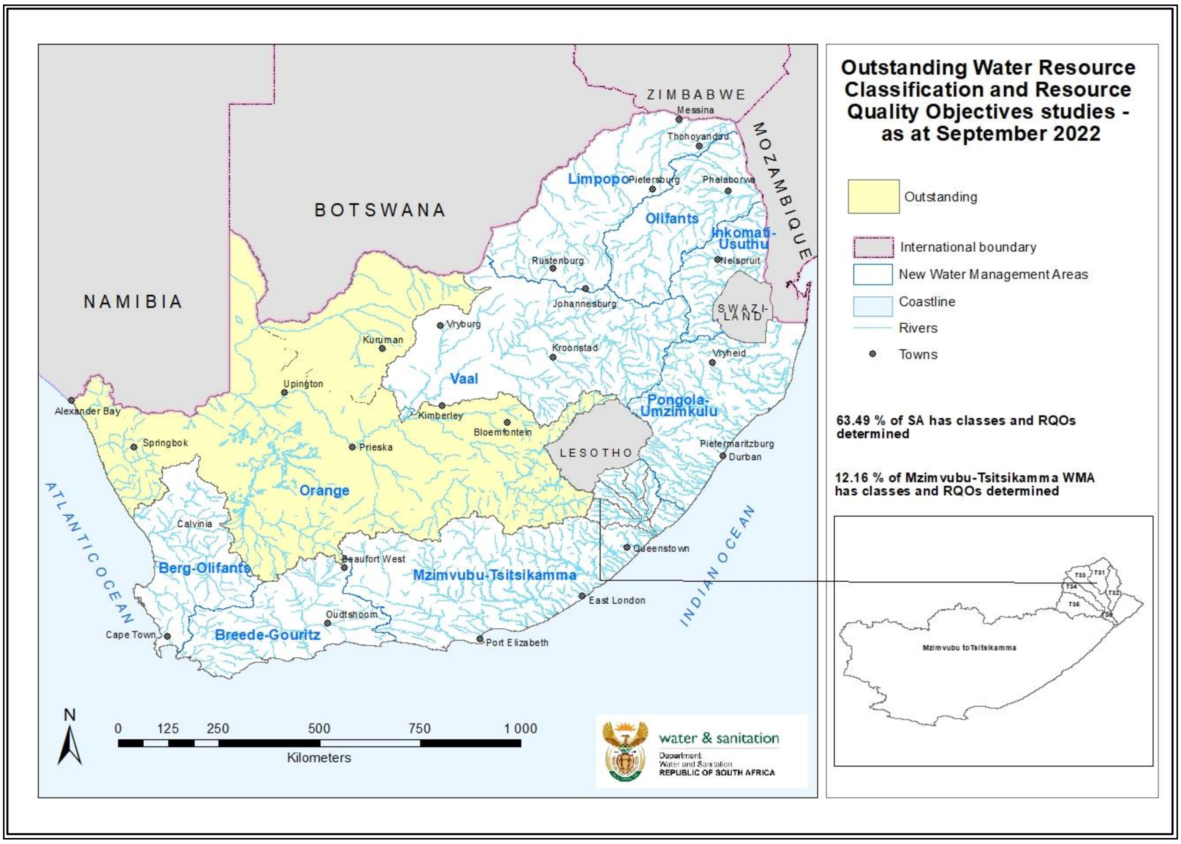


Figure 8.4: Outstanding Water Resource Classification and RQOs studies as of September 2022.

8.1.3 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 in the maps shown in Figure 8.5 and Figure 8.6. These maps have been made available to the regional offices to assist in the decision-making process for processing Water Use Authorisation applications.

Present Ecological State, Ecological Importance & Sensitivity Database, 2013

The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) have been determined for all main stem rivers in 1946 Quaternary catchments in South Africa (Kleynhans, 1999). The 2011 PES/EIS update included the PES and EIS for main stem rivers and their tributaries and important wetlands (DWS, 2014). The 1999 and 2011 PES/EIS databases are based on high confidence Reserve information that has been extrapolated to areas where there was insufficient data (Kleynhans, 1999; DWS, 2014).

The current desktop Reserve model used to produce desktop Reserves uses the updated PES/ EIS as input data for the ecological condition of any given water resource. The determination of the Ecological Water Requirements (EWR) requires the PES/EIS information to establish a Recommended Ecological Category (REC) for a particular river and for which the desktop Reserve model is run to determine the EWR. The PES/EIS (Kleynhans,1999 & DWS, 2014) data has been essential as input data to assess Water Use Licence Applications (WULA) and determine licensing conditions for water resource protection. The latter is especially applicable to non-consumptive users, such as Section 21 (c) and (i), where setting the flow is not the priority but specifying conditions to protect the habitat per the NWA. The Ecological Importance and Sensitivity component is of particular importance to indicate the sensitivity of the water resource to any imposed changes/impacts and to point out “red flags” or hot spot areas that require specific protection to secure the ecological health/state of the water resource.

Furthermore, the PES/EIS information is still being used extensively in the ecological monitoring programs such as the National Aquatic Health Monitoring Program (NAEHMP), notably the River Eco-status Monitoring Programme (previously known as River Health Programme) and has been used as the baseline information for compilation of the National Freshwater Ecosystem Priority Areas (NFEPA’s) produced by the South African National Biodiversity Institute, (SANBI).

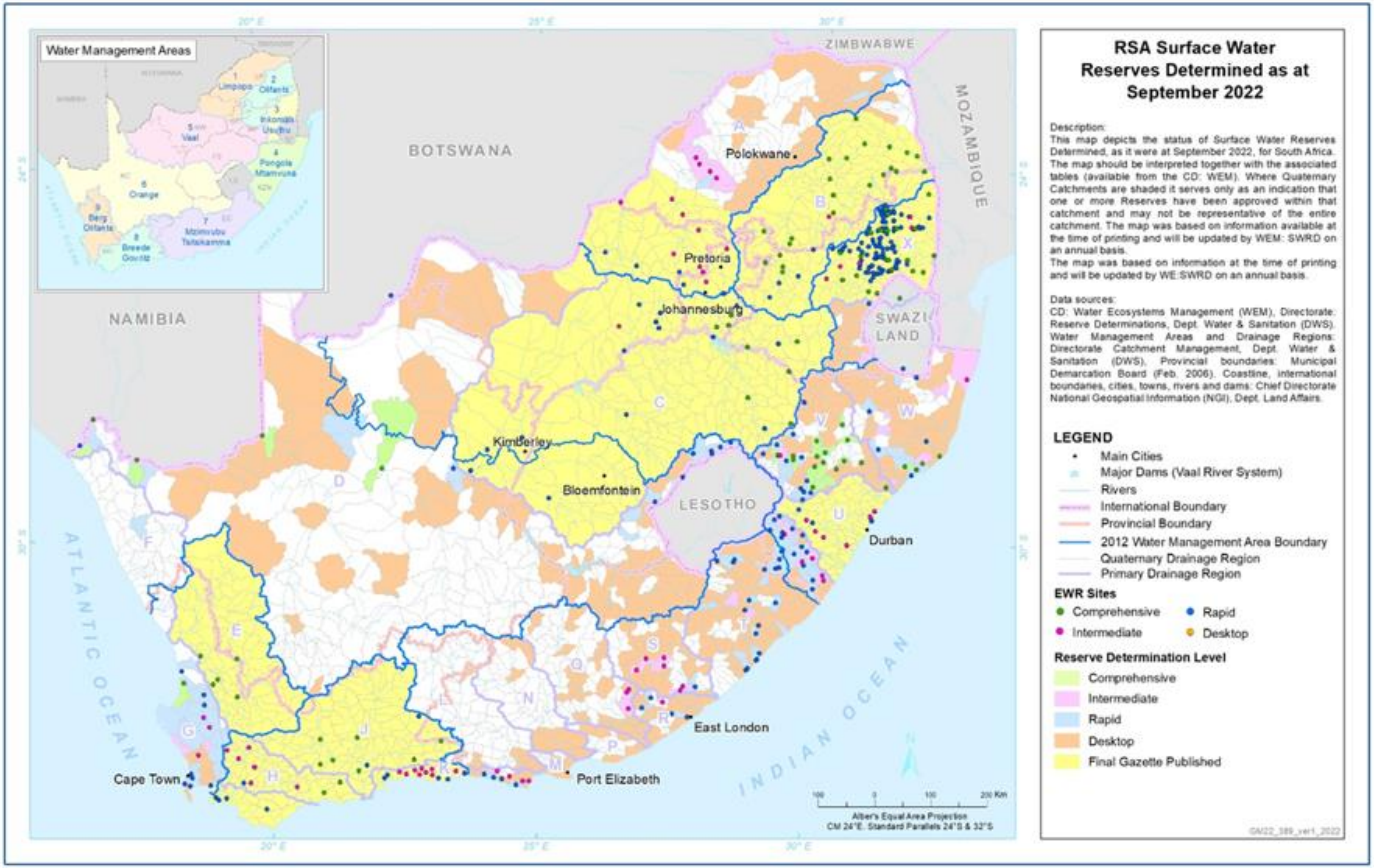


Figure 8.5: Surface Water Reserves determined as of September 2022.

