water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

NATIONAL STATE OF WATER REPORT FOR SOUTH AFRICA

SUMMER SEASON

October 2020 – March 2021

Department of Water and Sanitation
Branch: Water Resources Management
Chief Directorate: National Water Resource Information Management

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APPROVAL

Report Title:	*NATIONAL STATE OF WATER REPORT FOR SOUTH AFRICA – SUMMER SEASON (October 2020 – March 2021)*
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Report No:	*NSoW-SS 2020/21*
Status of Report:	*Final Report*
First Issue:	*30 June 2021*
Final Issue:	*22 July 2021*

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ABBREVIATIONS / ACRONYMS

Abbreviation/ Acronym	Description
AMD	Acid Mine Drainage
ARC	Agricultural Research Council
CMA	Catchment Management Agency
COGTA	Cooperative Governance and Traditional Affairs
CoT	City of Cape Town
CSIR	Council for Scientific and Industrial Research
DWS	Department of Water and sanitation
EC	Electrical Conductivity
FSC	Full Supply Capacity
FY	Financial Year
GHS	General Household Survey
IB	Irrigation Board
IRIS	Integrated Regulatory Information System
IVRS	Integrated Vaal River System
IWRM	Integrated Water Resource Management
KZN	KwaZulu Natal
LOR	Lower Orange Rover
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NCMP	National Chemical Monitoring Programme
NDP	National Development Plan
NEMP	National Eutrophication Monitoring Programme
NESMP	National Estuaries Monitoring Programme
NIWIS	National Integrated Water Information System
NQWQM	National Groundwater Quality Monitoring
NSoW	National State of Water
NWA	National Water Act
NWRS	National Water Resource Strategy
ORS	Orange River System
PWSS	Polokwane Water Supply System (PWSS)
RDM	Resource Direct Measures
REMP	River Ecostatus Monitoring Programme
RQIS	Resource Quality and Information System
RQOs	Resource Quality Objectives
RTTS	real-time telemetry systems
SANS	South African National Standard
SAWS	South African Weather Service
SDC	Source Directed Controls
SDG	Strategic Development Goals
SDGs	Sustainable Development Goals
SPI	Standardized Precipitation Index

TCTA	Trans-Caledon Tunnel Authority
UGEP	Utilizable Groundwater Exploitation Potential
VIP	Ventilated Improved Pit
VRESP	Vaal River Eastern Sub-system Project
WC/WDM	Water Conservation / water Demand Management
WARMS	Water Use Authorization & Registration Management System
WCWSS	Western Cape Water Supply System
WMA	Water Management Area
WRC	Water Research Commission
WRPM	Water Resource Planning Model
WSAs	Water Service Authorities
WUA	Water User Associations
WWTW	Wastewater Treatment Works

1 INTRODUCTION

1.1 Background

The South African National Water Act (NWA, 36 of 1998) requires that the nation's water resources are protected, used, developed, conserved, managed and controlled in an equitable manner efficient and sustainable manner. The National Government acting through the Minister of Human Settlements, Water and Sanitation is the public trustee of the nation's water resources.

Issues to do with water, its quality, quantity and availability, underpin all areas of life and environment in South Africa. Water in South Africa have a powerful link not only to all aspects of the physical environment, but to poverty reduction, sustainability, equity, and economic development (Knight, 2019). Water mediates all aspects of health and sanitation, agriculture and food, ecosystems and biodiversity, and many other aspects of life and the environment (Rockström et al. 2014; Ziervogel et al. 2014).

South Africa is located in a predominantly temperate and dry climate (Schulze et al. 2011). Broadly, the east of the country has high rainfall totals, lies in a summer rainfall zone, and is capable of supporting dense subtropical vegetation and agriculture; whereas the west of the country in the winter rainfall zone is semiarid to arid and able to support only sparse vegetation and extensive grazing agriculture (Knight, 2019). River systems are the common surface water expression of water availability in South Africa, with others being lakes, ponds and pans. South African river systems and catchments are characterised by a spatial variation in rainfall, as well as variations in catchment sizes and physical properties. These result in different river patterns and dynamics at catchment and further at a Water Management Area level and have implications for water resource availability (Knight and Grab, 2018).

As a developing country, South Africa requires additional water resources in order to support the growing economy. With 98% of the country's available water resources already allocated, opportunities to supplement future water supply are limited. Water security will be further threatened as supply decreases due to the negative impacts on yield arising from climate change, degradation of wetlands and water resources, siltation of dams, whilst water losses and demand escalate due to population and economic growth, urbanization, inefficient use, and changing lifestyles.

1.2 Purpose of the National State of Water Report

This National State of Water (NSoW) Report is an integration of water resource information based on a core set of water resource indicators that provide information on the status and trends of water resources in South Africa. This integration of water resource information provides information relating to the relationship between climatic conditions, quality and quantity of both surface and groundwater.

The main purpose of this report is to give a nationwide overview of the status of water resources in the country, and most importantly disseminate information to the general public, decision makers, researchers, water managers and all other water sector stakeholders. Furthermore, because there is uncertainty on the quality and quantity of water resources from year to year, this report aims to enhance the quality, accessibility and relevance of information and or data related to a goal of Integrated Water Resource Management (IWRM). In implementing a holistic approach in water resource management, it is critical that the Department of Water and Sanitation (DWS) provides adequate information. This is to ensure that stakeholders have access to the same information and same interpretation of results as derived from applications of various models.

This summer season report will give the status and historical trends of water resources for the summer season period from October 2020 to March 2021. Data and information used to compile the report were acquired from various monitoring programmes and information systems within DWS. Additional information was obtained from the South African Weather Service (SAWS) and Agricultural Research Council (ARC). Data from various monitoring programmes is analysed, integrated, and interpreted to reflect a synopsis of the water status in the country.

The information contained in this report will ultimately assist in decision making within the water sector value chain. Additionally, it will also be used in evaluating and assessing the effectiveness of the monitoring programmes and information systems within DWS. It is expected that through the interpretation and assessment of data and information provided in this report, the challenges experienced in managing the water resources will be highlighted and understood.

1.3 Institutional Arrangement

The National Department of Water and Sanitation is responsible for water sector policy, support and regulation. At the regional level are the Catchment Management Agencies (CMAs), and Water Boards (to be consolidated into regional water utilities).

The National Water Act, 1998 (Act No. 36 of 1998) and the National Water Policy for South Africa provide for the establishment of Catchment Management Agencies (CMAs) to facilitate the delegation of water resources management to a catchment level in support of the principles of integrated water resource management.

DWS has to date only established two of the nine CMAs, namely Inkomati-Usuthu and Breede-Gouritz, which are statutory bodies with delegated powers from the Minister to execute water resource management functions at a catchment level. The department has consolidated and reduced the number of Water Management Areas (WMAs) from 19 in 2004 to only nine WMAs in 2012 as presented in Figure 1.1.

Based on the outcome of the Departmental Institutional Reform and Realignment (IRR) study, the NWRS2 established nine (9) WMAs in South Africa, as from July 2012. These replaced the 19 WMAs identified prior to this date. It was recognised that these WMAs boundaries need to be reviewed periodically to accommodate new realisations and issues.

The intention is to establish a CMA in each of the WMA. WMAs are largely based on catchment boundaries, except for those catchments that cross international borders. Within these WMAs, catchments are subdivided into secondary, tertiary and quaternary catchments.

As water resources management is local in nature, the regional offices are currently acting as CMA in Water Management Areas where CMAs have not been established. The CMAs' initial function will be to promote community participation in water governance. It 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 (NWA, No.36 of 1998).

At the local level are Water Services Providers (Municipalities or private) that are regulated by Department of Cooperative Governance and Traditional Affairs (CoGTA) and provide water and sanitation services.

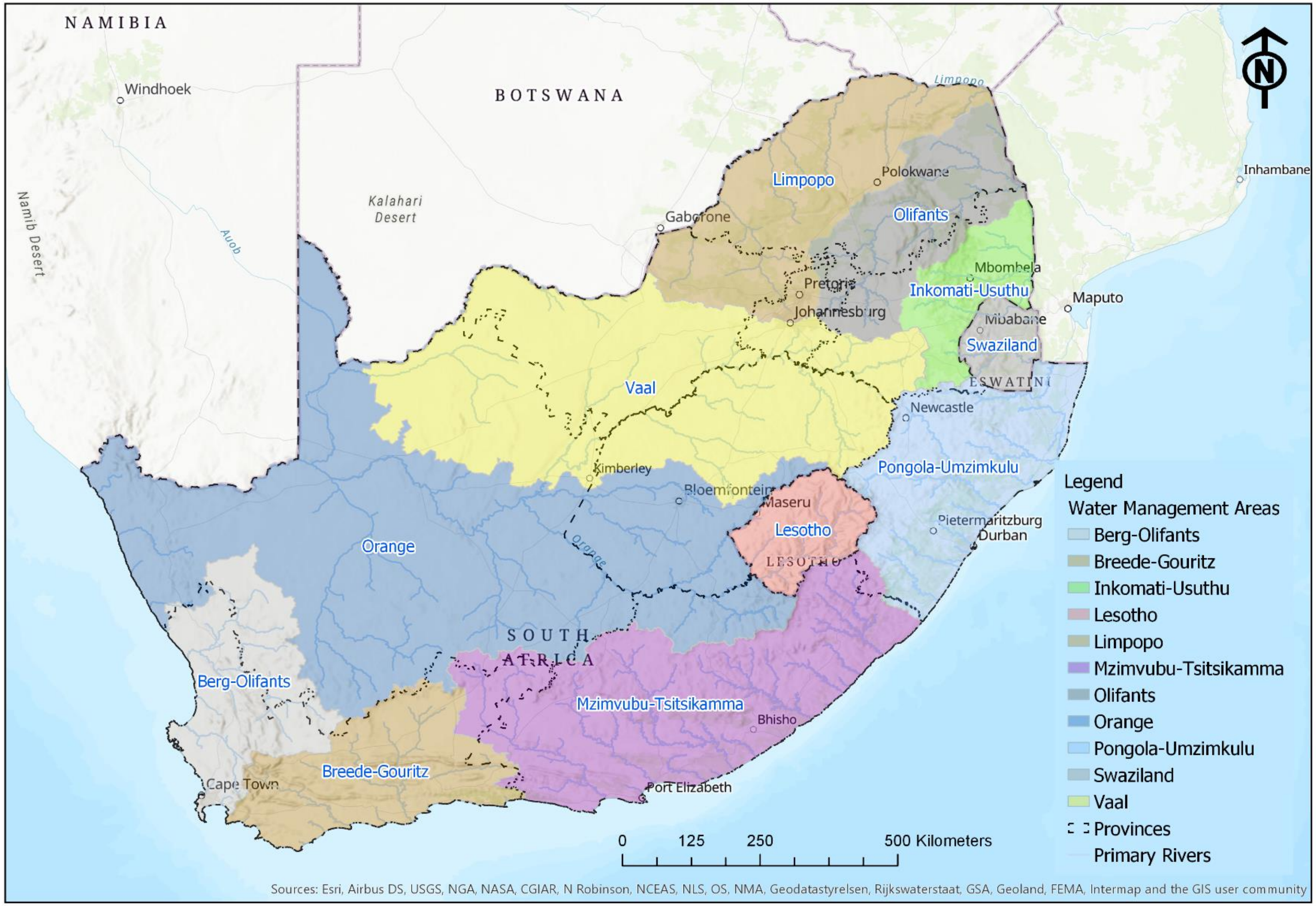

Figure 1.1. Water Management Areas as of 2012

1.3.1 Status of CMA Establishment

The Department of Water and Sanitation has embarked on several institutional re-alignment processes with the aim of transforming the water sector and building stable institutions with clearly defined roles and responsibilities across the sector and promoting effective institutional performance. It is proposed that going forward water resource management will be based on six water management areas for which CMAs will be established, these are: Limpopo-Olifants (1); Inkomati-Pongola (2); Mhlatuze-Mzimkhulu (3); Vaal-Orange (4); Mzimvubu-Tsitsikamma (5); Breede-Olifants (6) – see Figure 1.2 below.

As part of the Department's turnaround strategy in establishing CMAs, the extension of the boundary of the existing Breede-Gouritz CMA to incorporate the Berg-Olifants water management area has been gazetted for public comments in terms of section 78(1) of the National Water Act, 1998 (Act No. 36 of 1998) to establish the Breede-Olifants in September 2020. Furthermore, in March 2021, the extension of Vaal CMA to include the Orange water management area was also gazetted for public consultation in terms of section 78(4) of the National Water Act, 1998 (Act No. 36 of 1998). This incorporation will enhance revenue generation and sustainability of the CMA, as well as enabling an effective water resources management.

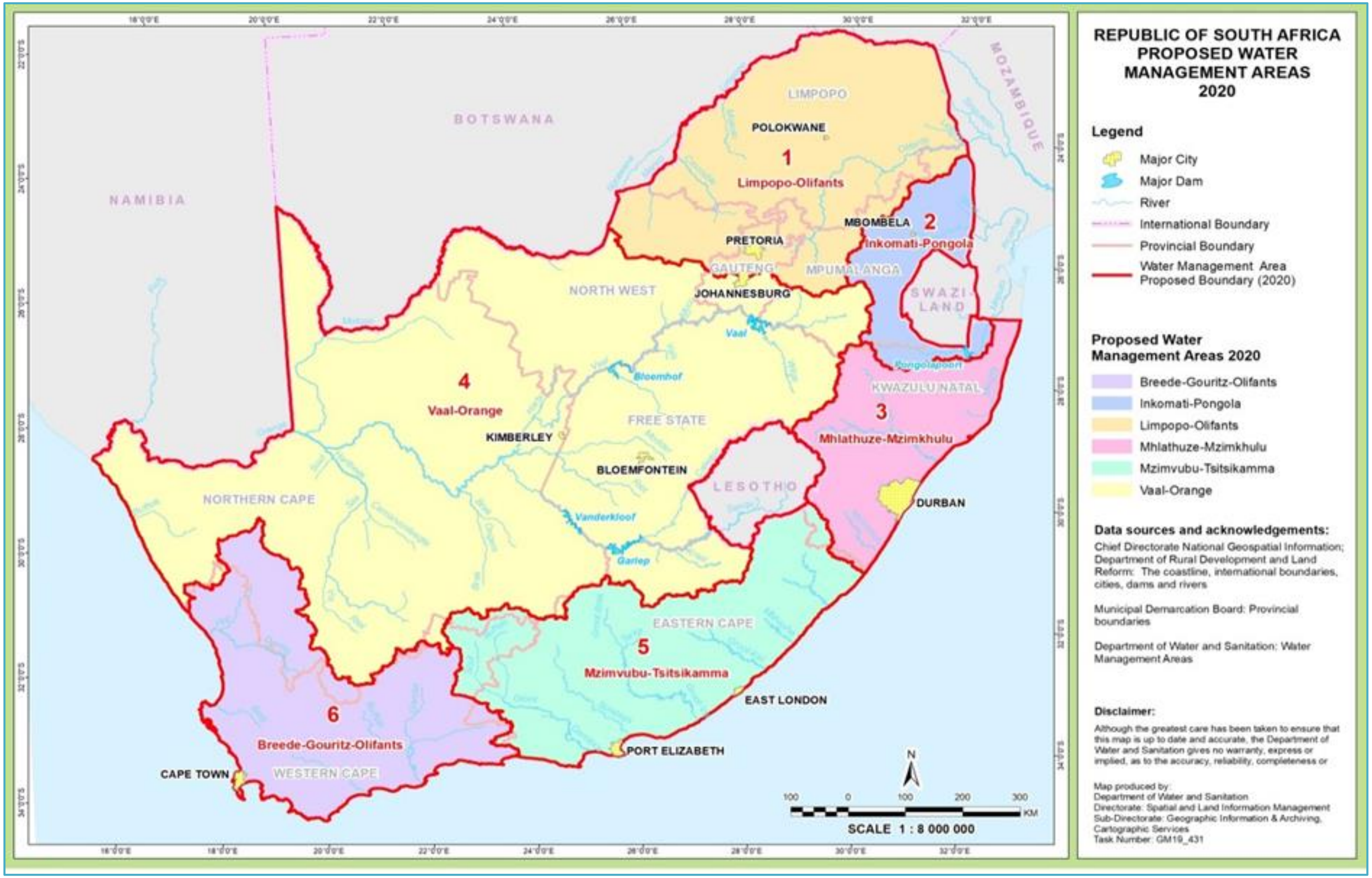

Figure 1.2 Proposed Water Management Areas configuration

2 WATER RESOURCES DATA

The national water resources monitoring programmes provide the necessary information required for analyses and assessment of water status and trends to ensure that the effectiveness of the implementation of the NWA is monitored and evaluated regularly. There is a considerable amount of pressure to expand the monitoring network due to an increasing demand for reliable data and information. DWS has established a number of monitoring programmes.

The purpose of these monitoring programmes is to provide data and information to ensure that water resources are protected, developed and managed effectively. The existing monitoring programmes have been reviewed with the intention to optimise monitoring and the implementation plan developed in order to address the future requirements for water resources monitoring for South Africa

2.1 Groundwater Monitoring

Groundwater monitoring within the Department of Water and Sanitation (DWS) is made up of two (2) programmes, namely groundwater quality monitoring and groundwater level monitoring. Figure 2.1 illustrates the current groundwater monitoring programmes.