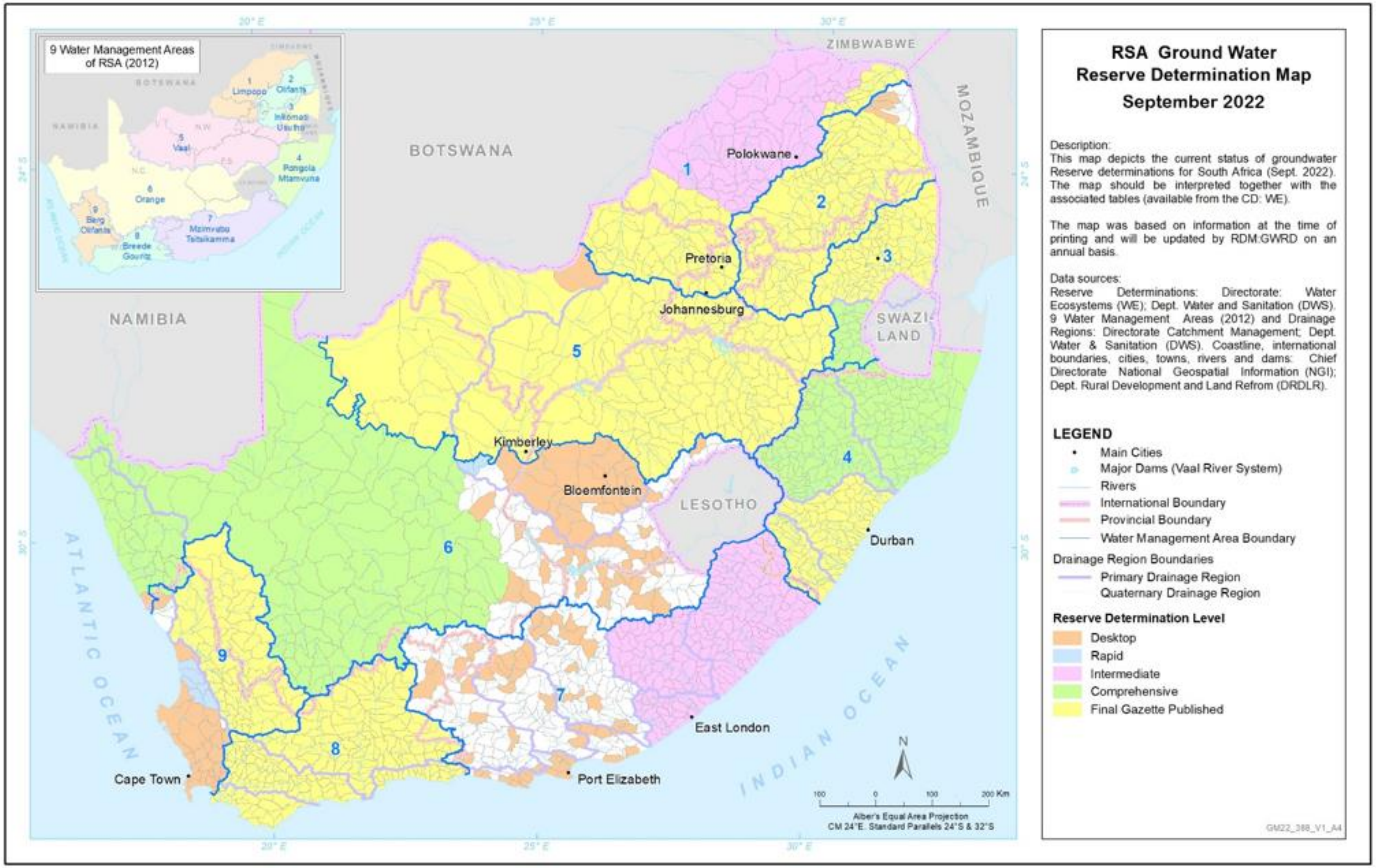


Figure 8.6: Groundwater Reserves determined as of September 2022.

(i) DWS Progress on Reserve Determination

A total of 20 desktop Surface Water Reserves have been determined and completed between October 2021 to September 2022. The number and level of Surface Reserves determined/approved per Water Management Area (WMA) are detailed in Table 8-4.

Table 8-4: Summary of Surface Water Reserves per WMA completed between October 2021 and September 2022.

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-Mzimkhulu	0	0	0	0	0
Vaal	5	0	0	0	5
Orange	1	0	0	0	1
Mzimvubu-Tsitsikamma	13	0	0	0	13
Breede-Gouritz	1	0	0	0	1
Berg-Olifants	0	0	0	0	0
TOTAL	**20**	**0**	**0**	**0**	**20**

(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 8-5.

Table 8-5: 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-Mzimkulu	41970
Inkomati	42584

Water Management Area/Catchments	Government Gazette Number
Olifants/Letaba (excluding B9 Shingwedzi secondary drainage region)	41887
Breede-Gouritz	46798
Croc-West and Marico	45568

8.2 Source Directed Controls (SDCs)

The role of SDCs is to ensure that the cumulative impacts of water use, in respect of quantity and quality, are not exceeding the limits appropriate to the class of the resource. SDCs are imposed on water use in order 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, 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.

8.2.1 Current SDCs Projects

The National Water Act (NWA) (Act No. 36 of 1998) provides for efficient, sustainable, and equitable water resource protection, use, conservation, management, and control. The comprehensive protection of water resources aims to ensure that water is available for current and future human use and to sustain the river ecosystems. In order to accomplish this, the Department has initiated projects through the Directorate: Source Directed Studies, which address the country's eutrophication impacts and rehabilitate water resources for the effective functioning of the water ecosystem. The projects are discussed in sections 8.2.1.1 and 8.2.1.2.

8.2.1.1 The Development of the Eutrophication Strategy for South Africa

The Department initiated this project in 2019. It was conducted internally and completed in 2022. The main aim of the project was to develop an EMSSA which will give effect to the strategic objectives and actions identified in the draft Integrated Water Quality Management (IWQM) Policy (2016), IWQM strategy (2017), and the National Water and Sanitation Master Plan (2018). The strategy is expected to assist in tackling issues related to the degradation of water resources due to excessive nutrient enrichment in water resources, which is key to addressing eutrophication. Figure 8.7 provides a brief synopsis of the project.

The Development of the Eutrophication Management Strategy for South Africa

Aim: *The aim of the project was to develop a Eutrophication Management Strategy to address issues related to the degradation of water resources due to excessive nutrient enrichment.*

***Project Objectives**:*

- Promote the allocation of resources (human, financial and technical) to deal with the problem of eutrophication;
- Provide the country with appropriate direction on how eutrophication should be controlled and managed;
- Monitor and report on the national status of coordinated efforts/intervention toward effective management of eutrophication;
- Promote the development of the national eutrophication-centred capacity; and
- Promote localisation of interventions such as the implementation of catchment assessment, monitoring stakeholder engagement, and implementation of catchment actions.

***Project Status**: Completed*

✓ *The EMSSA (Second Edition), and Eutrophication Management Strategy into Practice (EMSIP) (First Edition) reports have been completed.*

✓ *Stakeholder consultations have been undertaken through the Project Steering Committee (PSC), Catchment Management Forums, and at the ministerial level through the National Water and Sanitation Summit held in February 2022.*

Figure 8.7: Summary of eutrophication strategy development for SA rivers project

8.2.1.2 Rehabilitation Management Guidelines for Water Resources

The Department initiated the project in 2020 to develop the Rehabilitation Management Guidelines (RMG) for Water Resources in South Africa. The project draws from policies and strategies within the DWS such as the National Water Resource Strategy (NWRS), National Water and Sanitation Master Plan (NWSMP), Integrated Water Quality Management Policy and Strategy (IWQM) and Disaster Management which all call for proactive measures to mitigate water resource quality degradation and promote rehabilitation and restoration to maintain water ecosystem function.

The situation assessment phase, completed in March 2022 as shown in Figure 8.8, effectively identified five themes for the Rehabilitation Guidelines to be developed.

These themes have been categorised into Rivers, Wetlands, Estuaries, Dams and Lakes, and Groundwater as per the Act. The development of the RMG for Estuaries and Groundwater is currently underway. The draft guidelines for Dams and Lakes will be undertaken in the beginning of 2023 and will be completed by March 2023, it is anticipated that the project will be completed in July 2023.

Rehabilitation Management Guidelines for Water Resources

Aim: *To develop the Rehabilitation Management Guidelines (RMG) for Water Resources in South Africa in order to promote the protection of water resources which is critical for ensuring healthy ecosystems and water availability for current and future use.*

Project Objectives:

- 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 practices guidelines for rehabilitation management of water resources.

Project Status: *In-Progress*

Draft guidelines that have been completed:

- ✓ *Draft Rehabilitation Management Guidelines for Rivers Report;*
- ✓ *Draft Rehabilitation Management Guidelines for Wetlands Report.*

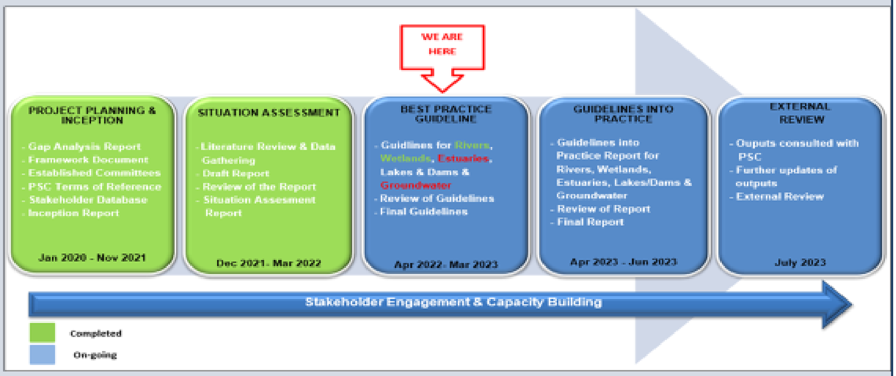


Figure 8.8: Summary of the Rehabilitation Management Guidelines Project.

9

WATER SERVICES REGULATION

9 WATER SERVICES REGULATION

9.1 The Green Drop 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, 2022a).

Consequently, the Green Drop certification process recognises and rewards progressive improvement and excellent performance. The process measures and compares the results of the performance of water services institutions and subsequently rewards or reprimands the institution upon evidence of their excellence or failures according to the minimum standards or requirements that has been defined.

9.1.1 The 2021 Green Drop Assessment

The first Green Drop Report was issued in 2009, and the latest report for the audit period 01 July 2020 to 30 June 2021 was issued in May 2022. A total of 144 municipalities were audited during the 2021 Green Drop certification process, as shown in Table 9-2, which was a decline when compared to the 2013 assessment period, where 152 municipalities were assessed. The decrease in the number of municipalities audited in 2021 is a result of Local Government reforms, which have resulted in the merging of some municipalities, combined with several name changes. A total of 850 systems were assessed in 2021 compared to 824 in 2013. The increase in the number of assessed systems is mostly a result of new treatment works constructed since 2013 or existing systems registered on the Department's IRIS system.

The Department reported a 100% audit coverage of all identified Water Services Institutions for this audit period (DWS,2022a). The Green Drop Report stated that many rural municipalities struggle to score more than 50%, and only 5% of rural municipalities (Free State and Limpopo) achieved this score in comparison to 75% of systems in Gauteng (DWS, 2022a). The high scores in urban municipalities often correspond to the availability of relevant skills, which are more prevalent in these areas (DWS, 2022a). **In the recent report, 39% of systems were identified as in a critical state compared to 29% of the systems in 2013,** as shown in Table 9-1. This indicates that there has been a regress in the state of wastewater systems. The Green Drop audit process also established that WSIs (Water Services Institutions) with low levels of investment in infrastructure, and low capacity in respect of skilled personnel, were more likely to have wastewater systems in a critical state. Figure 9.1 shows the national performance overview of municipal wastewater management.

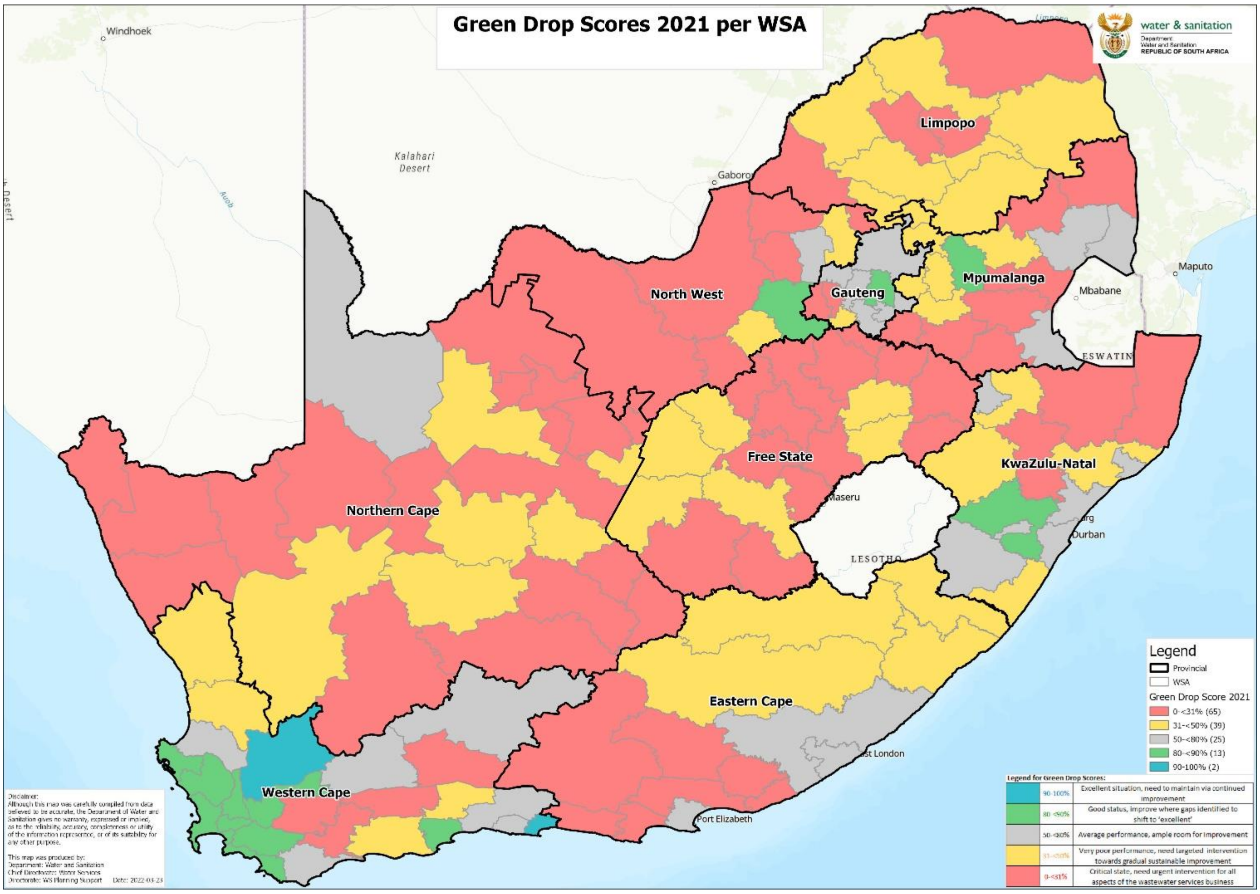


Figure 9.1: National compliance of municipal wastewater management.

The Department determined that 23 wastewater systems scored a minimum of 90% when measured against the Green Drop standards and thus qualified for a Green Drop Certification, this compares lower than the 60 systems awarded Green Drop Status in 2013. The comparative analysis of the green drop results since inception, and the 2021 GD performance highlights are outlined in Table 9-1.

The Water Services Institutions that were Green Drop certified include the City of Ekurhuleni, Lesedi LM, iLembe DM, uMgungundlovu DM, Witzenberg LM, Bitou LM, Drakenstein LM, City of Cape Town, Saldanha Bay LM, Mosselbay LM, and Sasol Sasolburg. A further 30 Green Drop Contender systems were identified with audit scores of <90%, but with microbiological- and chemical effluent quality not meeting the Green Drop standard.

Table 9-1: 2021 Green Drop highlights (Source: The DWS, 2022a)

Provinces	2013 GD Score (%)	2021 GD Score (%)	2021 GD Certified ≥90%	2021 GD Contenders (89%)	2021 Critical State (<31%)
Eastern Cape	65%	54%	0	0	48
Free State	51%	26%	0	0	64
Gauteng	83%	68%	7	5	9
KwaZulu Natal	82%	68%	3	1	20
Limpopo	45%	29%	0	0	50
Mpumalanga	44%	49%	0	3	33
North West	47%	30%	0	0	33
Northern Cape	44%	41%	0	0	59
Western Cape	85%	84%	12	21	18
Totals	-	-	**22**	**30**	**334**

Table 9-2 demonstrates an upward trend in average Green Drop (GD) scores from 37% in 2009, 45% in 2011, and 46% in 2013, followed by a decrease to 37% in 2021. A similar trend is observed for the number of systems with GD scores of ≥50%, which increased from 216 to 415 systems (44%) over the 2009 to 2013 period but decreased to 309 (36%) in 2021. This trend was mirrored by the number of systems with a GD score of ≤50% decrease from 460 (56%) in 2011 to 409 (49%) in 2013, followed by a regress to 541 (64%) in 2021. The same 'upward-downward' trend is also reflected by the average TSA score, which had increased from 51% in 2011 to 58% in 2013 but decreased to 47% in 2021. The Green Drop Certifications decreased from 60 awards in 2013 to 22 awards in 2021. It is also evident from Table 9-1 that a significant proportion of the wastewater systems are in either a *Critical State* or *Poor Performance* systems. **"It is of concern that 334 systems regressed to a critical state in 2021, compared to 248 systems in this category in 2013"** (DWS, 2022a).

Table 9-2: Green Drop trend analysis from 2009 to 2021 (Source: DWS, 2022a).