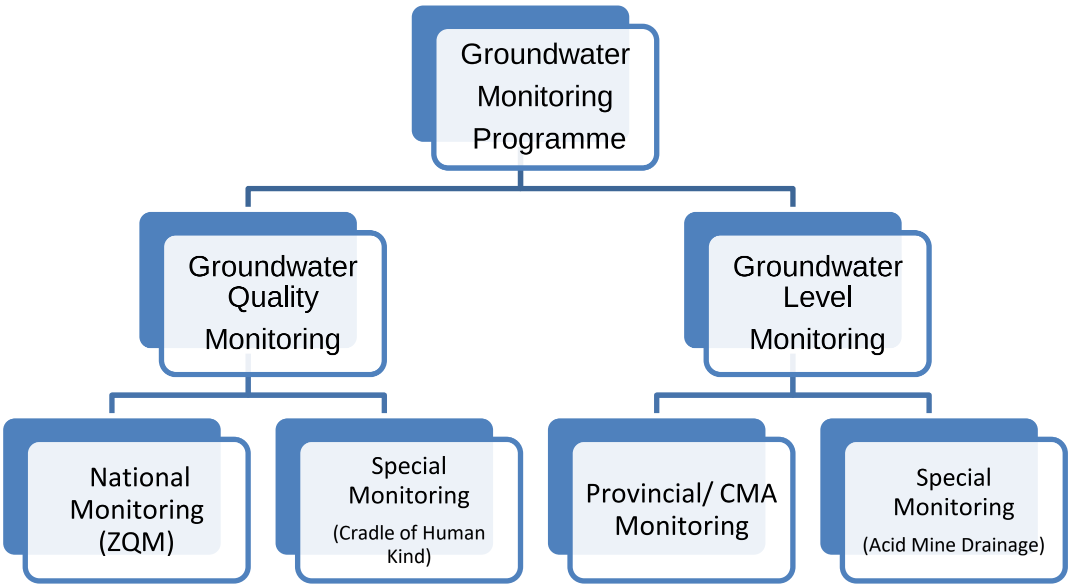

Figure 2.1 Groundwater Monitoring Programme

2.1.1 Groundwater Quality Monitoring

The Groundwater Quality Monitoring Programme consists of two main monitoring sub-programmes: (1) the National Groundwater Quality Monitoring and (2) Special Monitoring at the Cradle of Human Kind Heritage Site.

Generally, the monitoring programme is experiencing challenges of outdated field monitoring equipment and lack of auditing and or quality control of the sampling process, which threatens a successful continuous implementation of the monitoring programme. The spatial distribution of the national groundwater quality monitoring network is presented in Figure 2.2.

2.1.2 Groundwater Level Monitoring

The groundwater level monitoring network comprises a network managed by the Provincial Office and or Catchment Management Agencies (where established), and the special monitoring programme on Acid Mine Drainage (AMD) managed by the National Office. The monitoring network as presented in Figure 2.3, comprises of 1856 active stations. The monitoring data is archived on HYDSTRA whereas, additional stations data is stored in the National Groundwater Archives (NGA) (https://www.dws.gov.za/groundwater/NGA.aspx)

Cost cutting measures and restriction to travel, as a result of the Covid-19 pandemic, continue to affect monitoring and thus the availability of data at active stations. Figure 2.3 indicates the location of the active groundwater level monitoring stations across the country.

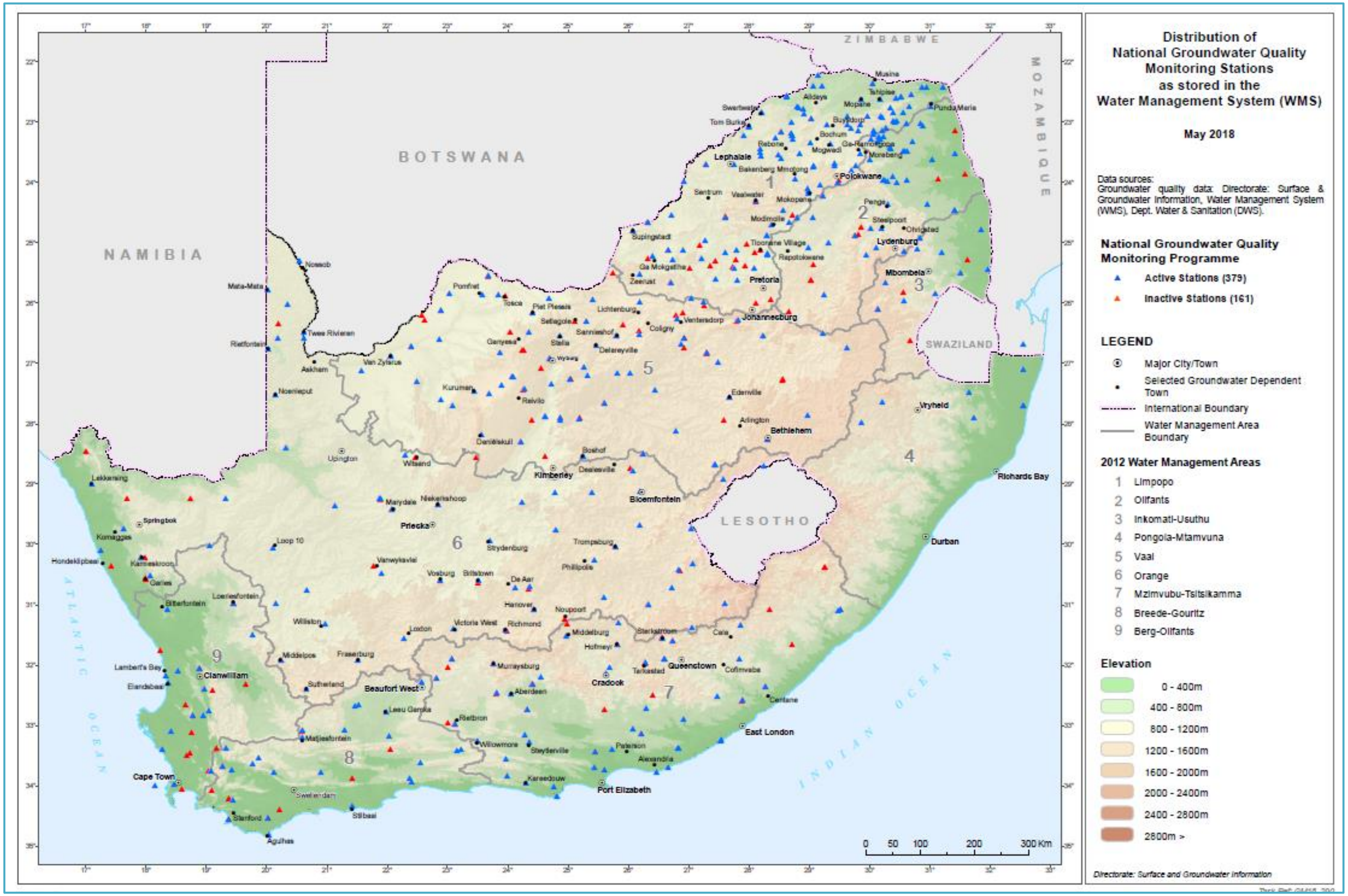

Figure 2.2 National Groundwater Quality Monitoring Network

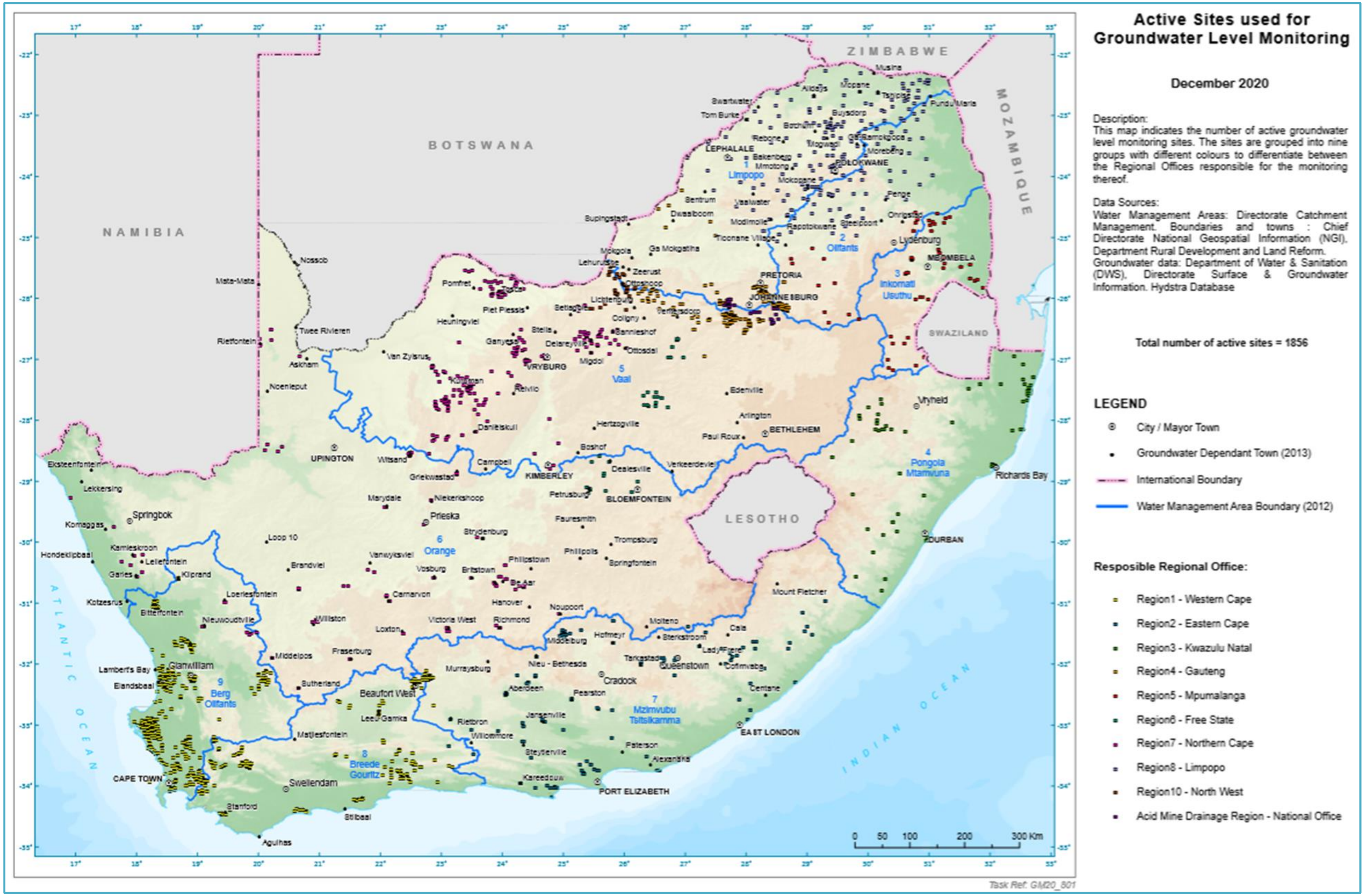

Figure 2.3 Groundwater Level Monitoring Network

2.2 Surface Water Monitoring

DWS has an established national network of gauging stations along rivers, dams, estuaries, eyes, canals and pipelines. The purpose of the national network is to measure hydro-meteorological conditions to enable informed water resource assessment and planning, monitoring of water supply, system operations and flood monitoring and forecasting. From the mid 80's DWS had equipped some of the gauging stations with automatic wireless communication data relaying systems.

The surface water monitoring illustrated in Figure 2.4 is composed of two programmes. The first being the surface water quantity monitoring which includes the "dam levels monitoring" and the "evaporation and rainfall monitoring". The second programme is the surface water flow monitoring which also entails the stream flow monitoring and the real-time data transmission systems.

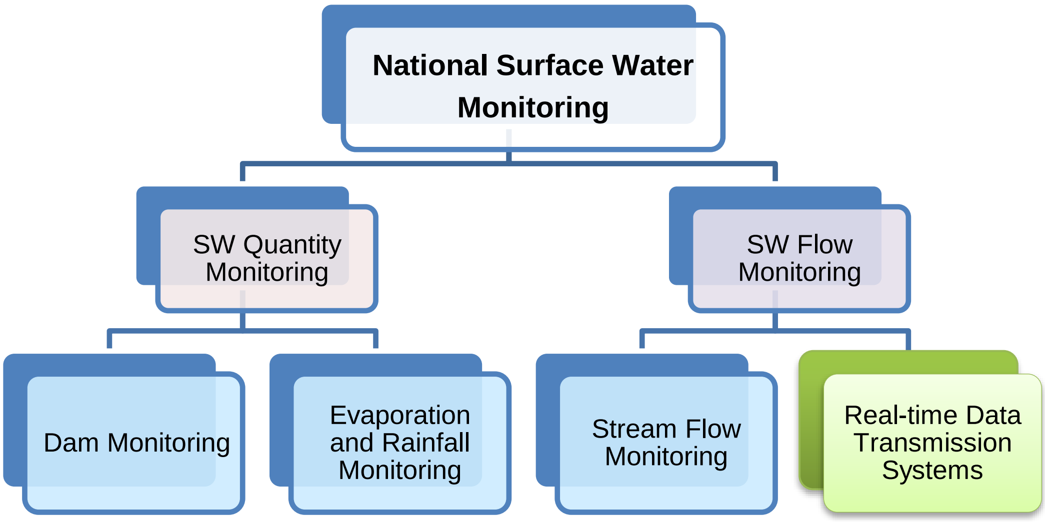

Figure 2.4 Summary structure of the surface water monitoring

Overtime gauging stations have been equipped with real-time telemetry systems (RTTS) for other essential water resource management resources assessment operations such as, water supply infrastructure operation and the monitoring of water abstraction and environmental water requirements status. Currently 700 hydro-meteorological gauging stations are equipped with RTTS. The number of stations has declined over the years due to vandalism, theft, failure, wear and tear, under investment and lack of maintenance due to challenges in supply chain processes.

Data for stations equipped with real-time transmission systems is readily available on HYDSTRA database system. Stream flow monitoring, data quality control and data capturing is done by the Provincial Offices, and this data is as a service standard usually made available on the system with a lag of three months. Figure 2.5 gives a summary of the availability of surface water monitoring data per Provincial Office in the national database – HYDSTRA at the end of the reporting period in March 2021.

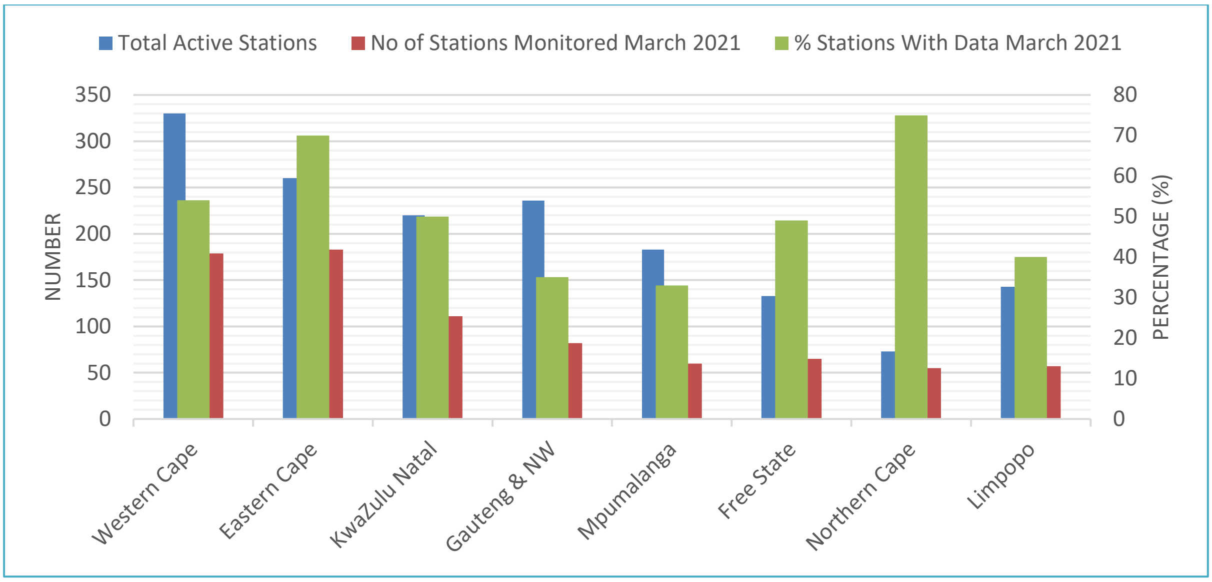

Figure 2.5 Surface Water Monitoring Data Availability (March 2021)

Only 55% of the national total active stations had data available at the end of the reporting period. At the end of the period of reporting only 1,578 stations were active or open, of the 2,747 total number of stations that have existed over time. The national distribution of the surface water monitoring stations is presented in Figure 2.6. The surface water monitoring data (dams, floods, flows) captured internally on the HYDSTRA system is available to the general public on https://www.dws.gov.za/Hydrology/Default.aspx .