GREEN DROP COMPARATIVE ANALYSIS					
Performance Category	2009	2011	2013	2021	Performance trend 2013 and 2021
Incentive-based indicators					
Municipalities (WSAs) assessed (#)	98 (26%)	156 (100%)	152 (100%)	144 (100%)	→
Wastewater systems assessed (#)	444	821	824	850	↑
Average Green Drop score	37%	45%	46%	37%	↓
Green Drop scores ≥50% (#)	216 (49%)	361 (44%)	415 (51%)	309 (36%)	↓
Green Drop scores <50% (#)	228 (51%)	460 (56%)	409 (49%)	541 (64%)	↓
Green Drop Certifications (#)	33	40	60	22	↓
Technical Site Inspection Score (%)	NA	51%	58%	47%	↓

NA = Not Applied NI = No Information *↑= improvement, ↓= regress, →= no change*

9.1.2 The National Green Drop Risk Ratio

The National Green Drop Risk Ratio, which provides a risk perspective for treatment plants, demonstrated an overall risk deterioration from 2013 to 2021. Municipal plants regressed from medium risk to high risk, while the Department of Public Works (DPW) plants regressed from 80% to 88% (critical risk). All private- and state-owned works are in low- or medium-risk positions. The most prominent risks were observed at the treatment level and pointed to works that exceeded their design capacity, dysfunctional processes and equipment (especially disinfection), lack of flow monitoring, and effluent and sludge non-compliance. This reflects the increased demand placed on existing collection and treatment infrastructure due to expansion driven by population and economic growth. The overall observations from the 2021 Green Drop assessments are as follows:

- Several institutions have invested in infrastructure upgrades but still fail the regulatory standards, mostly not meeting effluent quality limits and engineering and workmanship standards.
- Infrastructure is often being upgraded with the full system being taken out of commission, allowing untreated wastewater to bypass the plant discharging directly to the resource.
- There is a concern about the overall sub-standard quality of final effluent and biosolids that are being discharged to the receiving environments.
- Institutions with lower technical skills ratios were generally associated with lower Green Drop scores.
- Several wastewater systems are operating close to or beyond their hydraulic capacity.
- Severe deficiencies were found in the monitoring of operational and compliance parameters.

9.1.3 Wastewater Discharge Physical Compliance

Wastewater physical compliance measures compliance against physical variables of wastewater such as temperature (risk to aquatic life), suspended solids, and pH levels of wastewater. The physical wastewater compliance of WSA within each Province from **1 October 2021 – 30 September 2022** is presented in Figure 9.2. A total of 144 WSAs were monitored. According to data uploaded on IRIS, more than 60 percent of the WSAs achieved good to excellent physical compliance performance. Only one WSA in the Eastern Cape Province had poor wastewater physical compliance performance.

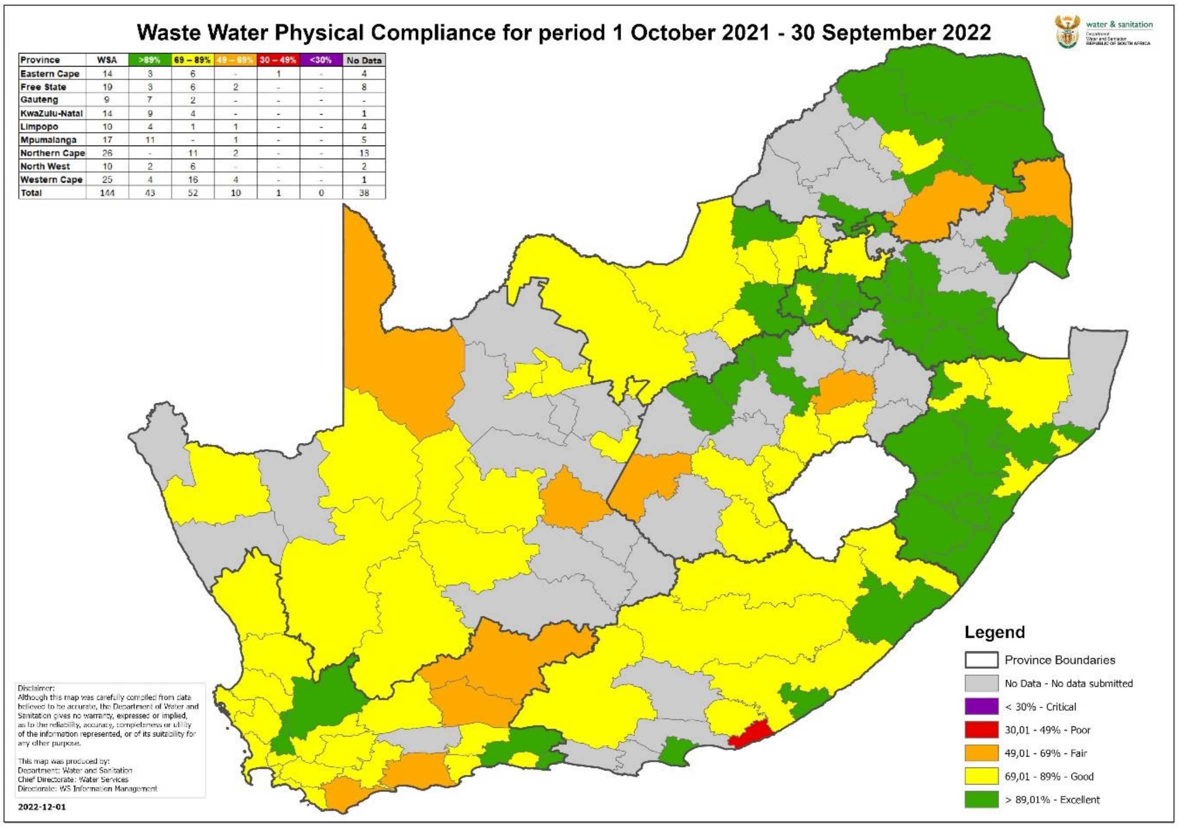


Figure 9.2: Wastewater physical compliance.

9.1.4 Wastewater Discharge Chemical Compliance

Wastewater chemical compliance monitoring is undertaken for wastewater treatment works in terms of soluble organic and inorganic pollutants that may be present in wastewater. Compliance is assessed against the water use authorisation issued to the Water Services Authority for the WWTW. Figure 9.3 presents the chemical compliance by WSAs per Province for the 2021/22 hydrological year. The typical chemical determinants in wastewater effluent are chemical oxygen demand (COD), ortho-phosphate, Nitrates, Nitrites, as well as Ammonia.

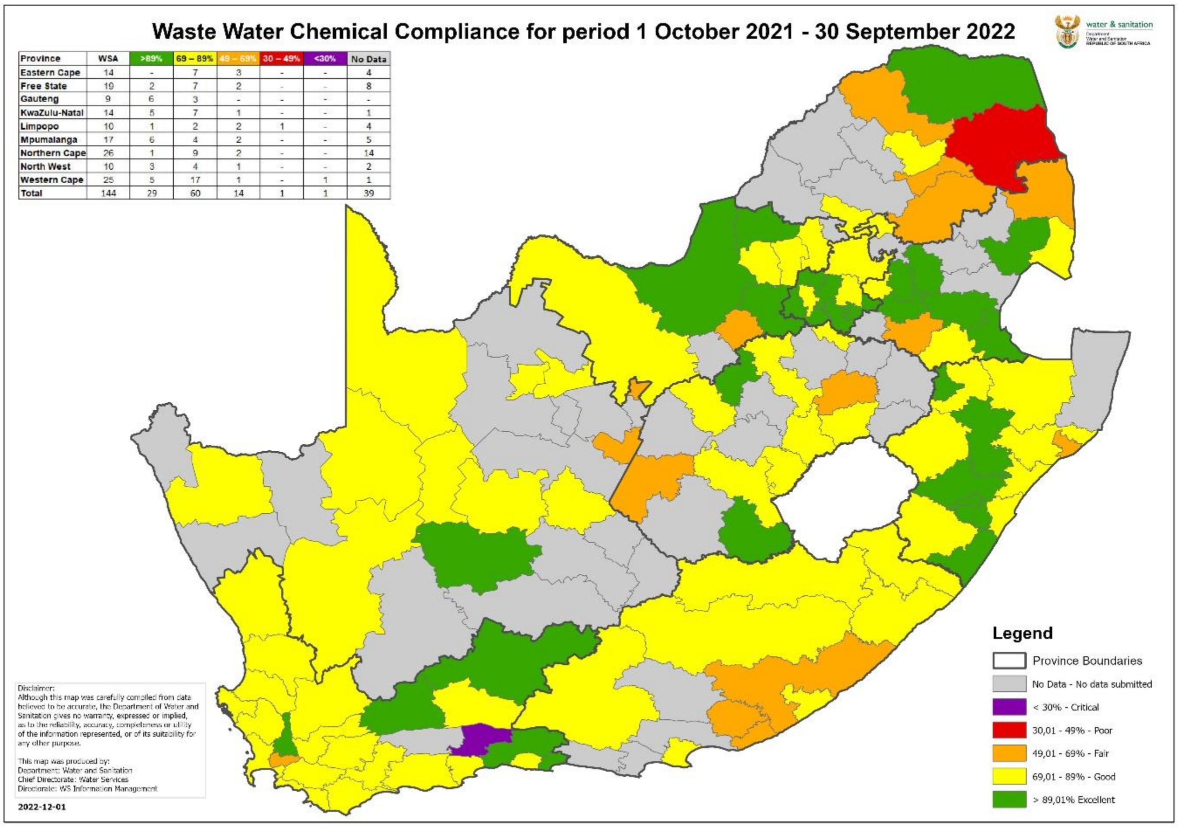


Figure 9.3: Wastewater chemical compliance.

One WSA in the Western Cape Province and one in the Limpopo Province were found to be in a critical and poor state respectively of wastewater chemical compliance. The Department should monitor this critical and poor performance on chemical compliance to ensure compliance as it poses a risk to the water resources.

9.1.5 Wastewater Discharge Microbial Compliance

Wastewater microbiological compliance monitoring is undertaken for wastewater treatment works in terms of microbial variables such as *E.coli* or Faecal Coliforms. These microbial variables indicate the level of faecal pollution but also the treatment efficiency of the WWTWs. The microbial compliance performance for effluent in WSAs per Province is presented in Figure 9.4.

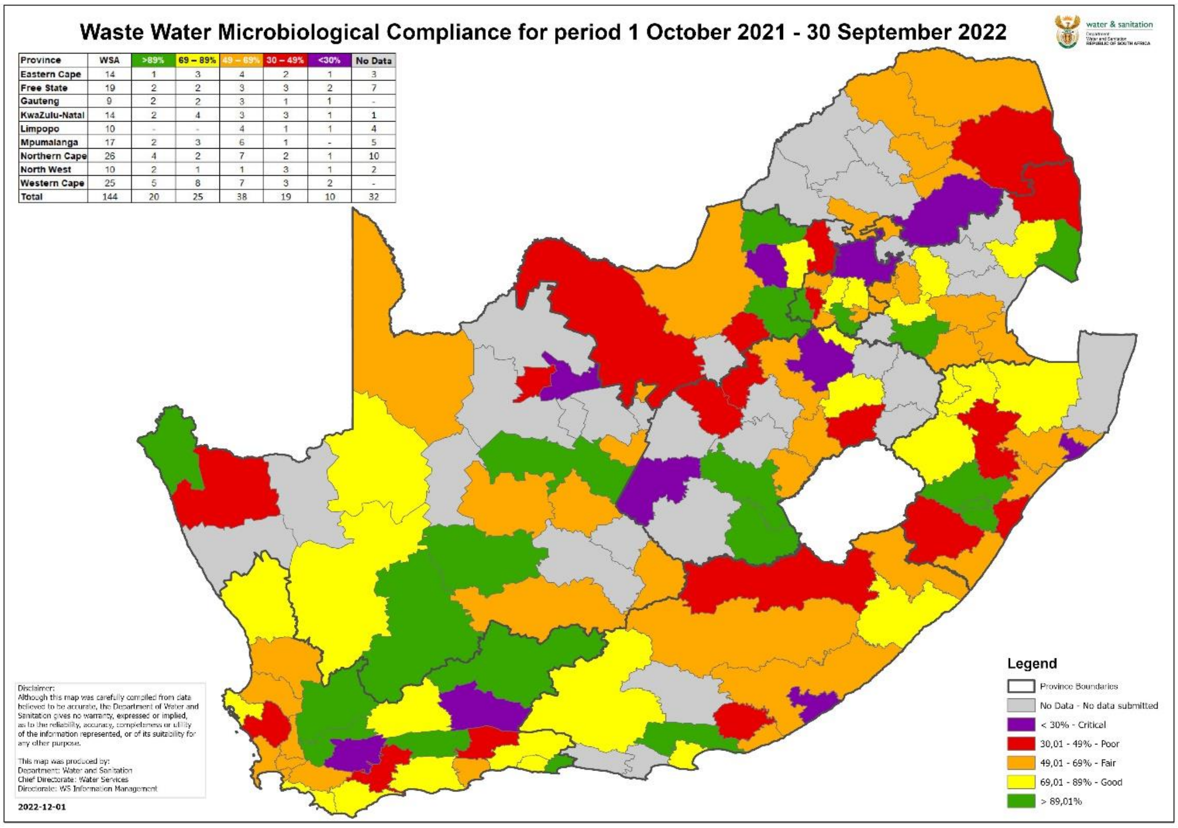


Figure 9.4: Wastewater microbial compliance.

In terms of microbiological compliance, ten WSAs were found to be in a critical state with less than 30% compliance during the current reporting period. About 14% of the WSAs monitored in the country achieved more than 89% (excellent compliance). The overall national picture shows a negative trend, as most wastewater treatment plants are non-compliant with effluent standards. Additionally, more than 20% of the WSAs across the country had no data, and therefore, their statuses could not be assessed.

9.2 The Blue Drop Programme

Incentive-based regulation was introduced in 2008 in the form of the Blue Drop Certification programme, whereby the Department of Water and Sanitation (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 Blue Drop 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 Water Services Act (Act No. 108 of 1997) prescribes the legislative duty of Water Service Providers (WSPs) to provide water and sanitation services according to national norms and standards. The National Water Act (No.36 of 1998) further compels the Minister to establish and maintain a national information system and monitor all water service institutions' performance. Based on this, the Department of Water and Sanitation established the Integrated Regulatory Information System (IRIS) to monitor drinking water quality. This is a system available to the public at http://ws.dwa.gov.za/IRIS/documents.aspx. The South African National Standard for drinking water (SANS:241) prescribes the minimum numerical limits that must be met for drinking water quality to be deemed safe for human consumption.

In South Africa, there are over 1 300 drinking Water Treatment Works (WTWs) owned by municipalities, water boards as well as privately owned WTWs. The Blue Drop assessment process is mainly championed by DWS regional offices, where drinking water quality compliance, plant, and process controller registration are thoroughly assessed to calculate the Blue Drop Risk Rating (BDRR) for each system. There are several determinants that are taken into consideration in determining compliance which are mainly grouped into microbiological (acute), chemical (acute) and chemical (chronic). In addition, physical and aesthetic determinants are also investigated. Compliance with drinking water standards must address the entire value chain in the water supply system, including sampling and testing of water at the treatment works intake and outflow points, in the distribution pipelines, reservoirs, and at the point of use as prescribed by the South African National Standard (SANS 241).

9.2.1 The 2021 Blue Drop Assessment

The Department conducted a Blue Drop assessment from 1 July 2020 to 30 June 2021, where 144 Water Services Authorities in South Africa comprising 1186 water supply systems were assessed, as shown in Figure 9.5. It is evident from Figure 9.5 that the Gauteng Province has the least number of supply systems (29). The Eastern Cape, KwaZulu-Natal, and North West Provinces have numerous supply systems with a low number of WSA’s. This is indicative of district municipalities who provide water to bulk water to rural schemes either directly as WSA or managing water service provision through local municipalities which operate as WSP.

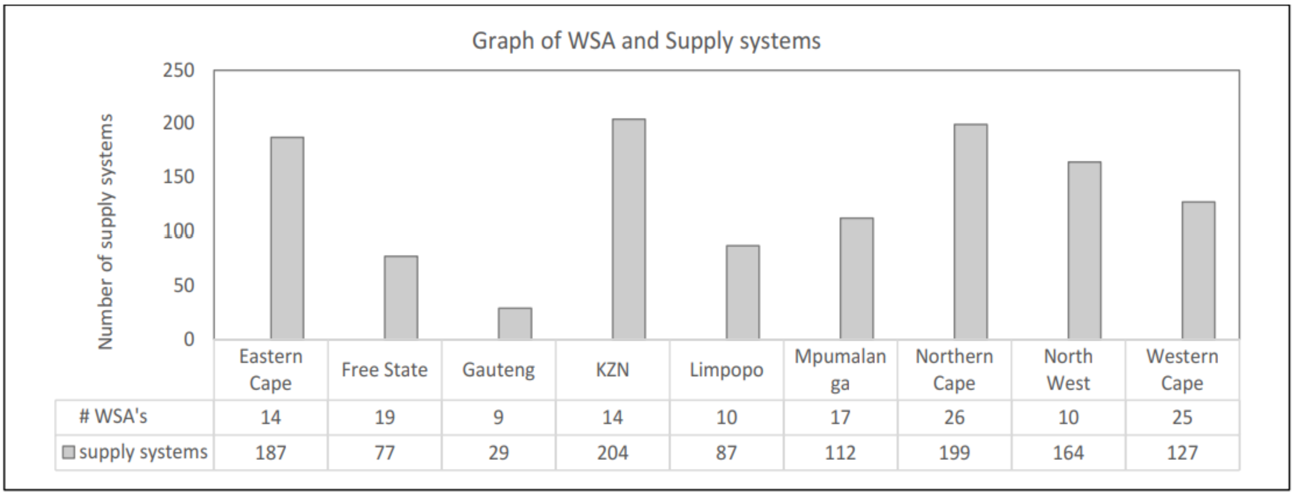


Figure 9.5: Graph of Number of WSA's and Supply systems for 2021(Blue Drop Progress Assessment Tool) BDPAT assessments (Source: DWS, 2022b)

The Blue Drop assessment of 2021 established that 48% of supply systems are in the *low-risk* category, while 34% of systems reside in the *high-risk* and *critical risk* categories. This is of concern to the Department as it presents a potential risk to consumers who are supplied by these supply systems (DWS, 2022b). The large proportion of low-risk supply systems in the Gauteng and Western Cape Provinces is a positive trend that the rest of the country must follow to ensure effective risk management of water services provided for all citizens in the country.

DWS (2022b) recommends that the 2021 BDRR score be used as a tool to implement strategic, targeted actions that will result in improved risk rating and sustainable water services delivery. The WSA must critically evaluate the individual components of the BDRR score to understand the reason for the current risk rating and the desired risk category for the delivery of safe drinking water. The 2021 Blue Drop assessment outcomes demonstrated in Figure 9.6 can be summarised as follows:

- 48% of supply systems are in low-risk category;
- 18% are in the medium-risk category;
- 11% are in the high-risk category; and
- 23% are in the critical risk category.

To use the BDRR score as a tool to implement strategic, targeted actions that will result in an improved risk rating and sustainable water services delivery, WSA's must critically evaluate the individual components of the BDRR score to understand the reason for the current risk rating and the desired risk category for delivery of safe drinking water.