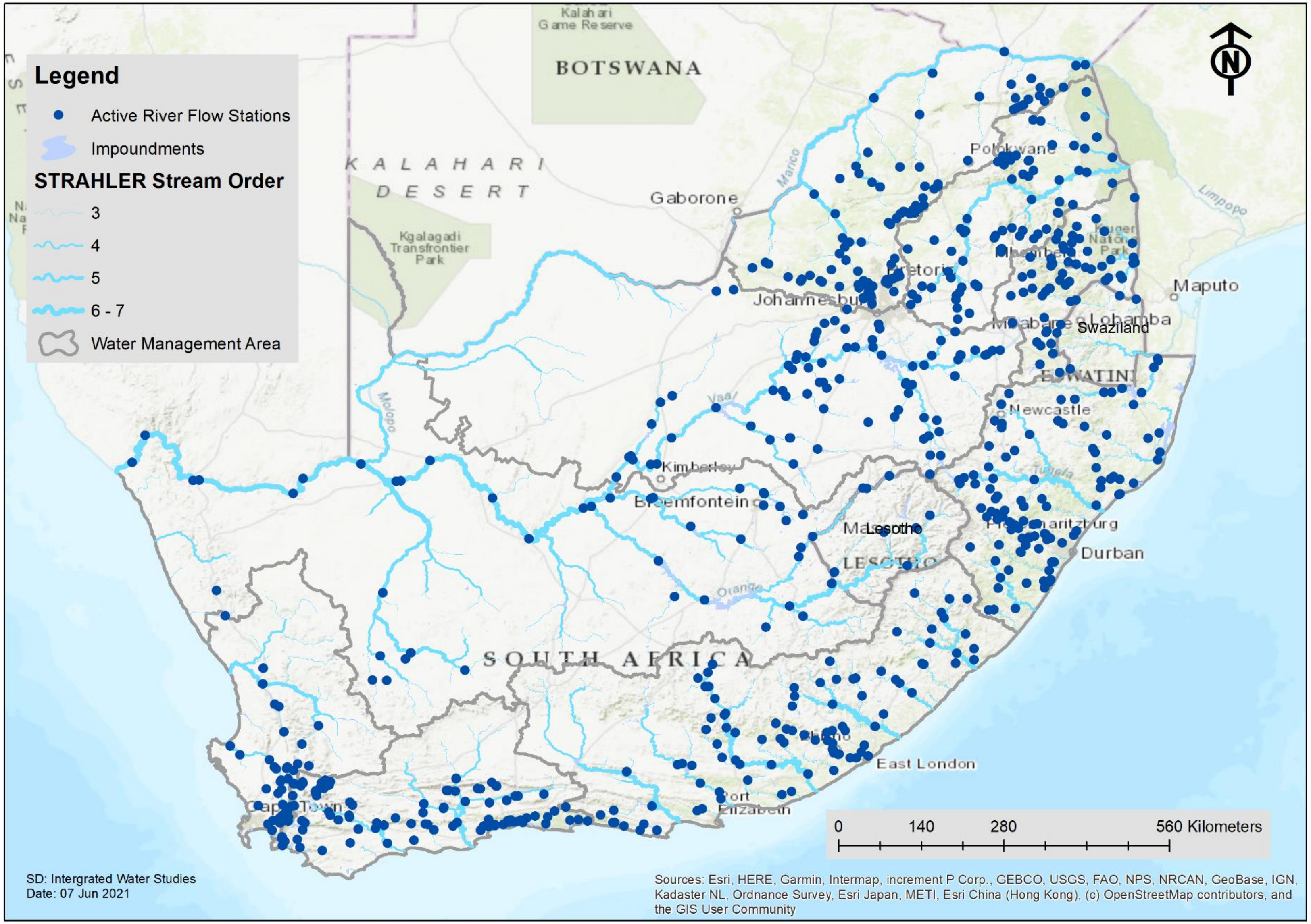

Figure 2.6 Distribution of Active Surface Water Monitoring Stations

2.3 National Water Resource Quality Monitoring

2.3.1 National Chemical Monitoring

The National Chemical Monitoring Programme (NCMP) was established in 1970s based on the state of knowledge and national priorities at the time. This is the longest running water quality monitoring programme which has provided data and information for the last 48 years for inorganic chemical quality of surface water resources. The programme depends on Provincial officials for data collection and the Resource Quality Information System (RQIS) laboratory for analysis and data capturing on the WMS database, this data is available to the public on https://www.dws.gov.za/iwqs/wms/default.aspx .

The main objectives of this programme include determining at a national scale the inorganic status and trends in South African rivers; to support the National River Ecostatus Monitoring Programme (REMP); contribution to the integrated overarching database and, dissemination of data and information. The parameters measured include salinity level of water resources which is measured as total dissolved solids or electrical conductivity including the concentrations of irons, sodium, chloride, magnesium, potassium and sulphate. The NCMP also measures the ammonium and nitrate-nitrite levels which are an indication of nutrient loading from return flows into water resources.

The monitoring programme has not been in full operation since 2018, resulting in data gaps as illustrated in Figure 2.7. Of the nine Provincial Offices, only the Boskop site office situated within Gauteng Province was operational with few data collected. Provincial Offices, in general have had limitations relating to sampling equipment from both RQIS and contract laboratories, through to inadequate budget for travel and non-operation of the RQIS laboratory. The challenges include the need for reagents and the replacement of aging analytical instruments for the RQIS inorganic laboratory to be fully functional.

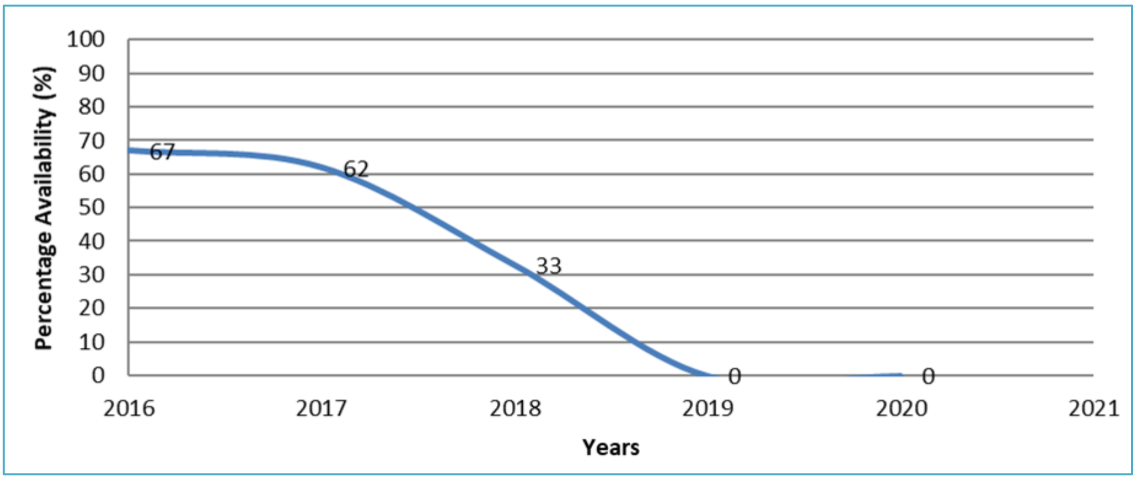

Figure 2.7 NCMP data availability

The national water quality status cannot be depicted for the reporting period due to lack of data across the country. Furthermore, the loss of RQIS lab accreditation is a critical issue which will affect the reliability on information from the programme.

2.3.2 National Eutrophication Monitoring

The National Eutrophication Monitoring Programme (NEMP) was established and officially implemented in 2002. The focus of monitoring is on areas affected by eutrophication through the Trophic Status Project which started in 1985. After the implementation of the National Eutrophication Monitoring Programme (NEMP) in 2002, the Department also began regularly releasing data maps indicating the extent of eutrophication in surface water resources across the country.

The objectives of the National Eutrophication Monitoring Programme (NEMP) are to measure, assess and report regularly on the current trophic status of South African water resources, the nature of current eutrophication problems, the potential for future changes in trophic status in South African impoundments and Rivers, early warning system for specific eutrophication-related problems, and nutrient balance by identifying the local source of the problem.

Currently RQIS laboratories can only analyse hydro-biological, algal identification and cyano-toxins samples. The macro chemical samples are sent to external laboratories for analyses and results supplied for capturing into WMS. Only 47 sites, which includes dams and rivers, were sampled out of the 219 active NEMP sites for the period under review. These are the sites RQIS personnel sample. The monitoring network will be expanded once laboratories are fully operational and Provincial offices start with their monitoring.

2.3.3 River Eco-Status Monitoring

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

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

- Create public capacity and environmental awareness.

River Eco-Status monitoring assists in identifying water-related problems at an early stage so that prevention measures can be initiated before the problem becomes severe. In areas where the status is poor or unsustainable, remedial actions can be initiated to rehabilitate the water resources.

3 STATUS OF WATER RESOURCES

3.1 Climate

Climate is one of the most important drivers of the hydrological response of a catchment. It includes processes such as rainfall, evaporation and temperature that are variable, and can have important implications for water supply for drinking, rain-fed agriculture, groundwater, forestry and biodiversity,

Climate change and variability can be drivers of additional stress on the already stressed water resources of South Africa, placing additional pressure on water availability, accessibility, quality and demand. Small changes in climate can have an exaggerated effect on runoff, because the impacts can be worsened by the complex response of the hydrological system.

3.1.1 Rainfall

The South African Weather Services (SAWS) is the custodian of meteorological data in South Africa, and data presented under this chapter is based on data and information provided by the SAWS. The rainfall regions across the country, together with the ranges of observed Mean Annual Precipitation (MAP) are presented in Figure 3.1. Rainfall in the far south-west falls mainly in winter, while the eastern parts receive summer rain. Rainfall on the south coast can occur at any time of year.

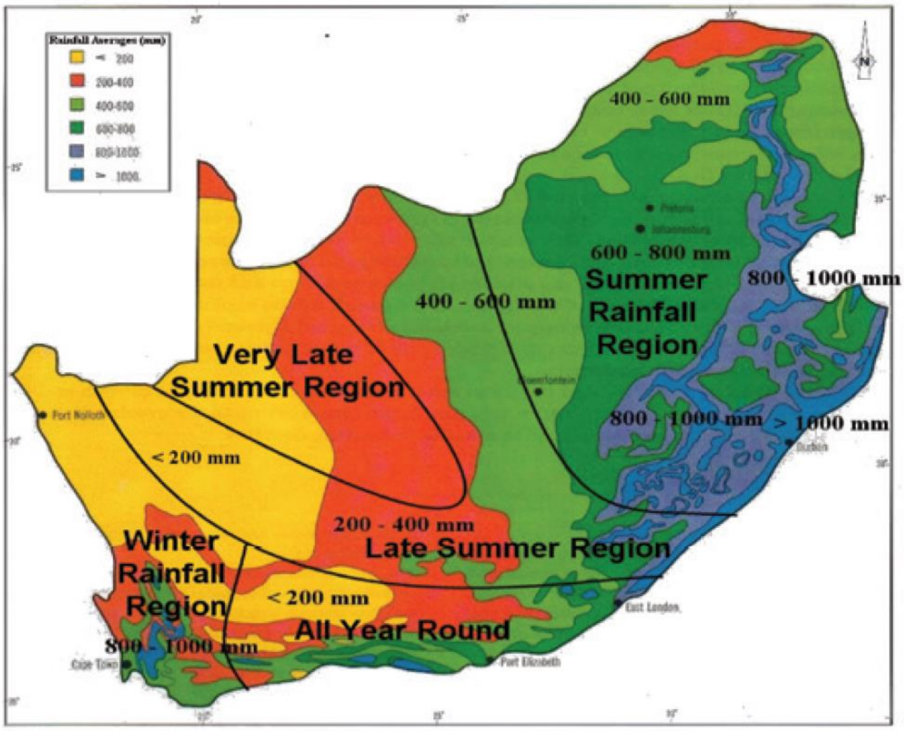

Figure 3.1 Rainfall Regions (Botai et.al., 2018)

The summer rainfall region is largely dominated by local convective-type thunderstorm activity, while the winter rainfall region is dominated by mid-latitude frontal systems, that can also extend across the whole of the country at different times of the year. Within the coastal areas advection from the Indian Ocean is frequently one of the main drivers of rainfall, while tropical cyclones may affect the Eastern parts of the country bringing extremely heavy rain and causing widespread flooding.

During the summer season from October 2020 to March 2021, somewhat dry conditions, with moderate to severely dry conditions in isolated areas, were experienced in parts of the Western, Northern and the Eastern Cape as well as in small parts of the Free State and North-West. The seasonal temporal variation of the rainfall received nationally is presented in Figure 3.2.

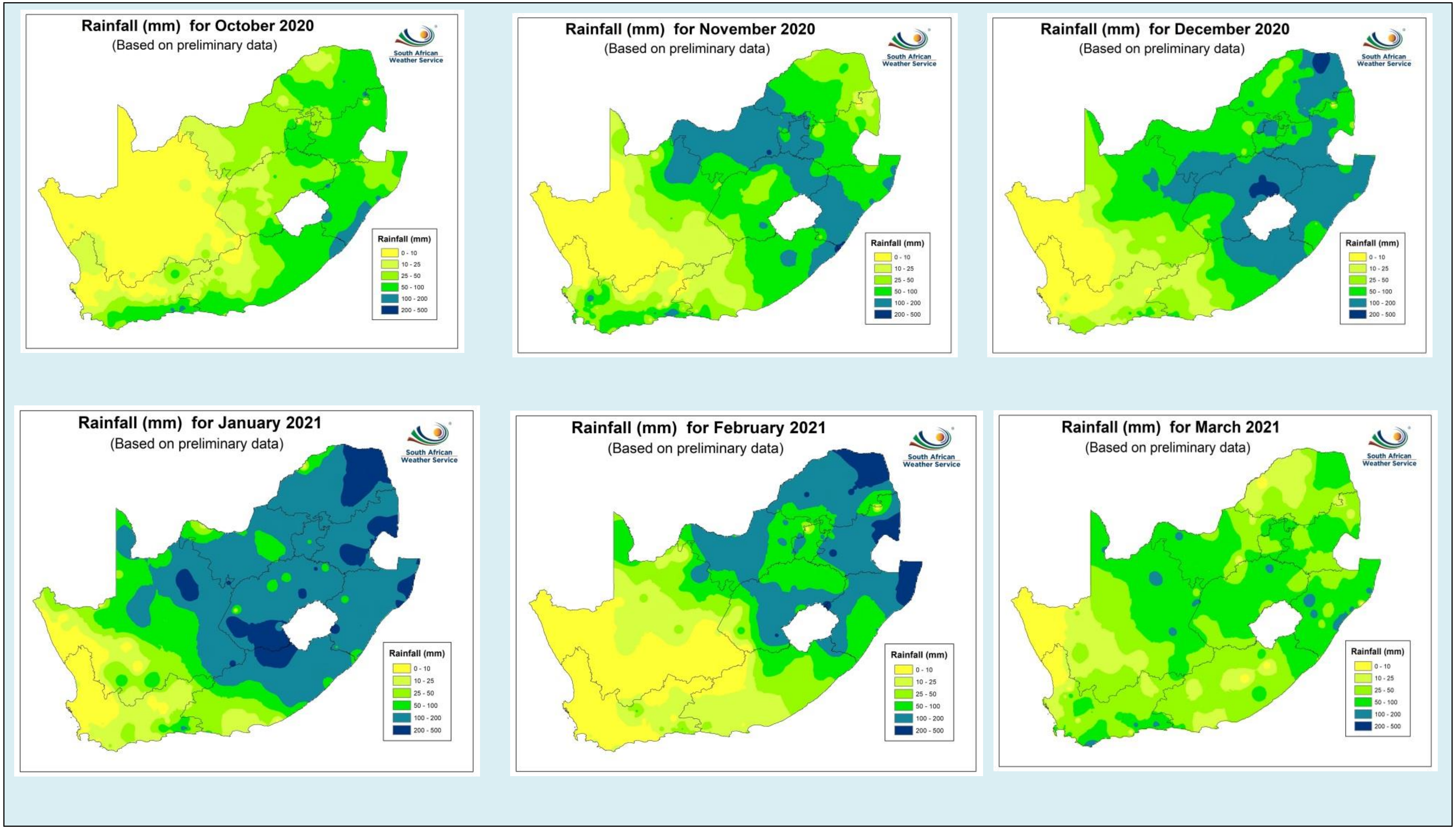

Figure 3.2 Summer Season monthly rainfall (Data Source: SAWS)

The comparison (anomalies) of seasonal rainfall received per WMA from October 1921 to March 2021, against the long term annual average normal (1921 to 1981) were computed. The WMA rainfall data or statistics are based on the average rainfall of the homogeneous rainfall districts, developed by SAWS, that mostly fall within a particular WMA. This approach ensures a more even weighting of rainfall stations in the spatial rainfall estimations. The rainfall districts used per WMA are presented in Figure 3.3 below.