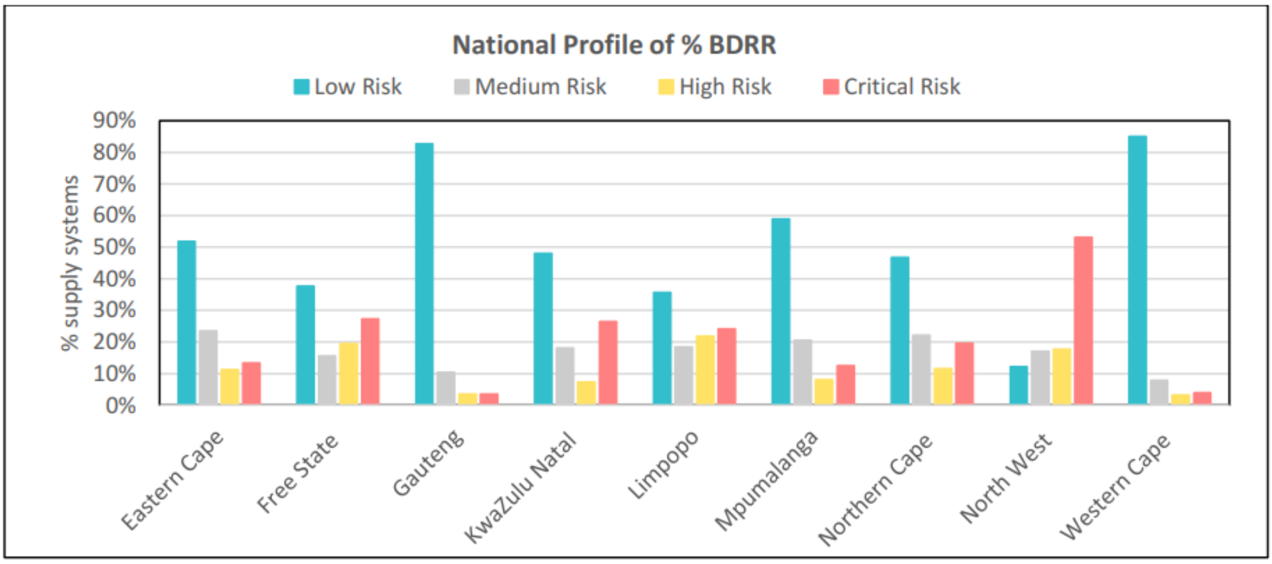


Figure 9.6: Breakdown of % BDRR scores per category (Source: DWS, 2022b).

9.2.2 Assessment of Blue Drop Risk Indicators

Risk Indicator A: Design Capacity, and *Risk Indicator B: Operational Capacity,* are important indicators to determine the plant's capability to provide sufficient and safe drinking water continuously. Once daily production approaches 90% of design capacity, the WSA must plan, budget, and implement projects to increase the treatment plant's capacity to ensure a sufficient supply for human consumption and economic activities. The 2021 BD assessment results indicated that 62% of plants are categorised as small plants (<2 Ml/d). Many of the supply systems did not provide daily operational flow data, which presents a serious risk.

Risk Indicator C: Water Quality Compliance is critical to ensure delivery of safe drinking water that does not present a health risk to consumers. This indicator reports on both water quality compliance and monitoring compliance which reports on enough sample points to verify the water quality at all points in the distribution network as outlined in SANS 241:2015. The results for Indicator C for the period January to December 2020 are summarised as follows:

- 40% of water supply systems achieved microbiological water quality compliance, and 23% have achieved chemical water quality compliance.
- 66% of water supply systems have adequate microbiological monitoring compliance, and 17% have adequate chemical monitoring compliance.

DWS noted poor water quality compliance results, which are of serious concern as most supply systems present a potential health risk to consumers (DWS, 2022b).

Risk Indicator D: Technical Skills evaluates the required technical skills to ensure effective operations and maintenance of water treatment plants and distribution networks. The assessment revealed that the availability of technical skills is poor throughout the country, with 12% of supply systems in low-risk category (90-100% compliance), 27% of supply systems with enough suitably classified process controllers per shift, 52% of supply systems with qualified supervisors, and 28% of systems with full maintenance teams in place, i.e., civil, mechanical and electrical personnel.

Risk Indicator E: Water Safety Plans is a measure of risk management procedures as outlined in SANS 241:2015 and World Health Organisation (WHO) guidelines. The results indicated that only 33% of supply systems in the country have Water Safety Plans, and 9% have comprehensive Water Safety Plans with all required components, including management approval, risk assessment, a risk-based monitoring program, and the implementation of corrective measures.

9.2.3 Chemical Drinking Water Compliance

The chemical water quality is determined by determinants 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, if risk to consumers has not been identified prior. 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 WSAs were assessed for the 2021/22 hydrological year, as shown in Figure 9.7 below. However, 45 of the 144 WSAs did not upload water quality data on the Integrated Regulatory Information System (IRIS) and could not be assessed. The results of the water supply systems compliance in terms of chemical drinking water quality: acute health determinants and chemical: chronic health from October 2021 to September 2022 are presented in Figure 9.7 and Figure 9.8, respectively.

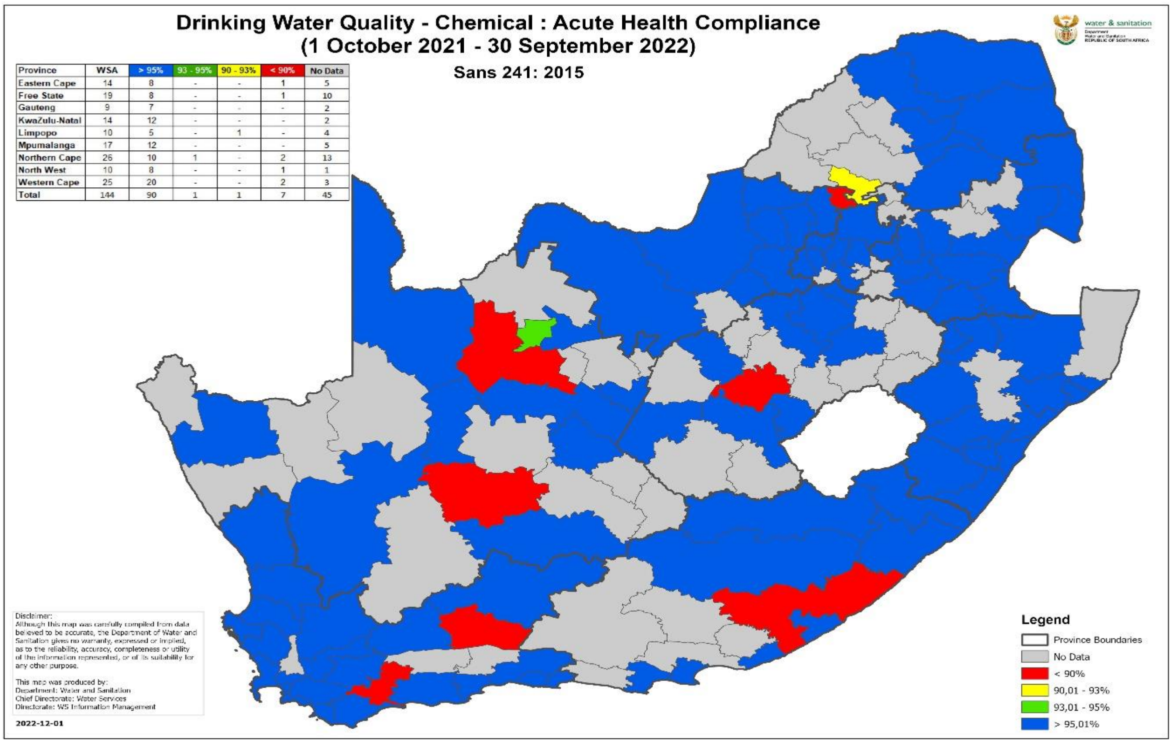


Figure 9.7: Status of drinking water chemical quality compliance: acute health.

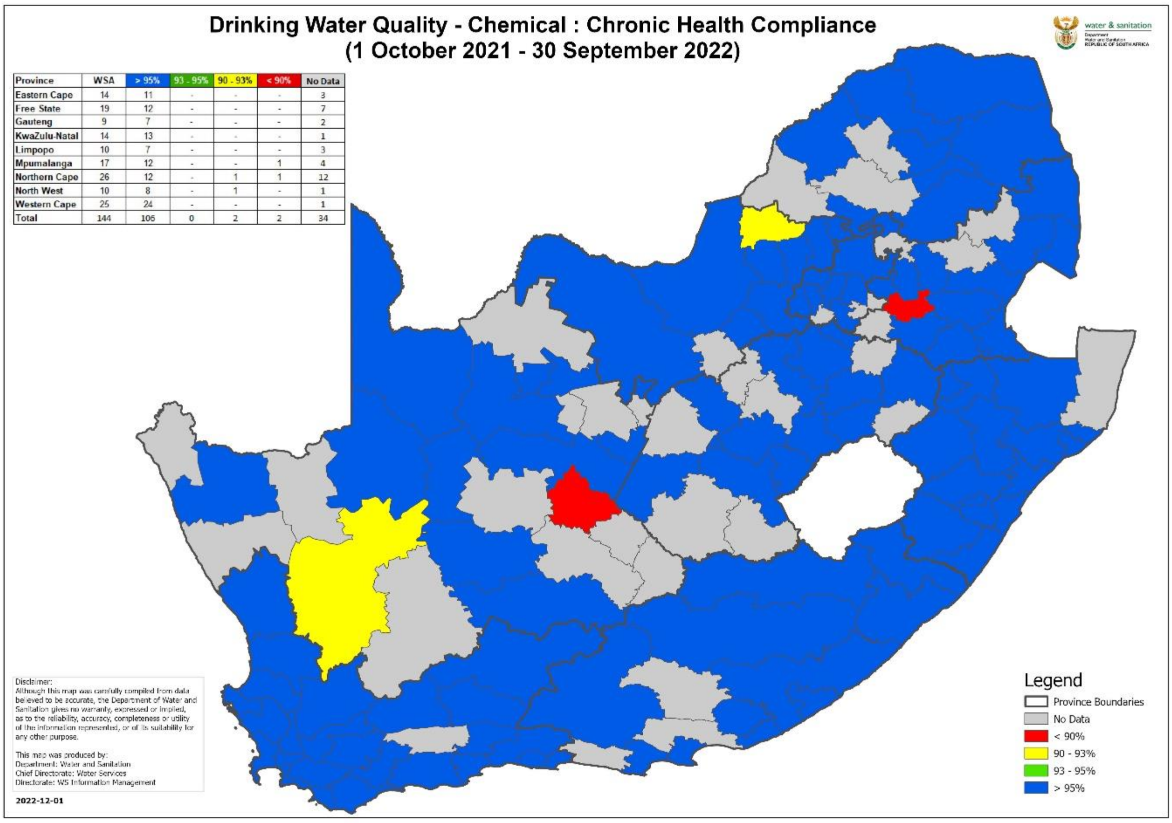


Figure 9.8: Status of drinking water chemical quality compliance: chronic health.

It is evident from the results presented that 62% of the systems demonstrated good to excellent compliance in terms of chemical quality compliance: acute health, while more than 73% achieved good to excellent compliance in terms of chemical quality compliance: chronic health. The Department will continuously investigate and monitor WSAs where:

(i) There were no reports uploaded on the IRIS; and
(ii) Non-compliance was observed (< 90%).

9.2.4 Microbial Drinking Water Compliance

Microbiological compliance reflects the actual compliance of the final water for the 2021/22 hydrological year against microbiological determinants. The presence of these determinants in water indicates sewage or animal waste contamination, which raises a potential risk of contracting diseases from pathogens. Therefore, WSAs are expected to be compliant 99% of the time for all microbial indicators analysed. The results for the drinking water microbial compliance for the reporting period are presented in Figure 9.9 below. For the reporting period (October 2021 – September 2022), a few WSAs achieved a 99% compliance level. **Most of the WSPs assessed had a compliance level below the acceptable 99% threshold**. It was also noted that 23 WSAs did not submit their data, thus impacting the national outlook as these WSAs could not be assessed in the absence of data submission to the Department.

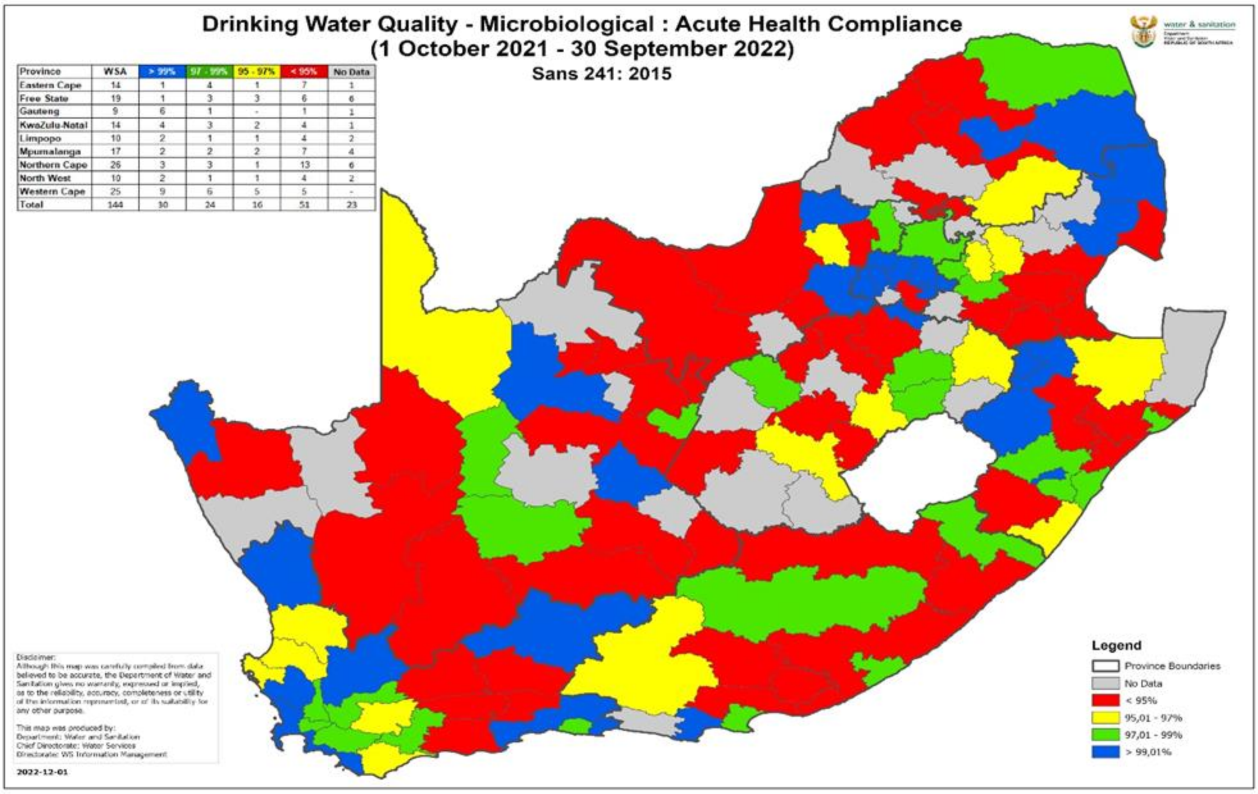


Figure 9.9: Status of drinking water microbial quality compliance: l acute health.

In terms of microbiological compliance, 35% of the water supply systems in the country fell under *critical risk* category for the reporting period (1 October 2021- 30 September 2022), and only 20% of the water supply systems achieved an excellent status. The overall low compliance results are of serious concern to the Department as most of the water supply systems present a potential health risk to the consumers.

The Department, through its provincial offices, is continuously monitoring and engaging with the WSAs whose microbiological compliance is below 99%, including those that are not submitting water quality results to the Department.

10

SANITATION SERVICES

10 SANITATION SERVICES

The Africa Water Vision 2025: is for *"an Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment."* This shared vision calls for a new way of thinking about water resources management and its use even in sanitation delivery programmes.

The first pillar of the shared Africa Water Vision 2025 focuses on "sustainable access to safe and adequate water supply and sanitation to meet the basic needs of all." This Pillar is in line with the aspirations of the National Development Plan 2030 vision, the national target for water supply and sanitation of achieving universal, sustainable, and reliable water supply and sanitation provision for all.

To develop, demonstrate, and validate appropriate alternative waterless and off-grid sanitation solutions by 2025. The DWS, in collaboration with the Department of Science and Innovation (DSI) is in the process of establishing the Sanitation Technology Technical Coordination Committee (STTCC) that will advise the sector on appropriate alternative sanitation technologies suitable for all settlement types that are using minimal resources and taking into consideration the effects of climate change.

10.1 Sanitation Technology Options used in South African

When considering technology choices for service provision, the choice has generally been full flush or latrine-based technologies. The technology choice is based on interlinked determinants such as availability of water, proximity in relation to the existing sewer network, and cost.

South Africa is a semi-arid country, with a projected 17% water deficit between demand and supply by 2030. The projected water deficit and climate change impact will significantly impact the traditional way of providing waterborne sanitation and requires the country to re-think sanitation provision, with more investment in non-sewered, low water, and waterless sanitation solutions.

10.2 Status of Sanitation Services

Statistics South Africa conducts the General Household Survey annually to determine the progress of the development in the country. It measures on a regular basis the performance of programmes and the quality-of-service delivery in key service sectors in the country.

A larger proportion (61%) of households are served with full flush toilets (waterborne sanitation) – which is a toilet connected to the sewer network, and wastewater treatment works, however, are not sustainable due to water shortages in the country and the impact of climate change and its dependency on energy (electricity) unless it is an oxidation pond. Figure 10.1 presents an overall breakdown of the sanitation system types used in South Africa. What is critical regarding water and sanitation is South Africa's anticipated 17% deficit between water demand and supply by 2030. Therefore, there is an urgent need to move towards adopting and implementing non-sewered sanitation systems aligned with the National Water and Sanitation Master Plan. South Africa can no longer afford to use drinking water for flushing toilets.