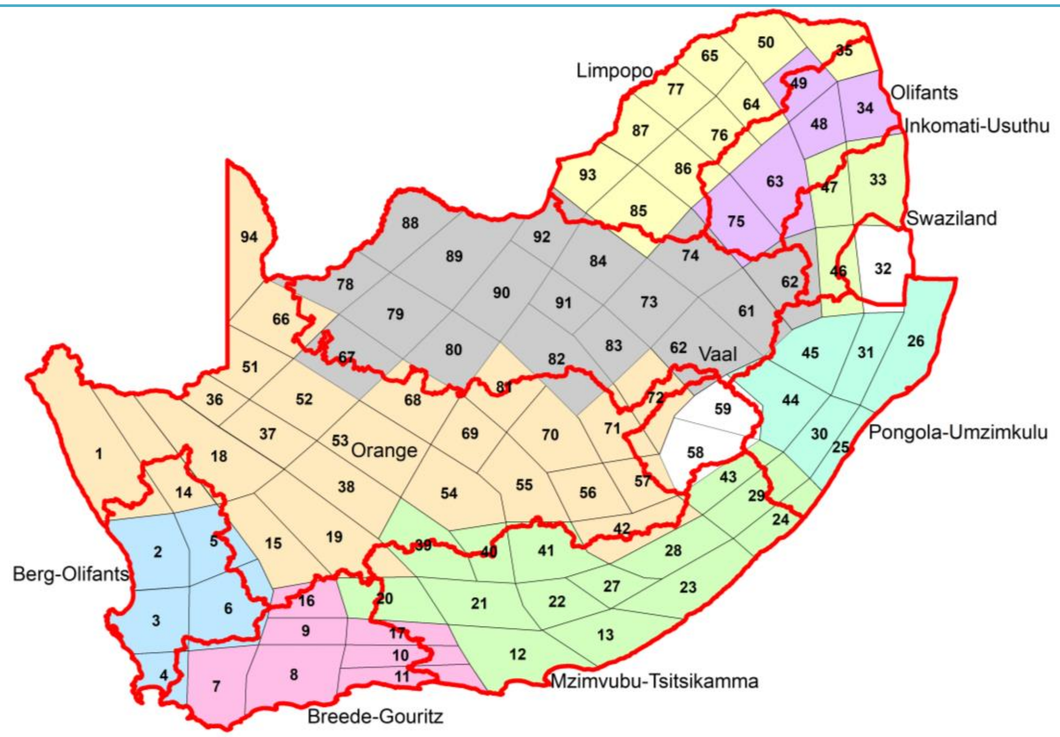

Figure 3.3 Water Management Areas and Rainfall Districts (Source: SAWS)

The national summer season anomalies (October 2020 to March 2021) are presented in Figure 3.4.

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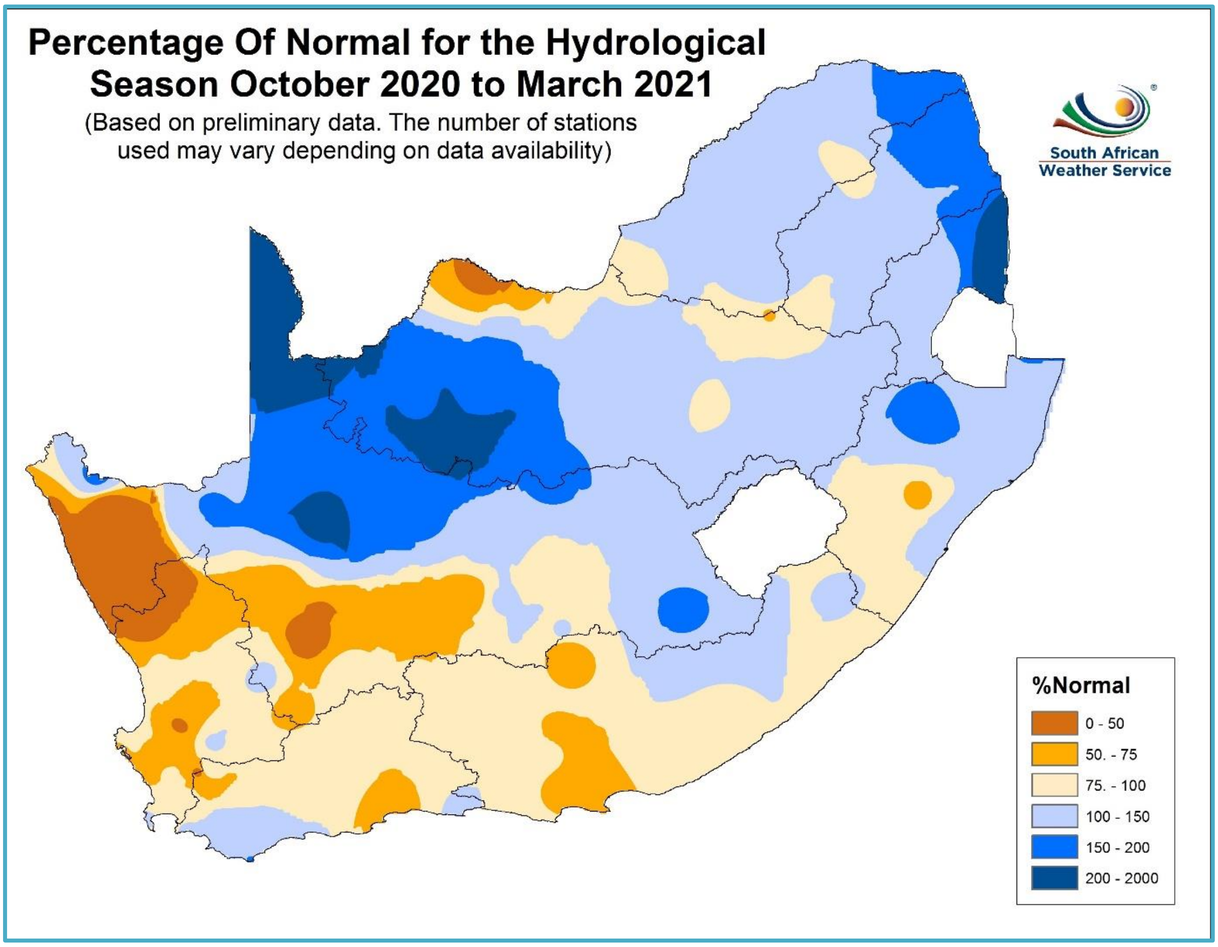

Figure 3.4 Summer Season rainfall anomalies (Data Source: SAWS)

In general, most of the central and north parts of the areas received seasonal rainfall that is above normal. Notably, the western parts of the country in the lower Vaal and lower Orange WMA experienced the highest above normal rainfalls by between 150% - 2000%. This is also the case for the north-eastern parts of both the Limpopo and Olifants water management areas, in Limpopo Province. The long term trend analysis per water management area is also presented in Figure 3.5 - Rainfall (% of Normal) - Oct 1921-March 2021; Normal Period: 1981 – 2010.

Figure 3.5 Summer Season Rainfall Anomalies: > 125% (wet) & < 75% (dry) (Data Source: SAWS)

3.1.2 Surface Temperature

South Africa experienced above-normal temperatures for the year 2020. The annual mean temperature anomalies for 2020, based on the data of 26 climate stations, was on average about 0.5ºC above the reference period (1981-2010), making it approximately the fifth warmest year on record since 1951, see Figure 3.6. According to the South African Weather Services, a warming trend of 0.16 ºC per decade is indicated for the country, statistically significant at the 5% level.

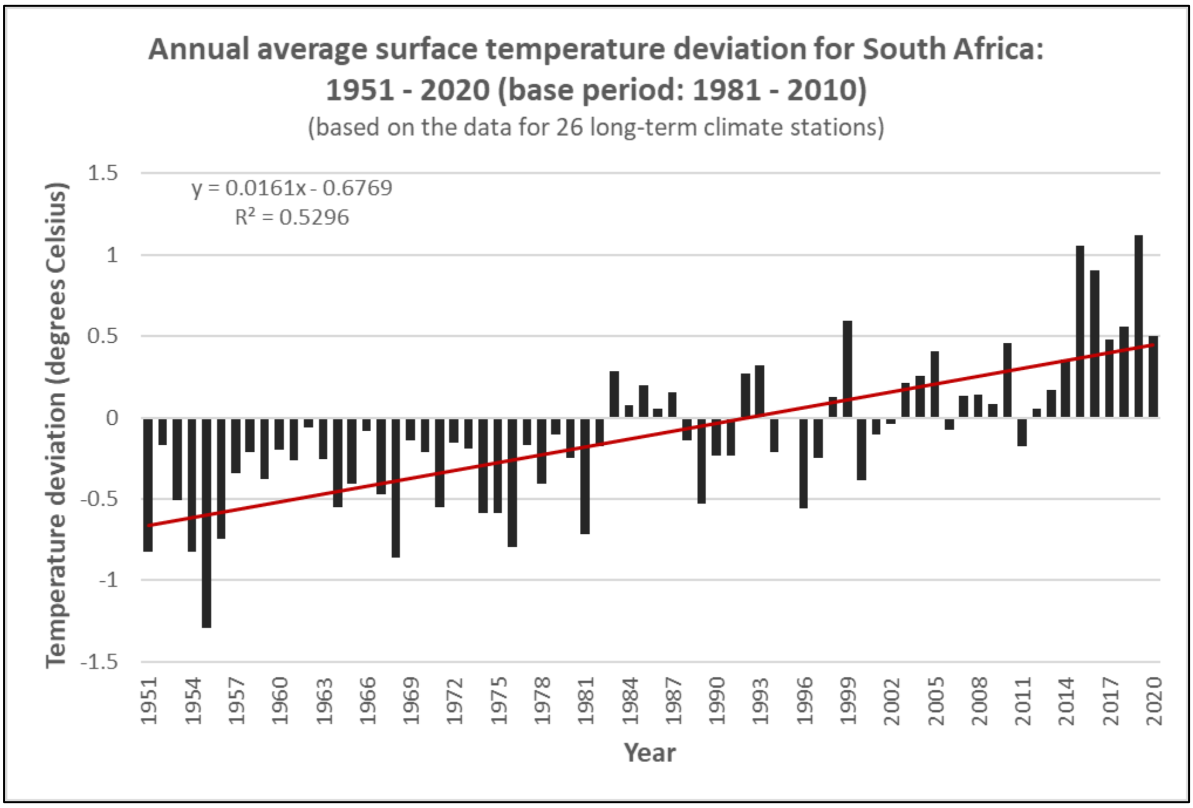

Figure 3.6 Average surface temperature deviation trend over South Africa (Source: SAWS)

3.2 Extreme climate and weather events

In South Africa, dry conditions persisted over large parts of the west of the country and in some parts the dry conditions have continued for approximately seven years (Kruger and Mcbride, 2020).

3.2.1 Tropical cyclone Eloise

Tropical cyclone Eloise was the sixth tropical cyclone to develop in the South West Indian Ocean, and the third such system to affect southern Africa. “Eloise” made landfall in the early morning hours of 23 January 2021 over the coast of Mozambique around the city of Beira, resulting in significant damage to infrastructure and loss of lives in the city. A few hours after its landfall, “Eloise” lost its strength and was reduced to an overland tropical depression (SAWS, 2021).

Figure 3.7(A) indicates areas over the Lowveld region of Limpopo and Mpumalanga that received significant rainfall amounts on the 23 January 2021. Stations such as Tshanowa Primary School outside of Thohoyandou recorded 188 mm of rainfall on 23 January in the early morning of the 24 January 2021, while Woodbush recorded 300 mm for the same period. Some parts of Limpopo and eastern parts of Mpumalanga and KwaZulu-Natal received up to 200mm of rainfall on the 25th of January – see Figure 3.7(B). Charters Creek for example in KZN had recorded 205mm of rainfall.

It is important to note that from 26 – 28 January the dominant weather systems were no longer that of a tropical system, but it was rather of a surface trough over the western parts of the country and an upper air trough west of the country (SAWS, 2021). The total measured rainfall for the period 23 January to 8 February 2021 is presented in Figure 3.7(C), while the indications of locations with adverse incidence and impacts related to this extreme event are presented in Figure 3.7(D).

The notable rainfall totals measured for this extreme event are:

- Tshanowa Primary School (Limpopo): 599,6mm
- Kruger Airport (Mpumalanga): 388,3mm
- Charters Creek (KZN): 367,6mm
- Thohoyandou (Limpopo): 343,6mm
- Levubu (Limpopo): 323,6mm

The observed hydrographs from the flow gauging stations within the vicinity of the rainfall stations where extreme storm events were observed are presented in Figure 3.8 for the following flow stations:

- A9H003 – Tshinane River at Chibase in Limpopo;
- A9H012 – Luvuvhu River at Mhinga Village in Limpopo (downstream the Nandoni Dam);
- A9H029 – Mutale River at Thengwe Village in Limpopo (Tributary of Luvuvhu River, before confluence with the Limpopo River); and
- X2H032 – Crocodile River at Weltevrede in Mpumalanga, by the Kruger National Park.

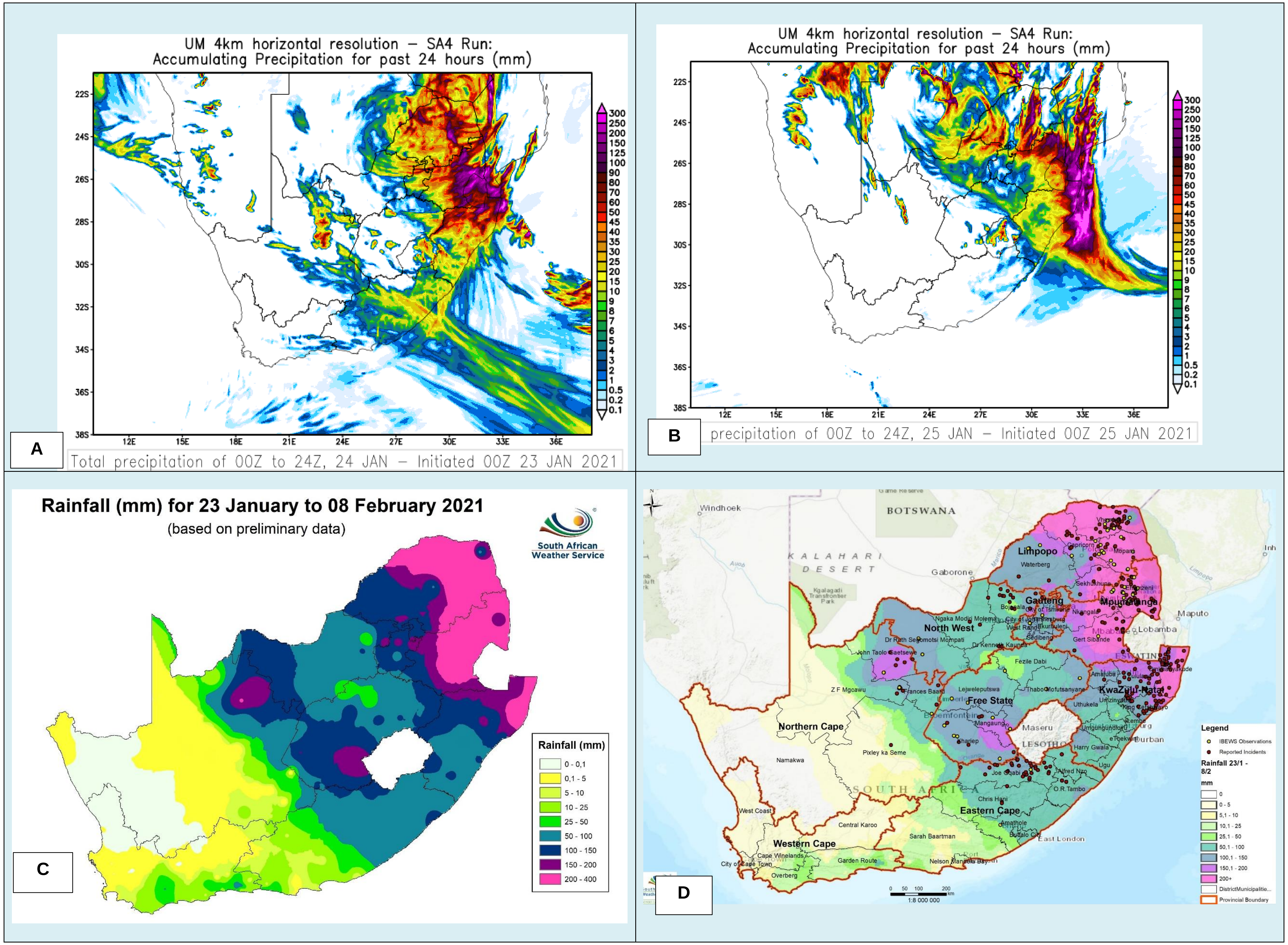

Figure 3.7 Unified model depicting 24-hour rainfall accumulation for 24 January 2021 (A) & 25 January 2021 (B) (Source: SAWS), (C): Total measured rainfall (mm) for the period 23 January to 08 February 2021 (Source: SAWS), (D): Composite map of total rainfall (provided by SAWS), overlaid with mapped locations of adverse incidents and impacts in relation to this event (Source: NDMC)

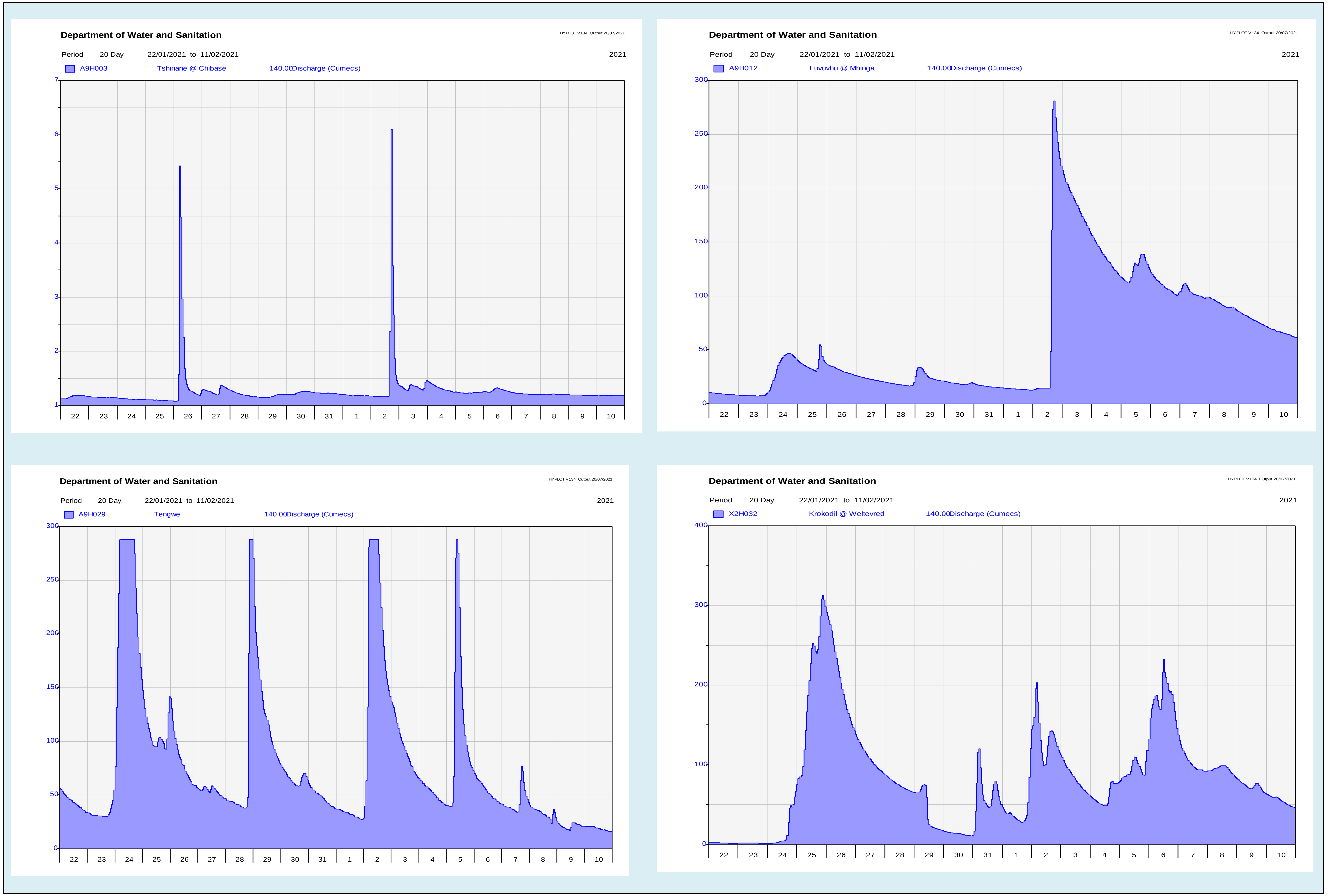

Figure 3.8 Observed hydrographs for period 22 January - 10 February 2021

3.2.2 Indications of Drought

A meteorological drought is defined on the basis of rainfall deficiencies in comparison to “normal” or average amounts of rainfall for a particular area or place and the duration of the dry period.

The Standardized 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. Long-term drought usually occurs when moisture supply is abnormally below average for periods of up to two years, where-after widespread desiccation occurs. A 12-month and 24-month SPI is a comparison of the precipitation for 12 and 24 consecutive months with the same 12 and 24 consecutive months during all the previous years of available data respectively. SPI’s of these longer timescales are useful in identifying areas of drought, as they are subsequently linked to streamflow, reservoir levels and even groundwater levels.

The 12, 24 and 36-month SPI maps as given in Figure 3.9 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 short term SPI (6-months) reflects a wet summer season most significantly in the central parts of the country, as well as the northern parts of the Limpopo and Olifants WMAs. There was generally no extensive area experiencing severe-extreme drought conditions according to the SPI.

On the medium term observation (12-month) SPI map, extremely dry conditions are most noticeable over the south-eastern parts of the Eastern Cape, while severe drought conditions are noticeable on some central parts of the Northern Cape. Most parts in the central to eastern half of the country were wetter than normal, while the northern-eastern parts of the Northern Cape remain severely-extremely wet.

On a long term scale (24-36 Month) SPI map, severe to extremely dry conditions are observed in the south and central parts of the Northern Cape, North-eastern part of the Western Cape in the Karoo, and the coastal parts of the Eastern Cape. To a lesser extent some areas in Limpopo and Mpumalanga Province. Due to improved rainfall over most parts of the country in the short term, the drought signal for most of the drought stricken large areas has somewhat weakened.

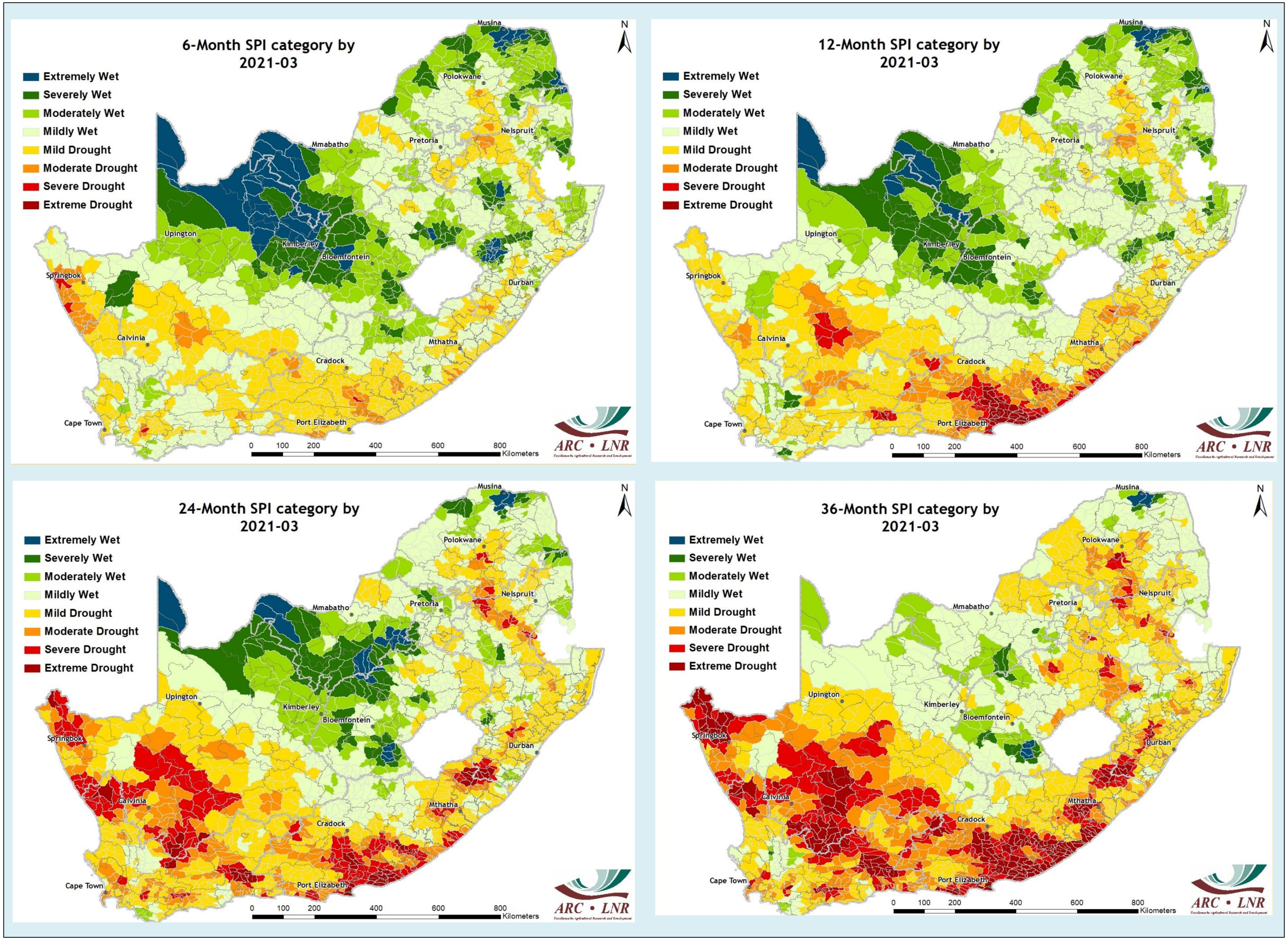

Figure 3.9 Spatial Precipitation Index (SPI) March 2021 (Source: ARC)

3.3 Status of Rivers

3.3.1 Stream flows

The total natural runoff (NAT) of water flowing in water courses to the seas, predicted largely based on the Pitman Model (WRSM200) from the Water Resource Study of 2012, was estimated to be 49,251 million m^3 per year. The present day flows (PD) for simulations up to September 2010 was 36,329 million m^3 per year (74% of NAT) (Bailey and Pitman, 2016). These results are presented schematically for key points in the country per 19 WMAs in Figure 3.12, while the strategic points of streamflow monitoring are presented in Figure 3.10. The natural runoff is streamflow without anthropogenic impacts, while present day streamflow is simulated with the inclusion of afforestation, irrigation, alien vegetation, reservoirs, storages, mining and transfers.

The Pitman Model (Pitman, 1973) comprises three conceptual storages (interception, soil moisture and groundwater) and simulates infiltration-excess flow, saturation-excess flow, direct overland flow and groundwater flow. It is a conceptual, semi-distributed, monthly rainfall-runoff model that uses monthly rainfall data and monthly estimates of evapotranspiration as input (Kapangaziwiri and Hughes, 2008). It has been successfully used for water resources estimations in the ungauged parts of South Africa for more than four decades.

It is important to note that the Present Day runoff assumes land use is stationary based on data for 2010 (hydrological year - October 2009 to September 2010) throughout the simulation period from 1920 to 2010, i.e. if irrigation started in 1940 at 10 km^2 in a particular catchment and grew to 50 km^2 in 2010, the simulation for the whole period from 1920 to 2010 are based on the fixed value of 2010 (50 km^2).

Each river system, however, shows somewhat different real measured values compared to natural values, depending the changes overtime in water abstractions, land use changes and inter-basin transfers. The location of strategic points for which the trend and status of streamflow information can be derived from monitoring data is presented in Figure 3.11.

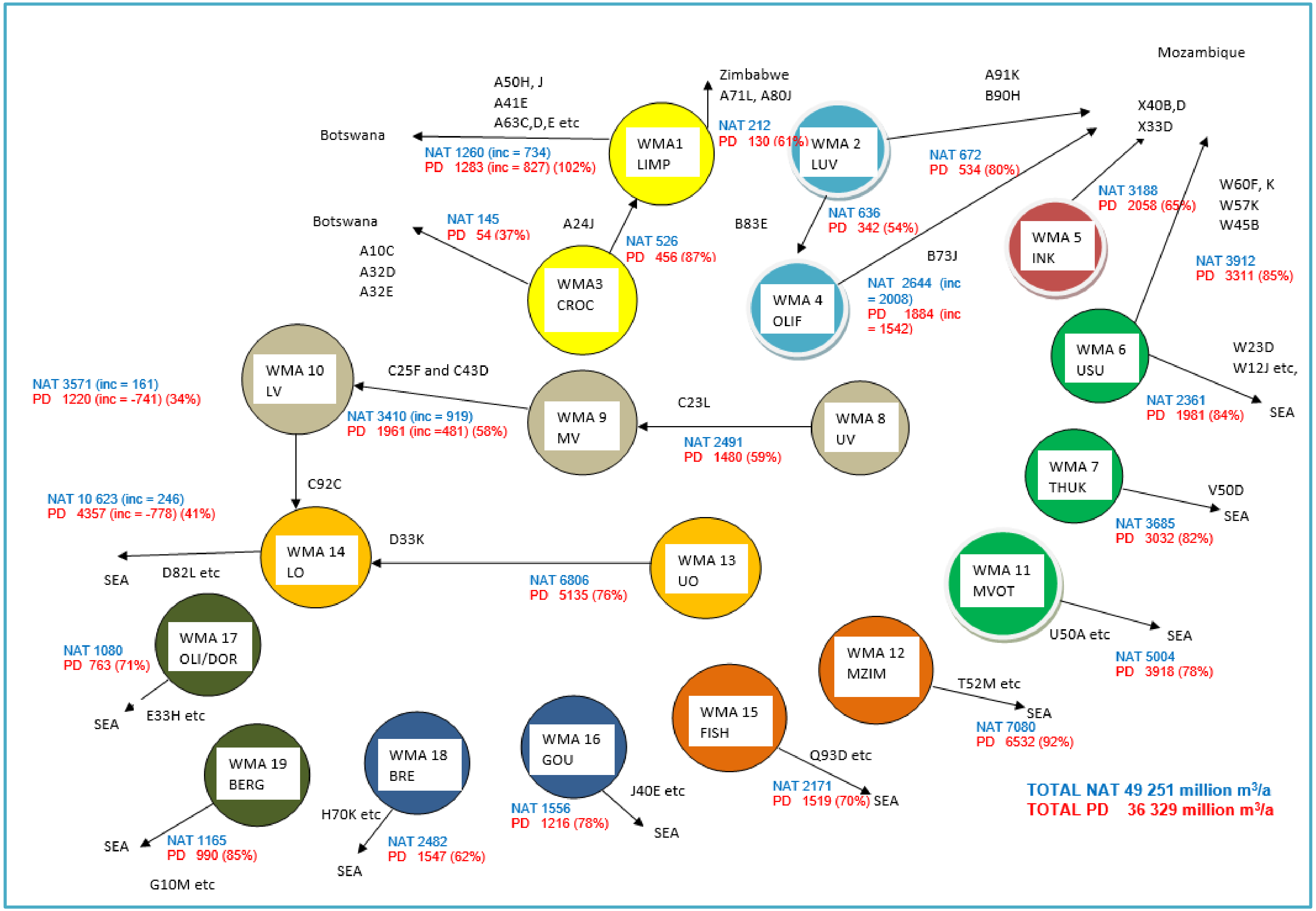

Figure 3.10 WR2012 Natural and Present day Flows (Bailey and Pitman, 2016)

Figure 3.11 Strategic River Flow Monitoring Stations

3.3.2 River Nutrient Status

Median Dissolved phosphate (orthophosphate or PO_4-P) concentration in dams and rivers for the summer season based on available data is presented in Figure 3.12, most results were found in the Gauteng Province. Most of the sites in this part of the country were in good quality while other though few sites were in unacceptable condition. Other nutrients such nitrate-nitrite showed good indication of water quality with few sites unacceptable as represented in Figure 3.13.

Effects of different classes of electrical conductivity on human health is given in Table 3-1. Electrical conductivity is an easily measured indicator of salinity. Electrical Conductivity as presented in Figure 3.14 was mostly in fair condition with very few sites that were slightly higher. In general, the results showed that nutrient status in the period of reporting was not poor as most sites showed a good water quality status.

Table 3-1 Electrical Conductivity Classes

Class	**Quality**	**Health Effects**
Blue	Ideal	No Effect
Green	Good	Insignificant effect on sensitive groups
Orange	Marginal	Slight possibility of salt overload in sensitive groups
Purple	Poor	Possible health risk to all individuals
Red	Unacceptable	Increasing risk of dehydration

Effects of different Sulphates classes on human health is given in Table 3-2 below, while results for the period of reporting is presented in Figure 3.15.