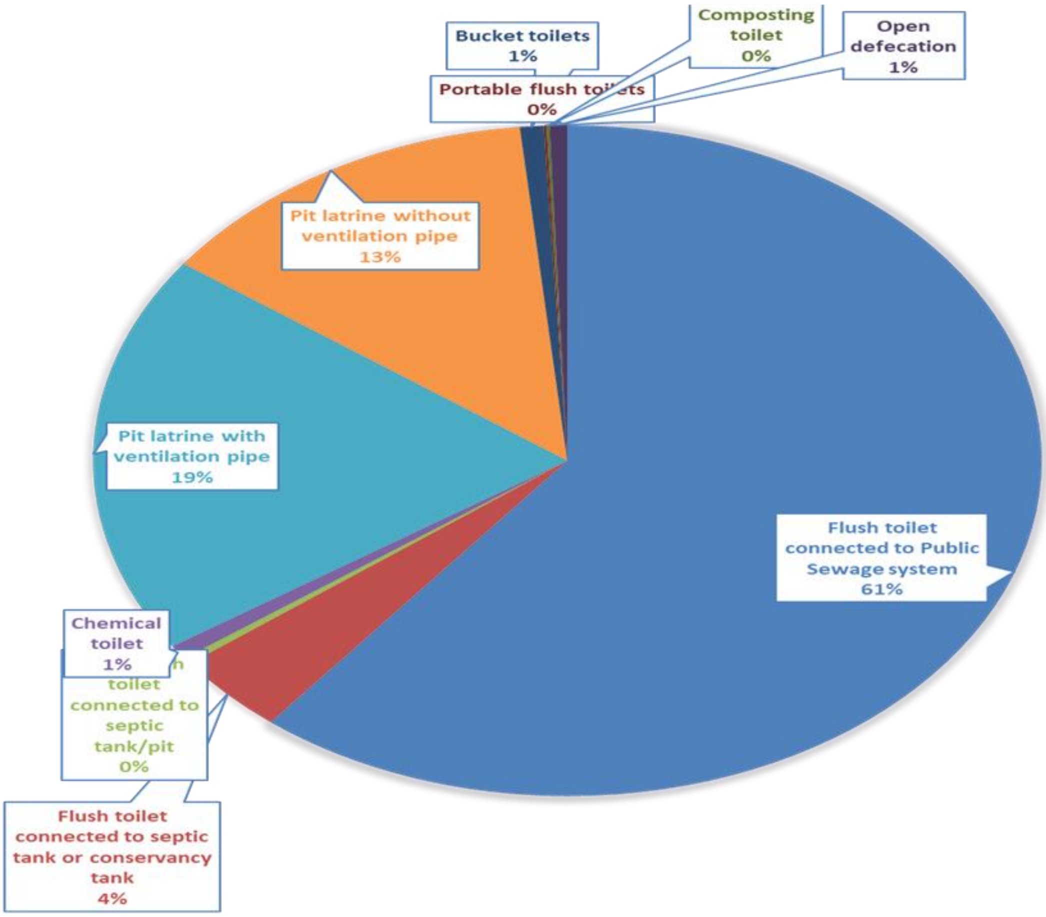


Figure 10.1 Sanitation systems used in South Africa (Stats SA, 2022)

In South Africa, significant progress has been made in addressing the sanitation backlog and providing appropriate sanitation to poor households in the country since 1994. Figure 10.2 Presents the sanitation delivery per province in 2021. Overall, the country has achieved 84% sanitation delivery in sanitation services.

Through the provision and the efforts of the government, support agencies, and existing stakeholders, the percentage of households with access to improved sanitation increased by 22,4 percent from 61,7% in 2002 to 84,1% in 2021. Most of the improvements are noted in the Eastern Cape, where the percentage of households with access to improved sanitation increased by 58,3%, and Limpopo with an increase of 31,6% to 58.6% in 2021.

However, there are still approximately 2.8 million households in South Africa without access to improved sanitation services which in some instances leads to open defecation. The eradication of open defecation requires immediate intervention.

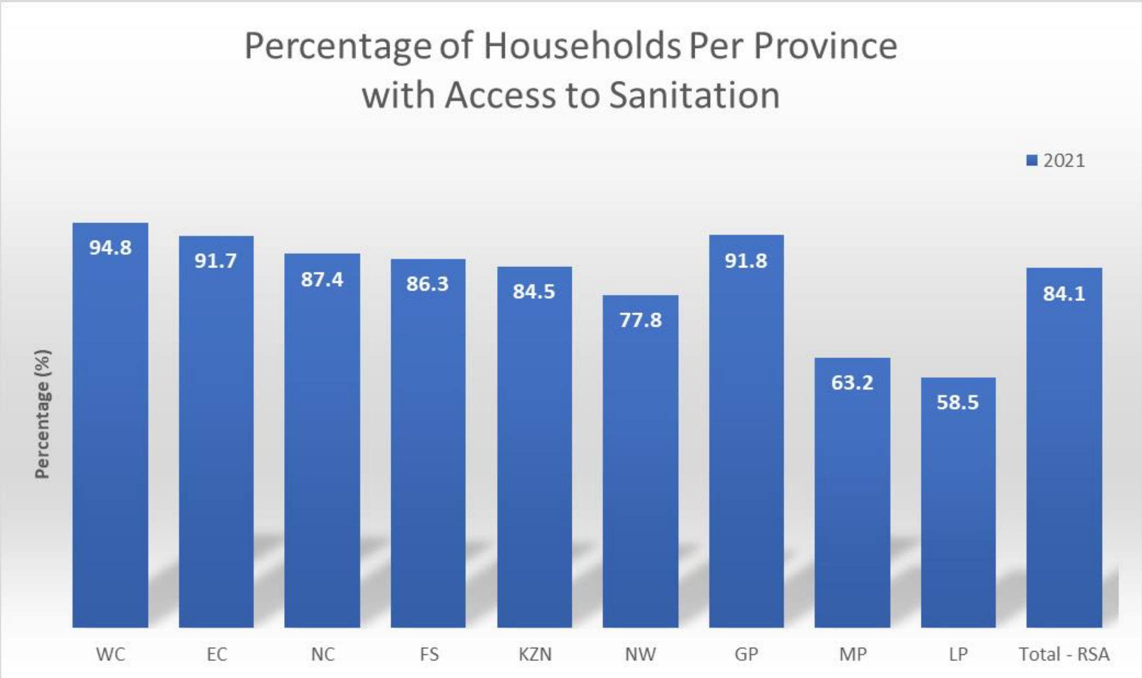


Figure 10.2 Access to sanitation per province, 2021.

10.3 Development of the Faecal Sludge Management Strategy

There are operations and maintenance needs that should be met which necessitate faecal sludge management from the collection, transportation, treatment, safe disposal, or reuse. In the past, the operation and maintenance of onsite sanitation technologies have not been given attention when compared to offsite sanitation systems, which include sewerage networks and Wastewater Treatment Works.

Faecal sludge management technologies: South Africa has access to a variety of uncertified technologies for toilets/containment technologies, emptying, and on-site treatment. Perceptions of these technologies are that they are interim solutions and that they are inferior technology. In addition, there is no transparent standardisation process in place. In addition, planning and budgeting for FSM technologies at the Municipal level needs strengthening. Finally, the services required to use those technologies safely are not in place and need to be regulated.

Faecal sludge management financing: Key issues for current FSM financing mechanisms in South Africa are as follows:

- Equitable Share is inadequate to meet all infrastructure maintenance requirements.

- The Municipal Infrastructure Grant is a well-established mechanism to support on-site sanitation. However, more funds are allocated to water supply than sanitation.
- The Water Services Infrastructure Grant tends to focus on water infrastructure in rural areas. The contribution to on-site sanitation and FSM is minimal
- Capital grants for networked/sewered sanitation services dominate overall sanitation expenditure.
- Tariff revenue tends to be well short of cost-recovery levels, leaving no room for cross-subsidy.
- Capital and operational subsidy go primarily to capital expenditure in most municipalities. Support to operations is inadequate.

10.4 Transforming Sanitation into the Future

Most South Africa's urban population sanitation needs are addressed through reticulated waterborne systems. The requirement for the technical functioning of these systems is water. According to Pillay and Bhagwan (2021) and research produced by the Water Research Commission (WRC), South Africa is over-exploiting its water resources, and withdrawals are expected to increase over the next 20 years. The flushing of 9 to 12 litres of potable water with faeces may not be viable in the near future and represents one area amongst many where South Africa's high per capita usage could be reduced.

Studies conducted by the WRC indicated that Dry sanitation is considered the "poor person's toilet" and a strong user preference for a flush toilet over dry sanitation technologies. Whereas the implementation of the VIP has shown fault lines along user acceptance and the Operation and Maintenance challenges of emptying and disposal of accumulated faecal sludges. Universal access to waterborne sanitation may not be realised due to the prohibitive costs and the availability of water. This calls for a paradigm disruption.

The WRC developed a systems approach to transforming sanitation into the future by addressing the much-needed paradigm shift. According to Pillay and Bhagwan (2021), the SANITI strategy incorporates the elements of behaviour change, industrial development, policy development for new sanitation, technology standards and regulations, technology testbeds, Research, Development, and Innovation (RDI) focused on supporting the strategy and sanitation academy which build the next cohort of skill and artisans required to service this new frontier resulting in:

- New sanitation that meets user needs and expectations while less demanding natural resources. The new sanitation must be replicable on a large-scale and the components must be easily sourced throughout the supply chain.
- Circular economy principles in which products in the value chain are recycled or re-used with the addition of other revenue streams.
- Establishing market needs and demands.

- Presenting a RDI pathway to achieve technical, policy and procurement targets in line with the vision.
- Creating a sanitation manufacturing industry around the technical advancements and creating several new jobs and employment around this.

The Department of Water and Sanitation will have to play a leading role in disrupting the current paradigm.

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