Table 3-2 Sulphates concentration classes

Class	**Quality**	**Health Effects**
Blue	Ideal	No Effect
Green	Good	Insignificant health effects
Orange	Marginal	Slight chance of initial diarrhoea in sensitive groups
Red	Poor	Possibility of Diarrhoea – poor adaptation in sensitive individuals

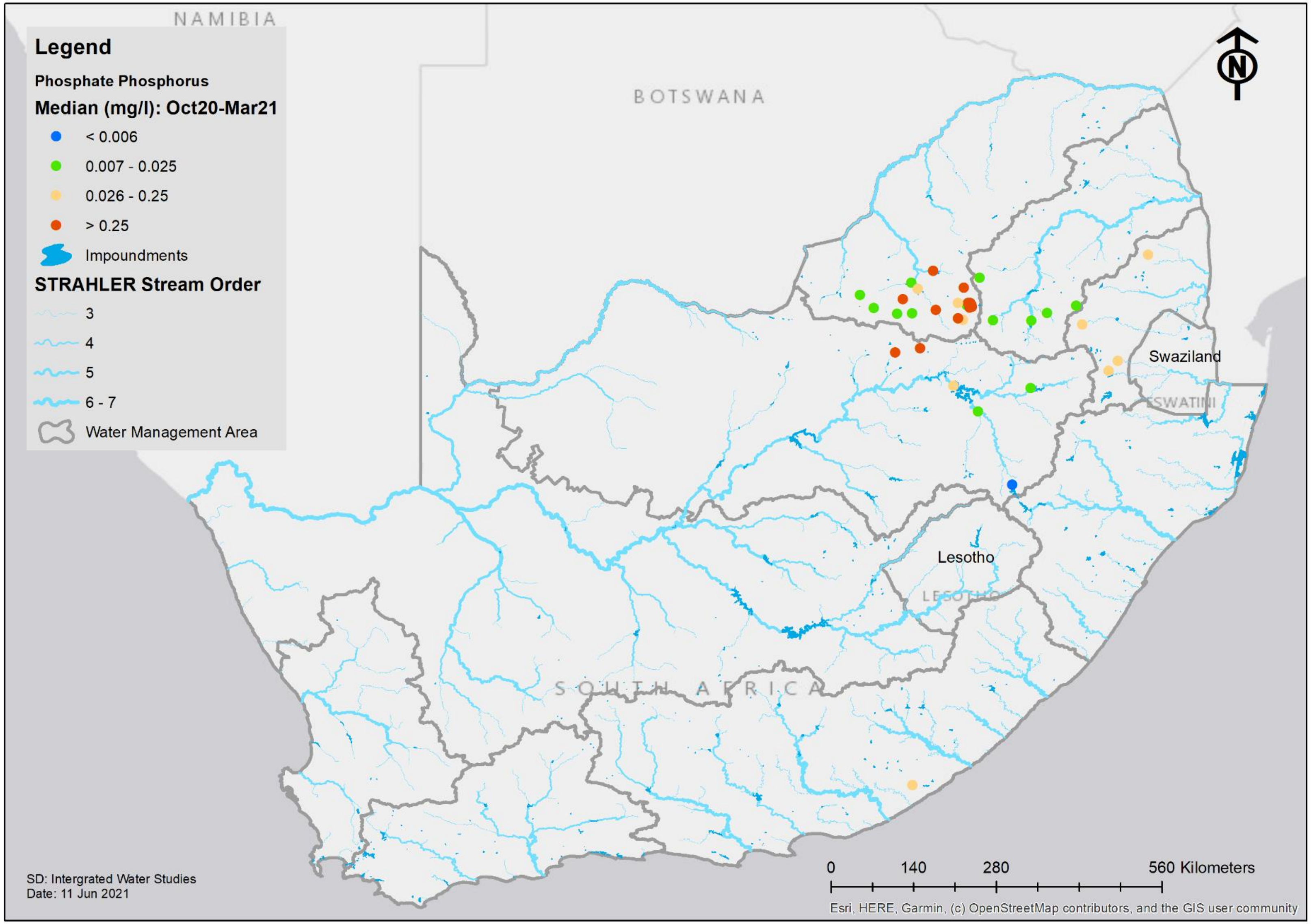

Figure 3.12 Median Orthophosphate as Phosphorus (mg/l) concentration in water resources

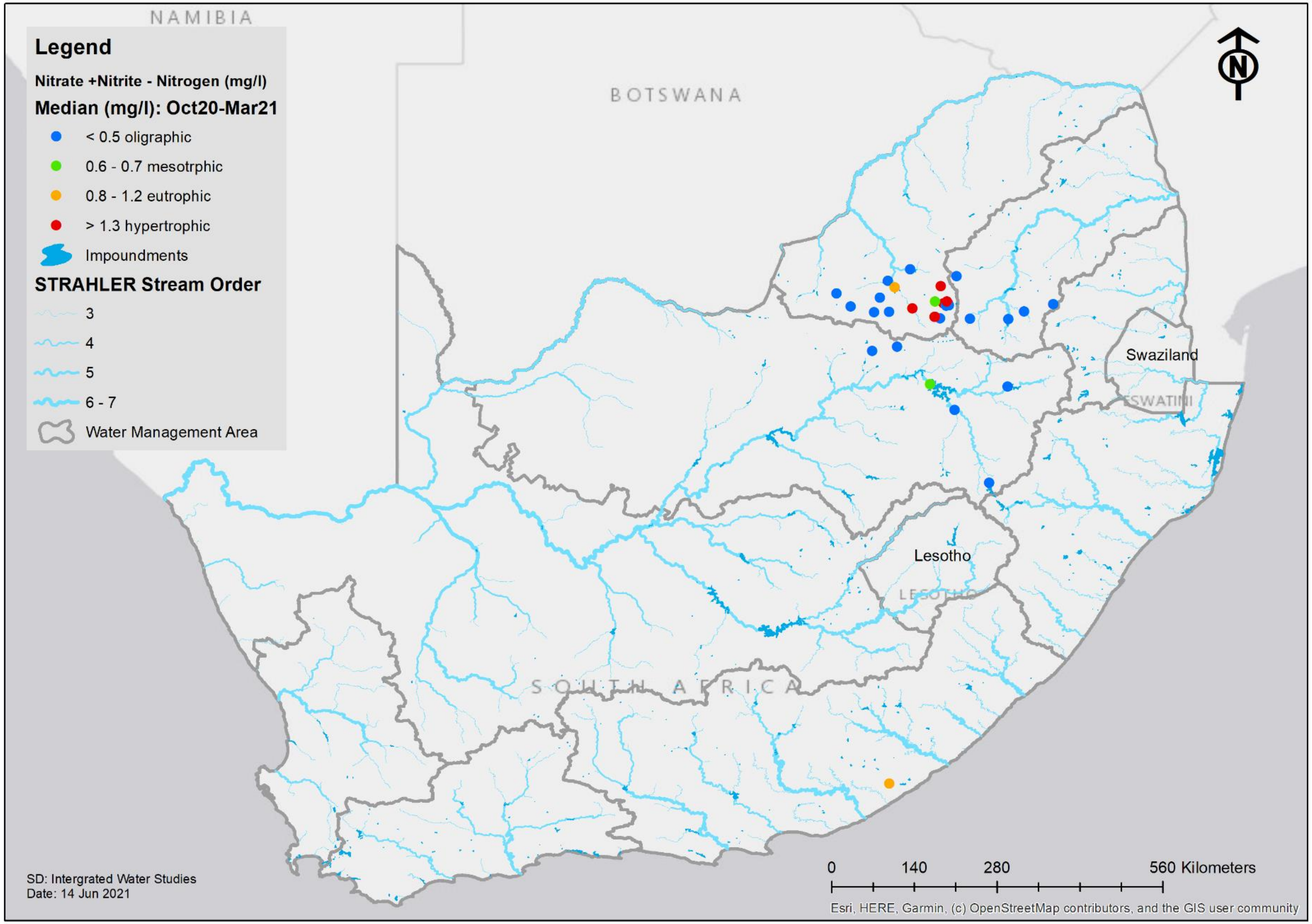

Figure 3.13 Median sum of Nitrate (NO_3^-) and Nitrite (NO_2^-) expressed as Nitrogen with an estimation of trophic status

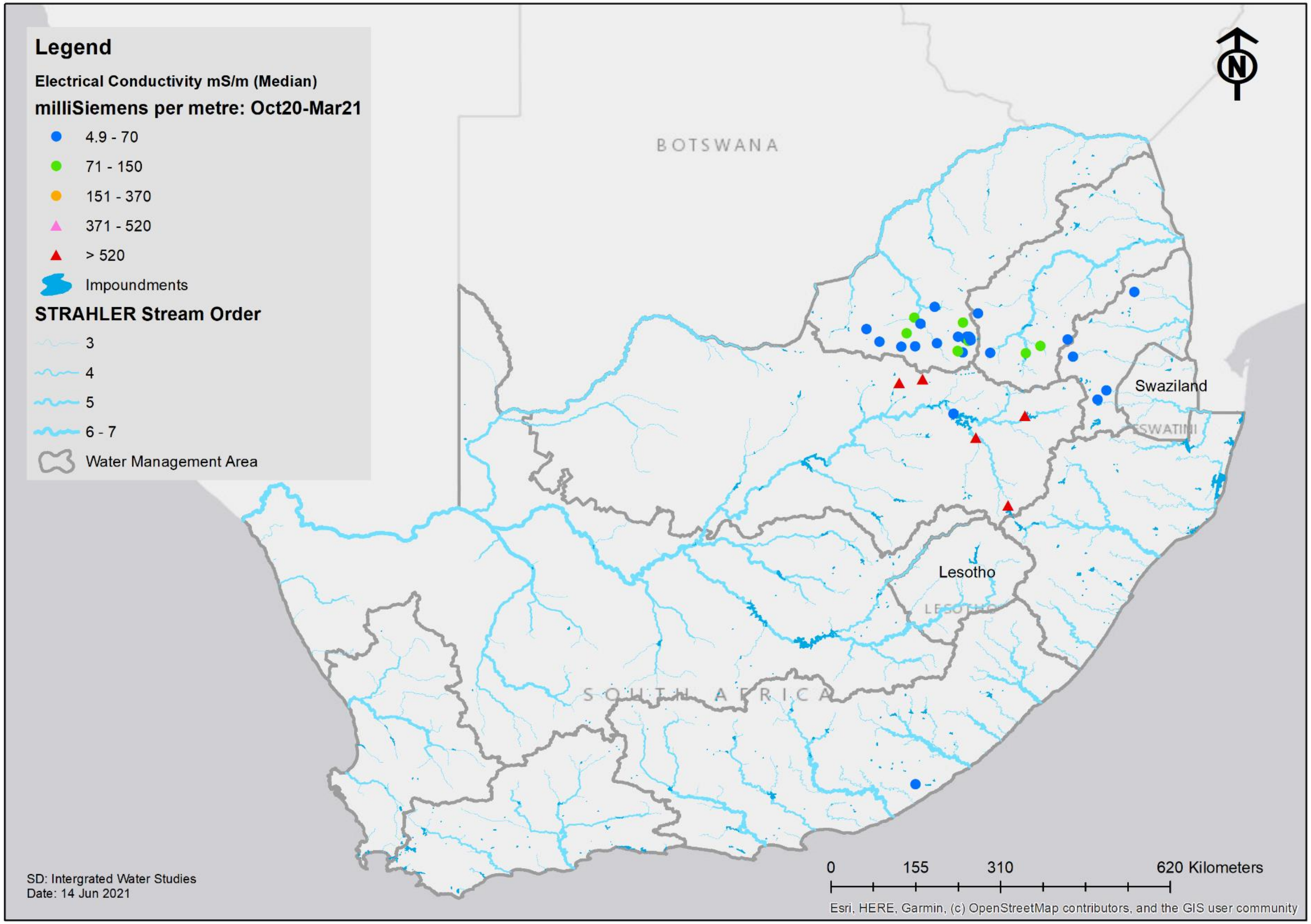

Figure 3.14 Electrical conductivity as an indicator of salinity

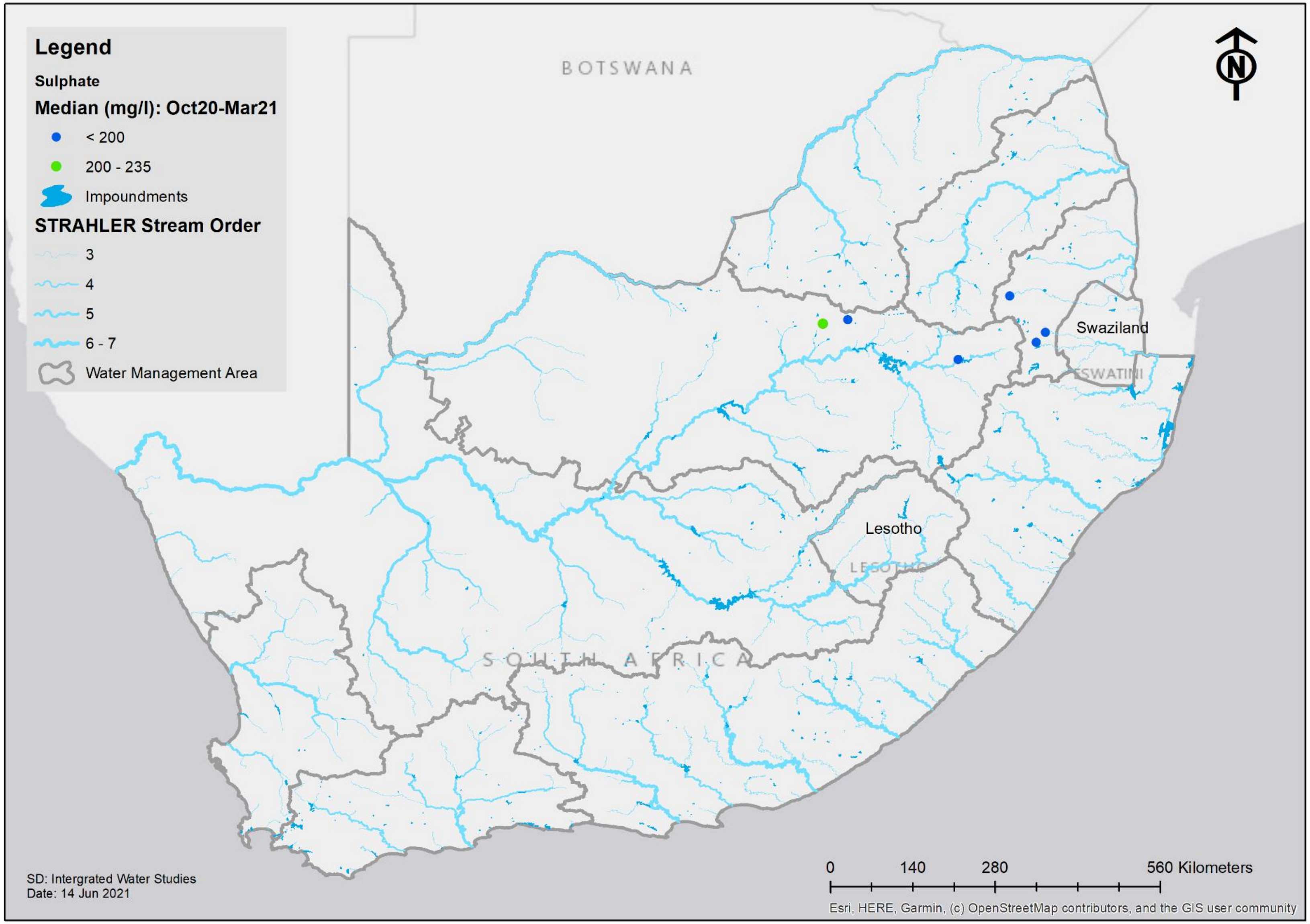

Figure 3.15 Sulphate concentrations in water bodies

3.4 Status of Surface Water Storage

DWS, through its surface water monitoring networks, monitors water storage levels in approximately 223 state and municipal owned dams. There are also farm dams which play an important role in agriculture as they capture runoff that can be used during dry periods of low or no rainfall. While in most cases the impact of an individual farm dam is relatively small, the cumulative impact of a large number of farm dams and unmonitored small municipality dams on stream-flows and available water storage reporting can be significant.

Accounting for storage in farm dams is important to get a more accurate reflection of the surface water available at any time of reporting, as they can drastically impact on total catchment yield, projected demands and the availability of water supply to users. It is for these reasons that the surface water storage data given in this report is a reflection of water availability within a water management area, rather than presenting the complete national water storage status, given that it is based on only large dams.

The weekly dam storage trends for the summer season are presented in Figure 3.16 for water management areas and in Figure 3.17 is surface water storage for Provinces. The total volume of surface water stored in dams nationally is expressed as a percentage of full supply capacity. At the beginning of the summer season (October 2020), surface water storage levels for all WMAs were above 50% of their full supply capacities (FSC), this was with an exception of Mzimvubu-Tsitsikamma (48.6%) and an international area, Kingdom of Lesotho (16.8%). Notably, the winter rainfall dominated Berg-Olifants had begun the summer season at a high of 99.96% of FSC.

Mzimvubu-Tsitsikamma WMA has consistently been showing dam levels below 56% of full supply capacity for the whole period of reporting. This region has continued to experience dry conditions and water use restrictions have been implemented for all water supply systems within this water management area, namely: Algoa, Amathole, Klipplaat, and Butterworth water supply systems.

It is also worth noting that the international areas of Lesotho and Swaziland have also during the wet season experienced below optimal storage levels. Lesotho was at a low of approximately 15% in November 2020 while Swaziland was at a low of 37% of full supply capacity in January 2021.

At the end of January to early February, storage levels in all WMAs in the summer rainfall region have increased at a significant rate with the exception of Berg-Olifants and Mzimvubu-Tsitsikamma (slight increase, almost flat curve). This was due to Cyclone Eloise which was experienced between 23 January and 8 February mostly in the central and eastern half of the country. The influence of the cyclone is evident, in the Orange WMAs that experienced a high of 111.16% of FSC in February, followed by the Vaal, Swaziland (eSwatini), Inkomati-Usuhtu and Limpopo, where storage above the national average were experienced during this period.

Provincially, the Gauteng, Northern Cape and Free State Provinces had for the whole period of reporting experienced storage levels above the national storage levels (Figure 3.17), where all three Provinces reached a high of 102.3%, 129.6% and 105.4% on the 8 of February 2021, respectively. Limpopo, North-West, KwaZulu-Natal and Eastern Cape have notably even after the cyclone, continued to experience storage levels below the national storage. Dam levels in these four provinces as well as the whole country in general have been mostly affected by below normal rainfall received during the past seven years.

The long-term trend of % of FSC per water management area as an anomaly against the selected normal period (October 1979 to March 2021) is presented in Figure 3.18. Based on the set classification that storage anomalies below 50% would represent a dry period where storage levels are below optimal level, only the Breede-Gouritz could be identified to have experienced a dry summer season in the past 10 years. However, even when a WMA experienced hydro-meteorological drought, surface water storage could also be kept at optimal levels due to systematic catchment transfers and implementation of water use restrictions. Notably, in terms of storage anomalies the following WMAs experienced surface storage levels above normal during the summer season of 2020/21:

- Vaal (123%);
- Breede-Gouritz (119%);
- Olifants (110%);
- Limpopo (110%).
- Berg-Olifant (109%);
- Orange (102%); and
- Inkomati-Usuthu (101%);

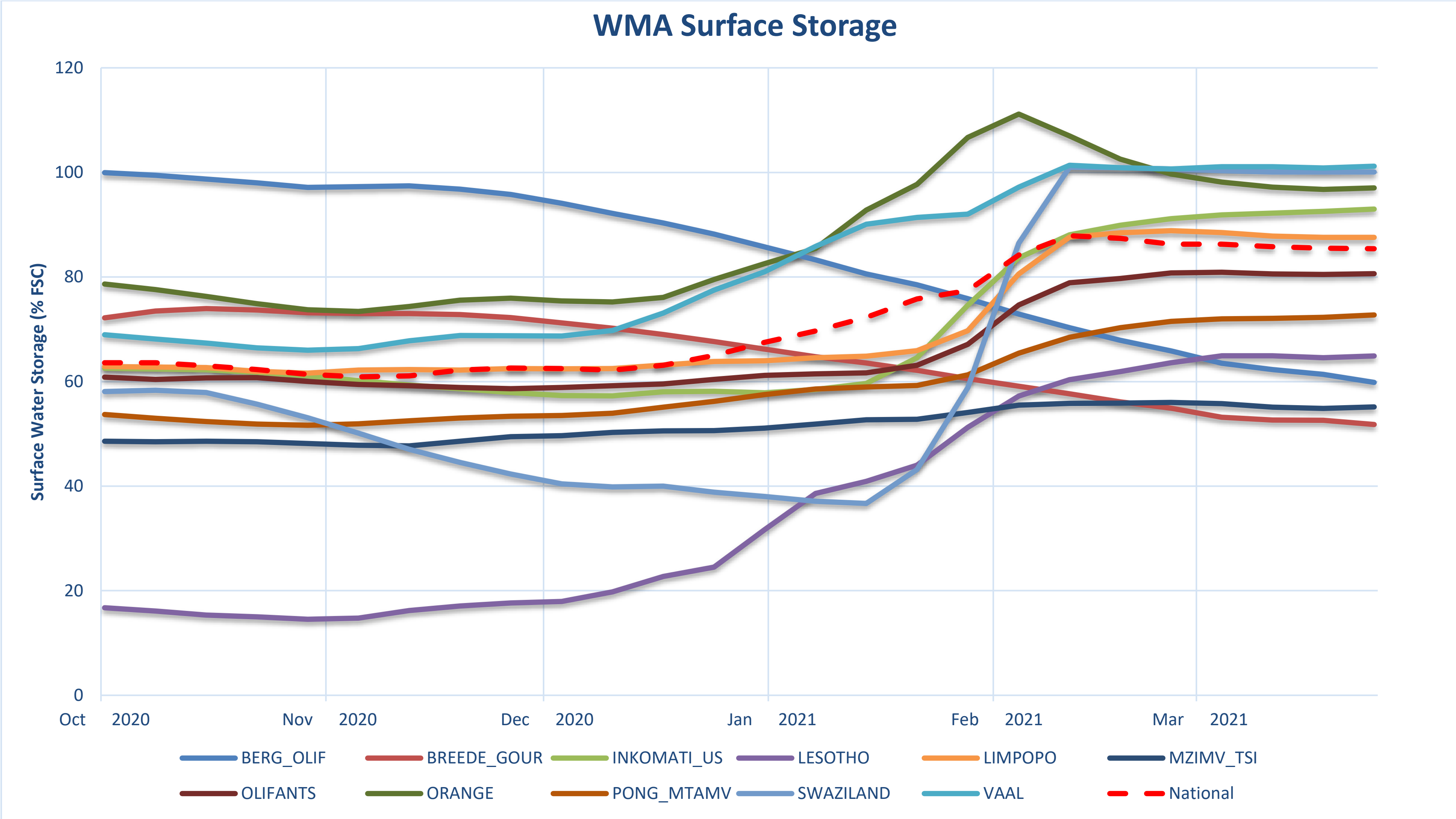

Figure 3.16 Water Management Areas Surface Water Storage

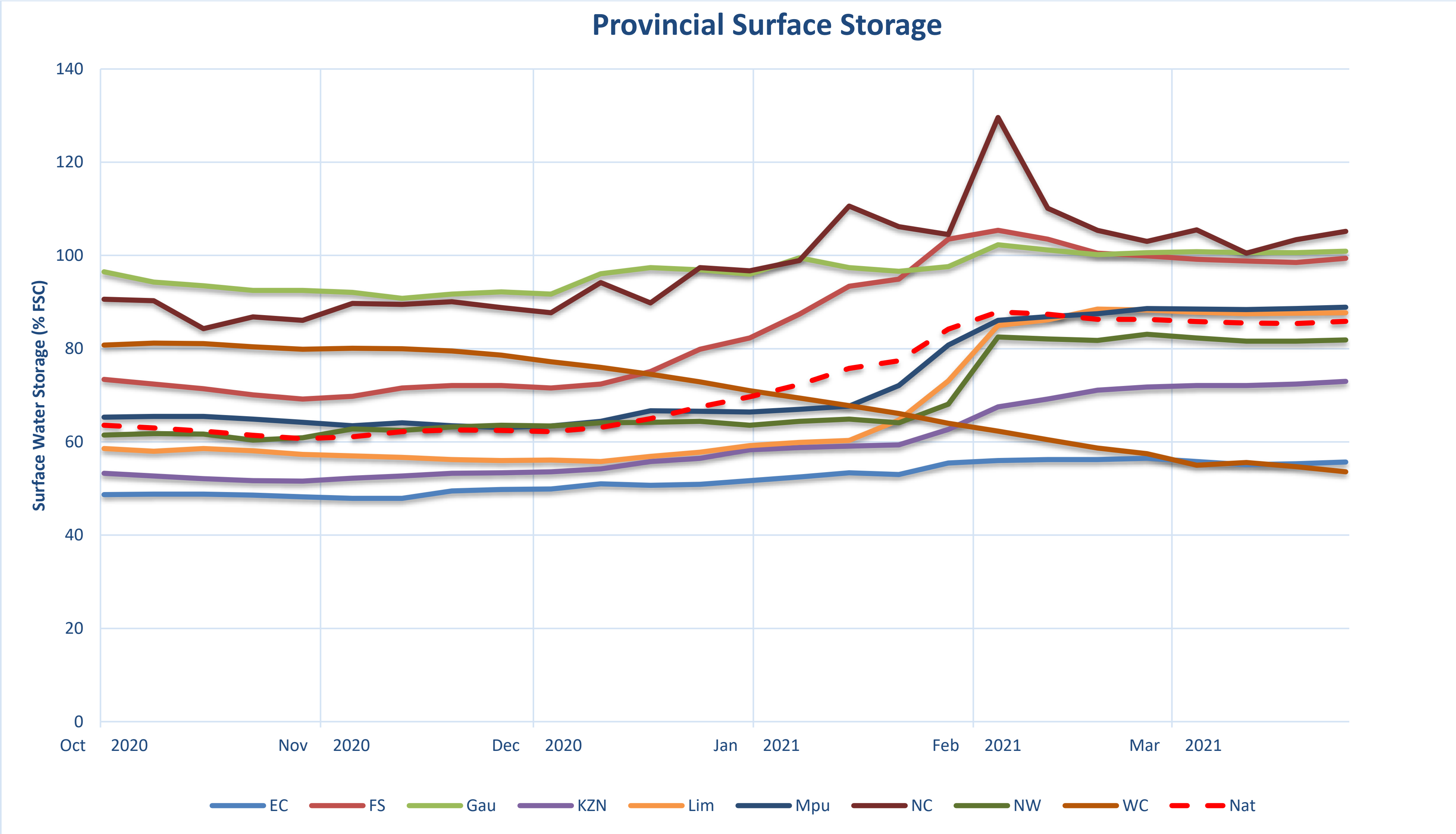

Figure 3.17 Provincial Surface Water Storage

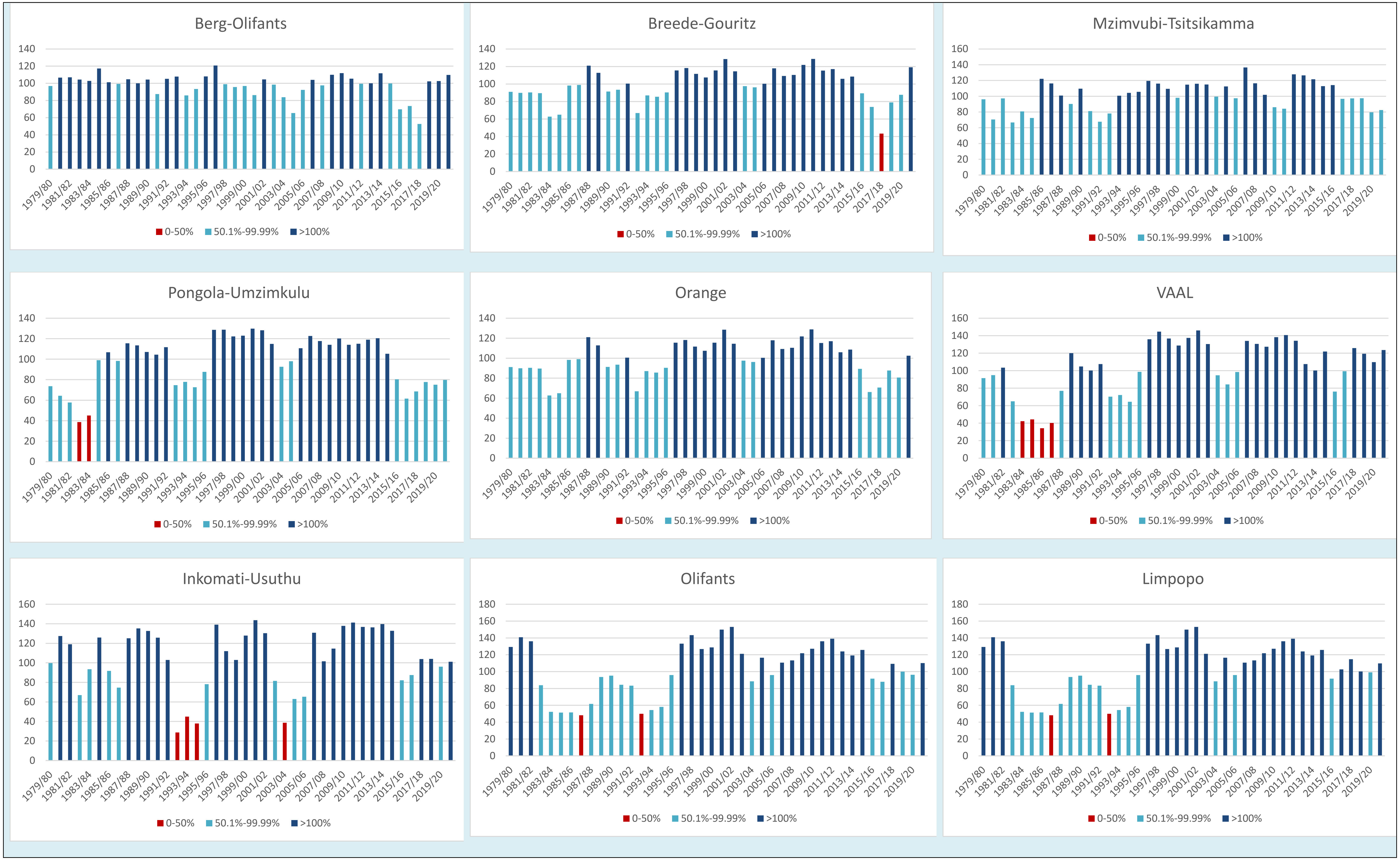

Figure 3.18 Summer Season Storage Anomalies: >50 <99.99% (optimal); > 100% (wet) & < 50% (dry)

3.5 Status of Groundwater

Groundwater is a national asset and forms an integral part of South Africa's water resources. Groundwater represents a major storage of water, which together with surface water storage is critical for a reliable water supply in the country. The growing water demand in South Africa has almost reached the limits of what surface water from rivers and dams can supply and therefore groundwater becomes the life line to augment surface water resources in the backdrop of increasing population and impacts of climate change.

The number of groundwater monitoring sites that has data available during the summer season (October 2020 to March 2021) has decreased as compared to the past two hydrological years (HY). This is as a result of the monitoring interruption by the Covid-19 pandemic which emerged in South Africa in March 2020 and the nationwide lockdown which followed. Figure 3.19 illustrates the changes in sites with available data. WMA 7 (Mzimvubu-Tsitsikamma) – Eastern Cape Provincial Office, has had the most significant decrease a lot compared to 2019/20 period.

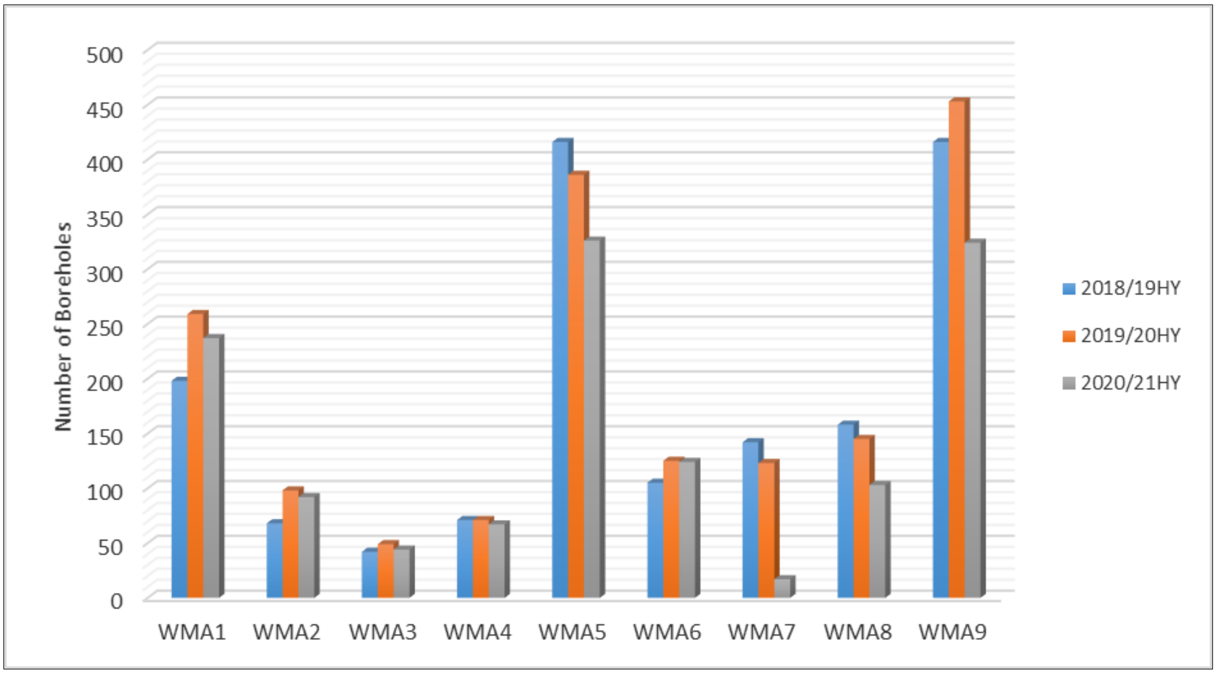

Figure 3.19 Groundwater sites with available data per WMA

3.5.1 Groundwater Quality

Groundwater quality sampling has not been conducted for seven of the nine Provinces. The Western Cape, Eastern Cape, KwaZulu-Natal, Free State and National office had no water quality data available for the period October 2020 to March 2021. Limpopo and the Northern Cape are the only two regions with water quality data sampled. Most sampling activities within the National Groundwater Quality Monitoring Network are expected to resume to normal with the relaxation of Covid-19 restrictions.

Figure 3.20 presents the number of total active groundwater stations in the regions compared to the sites sampled for the October 2020 to March 2021 period.

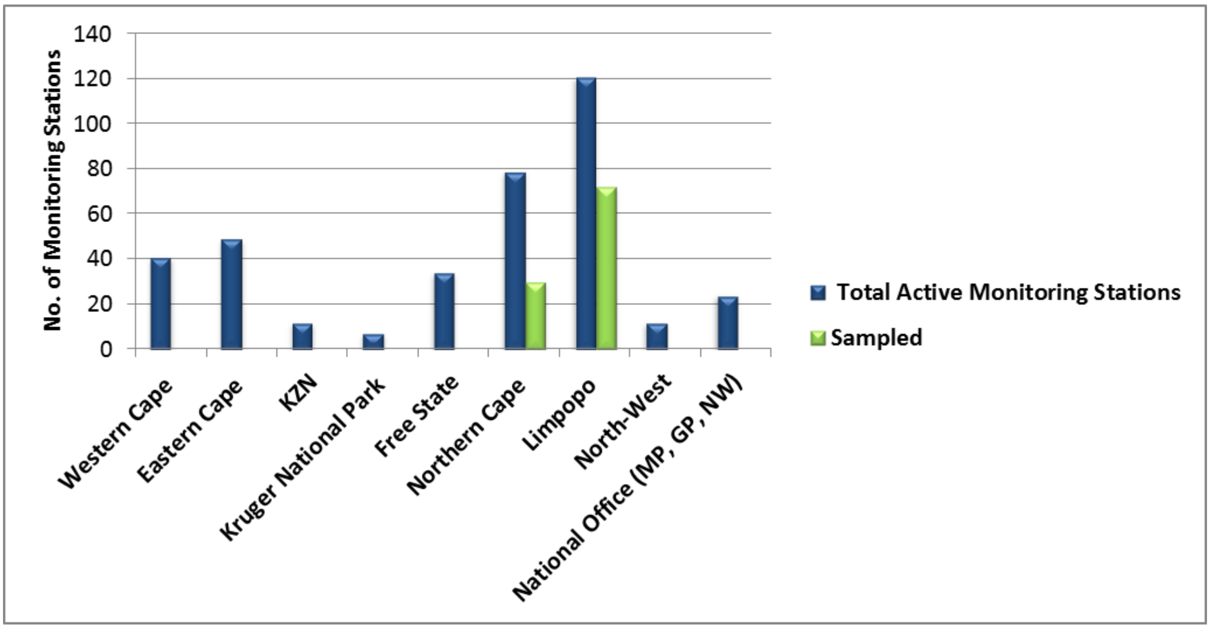

Figure 3.20 Sampled Groundwater Quality Sites per Province (October 2020 to March 2021)

3.5.2 Groundwater levels

Groundwater level monitoring for the summer season accounts for the October 2020 to March 2021 period. The average groundwater level of each borehole per WMA for the period of reporting was used (Figure 3.21). The determined averages were then compared to the 2019/20 HY averages and the change in groundwater level was determined using Equation 1 (see Figure 3.22)

$$\Delta GWL = Ave\ GWL_{\ 2020/21\ SS} - Ave\ GWL_{\ 2019/20\ HY} \quad (1)$$

where:

ΔGWL *is the change in groundwater level (mbgl);*

$Ave\ GWL_{\ 2020/21\ SS}$ *is the average groundwater level for the Summer Season (October 2020 – March 2021);*

$Ave\ GWL_{\ 2019/20\ HY}$ *is the average groundwater level for the 2019/20 hydrological year.*

According to the grouped groundwater level classes across the country in Figure 3.21 below, majority of water levels reported are within the 0 to 30 meters below ground level (mbgl). This is representative of general shallow aquifer conditions. The deepest water levels monitored are found predominately in the North West Province on the border between South Africa and Botswana with water levels ranging between 60mbgl and 120mbgl.

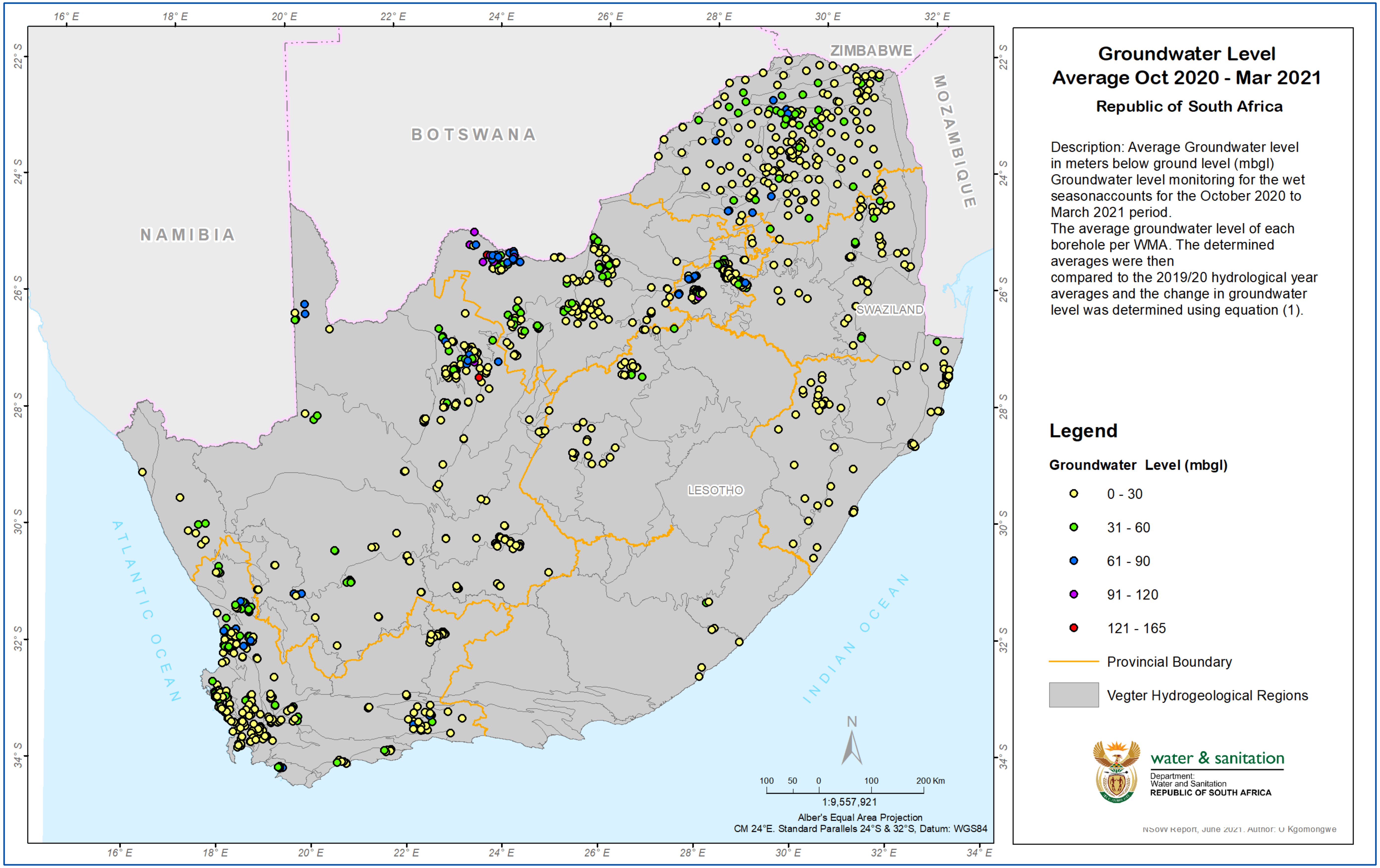

Figure 3.21 Summer Season Average groundwater levels

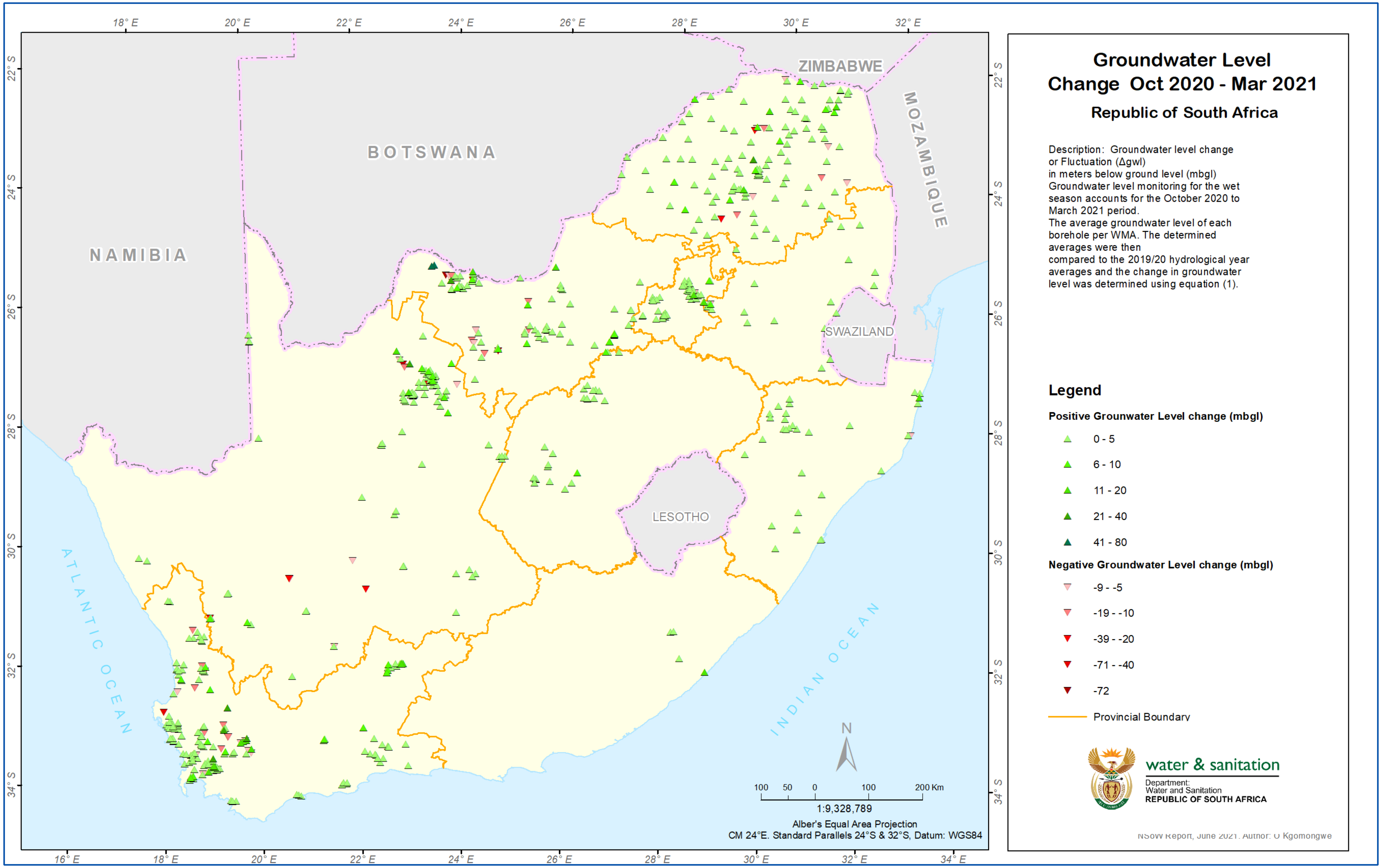

Figure 3.22 Groundwater level change between hydrological year 2019/20 and summer season (October 2020 – September 2021)

These boreholes are located within the Khakhea/Bray Dolomite Transboundary Aquifer and the deep water levels do not correspond with the extremely wet and severely wet mapped 6 to 36 month SPI conditions (see Figure 3.9), which would suggest increased recharge into the ground resulting in shallower as opposed to the deep water levels pattern that is reported (Figure 3.21). According to Haasbroek (2018), over abstraction by mining and the South African Defence Force in the 1980s resulted in the decline in water levels and the water levels have not since recovered due to low recharge conditions in the area

3.5.3 Groundwater Use

The growing water supply challenges throughout the country have led to more extensive drilling of boreholes as part of intervention plans to access groundwater by individuals within communities and water services authorities, including DWS. Whilst the department aims to improve policies to better control drilling activities to access groundwater resources within the Country to ensure optimal management and utilization of the resource, improved coordinated efforts are required within DWS Provincial offices to coordinate new groundwater drilling data and reports to regional and national groundwater units to be incorporated into immediate drought relief efforts and general groundwater management of this precious resource.

Based on the Water Use Authorization & Registration Management System (WARMS) data set period of April 2020 through to March 2021. Groundwater use is based on registered volumes of the taking of water through boreholes, registered boreholes and windmills from government land and registered spring/eye data. Agriculture, composed of aquaculture, irrigation and livestock watering, is the leading user of groundwater making up 40% of registered groundwater use. Industry (non-urban and urban) is at 19%, mining 17% and water supply services at 10%. Figure 3.23 illustrates the registered groundwater use volume per sector.

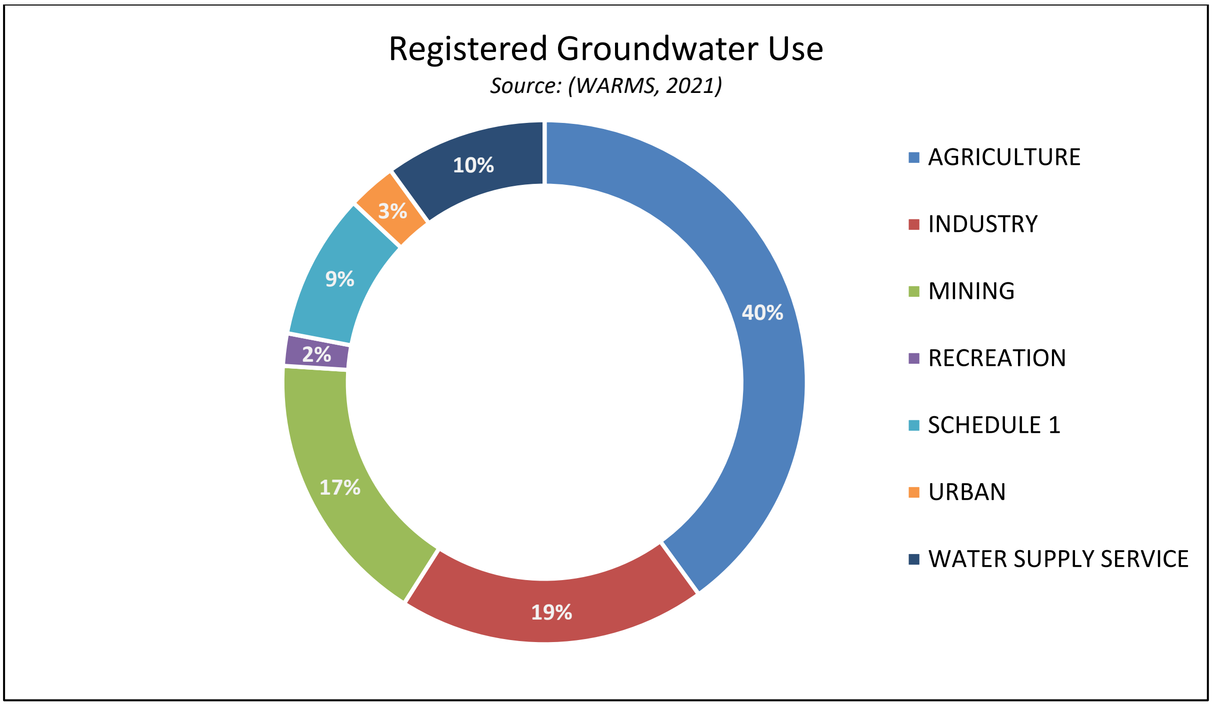

Figure 3.23 Registered Groundwater Use Volume April - March 2021 (WARMS, 2021).

3.5.4 Proposed Regulation Impact on Groundwater Resources

The proposed regulations are called *Regulations for the Use of Water for Exploration and Production of Onshore Naturally Occurring Hydrocarbons that Require Stimulation Including Hydraulic Fracturing and Underground Coal Gasification to Extract and any Activity Incidental Thereto that may Impact Detrimentally on the Water Resource* with the aim of soliciting public comments from page 46-58 of *Gazette no: 44545 07-05*.

The purpose of these regulations is to protect the water resource, particularly groundwater resources, so as to avoid and minimise detrimental and cumulative impacts on the water resource by the controlled activity.

4 INFRASTRUCTURE DEVELOPMENT

Water infrastructure is ageing and becoming dis-functional. 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, also responsible for the management of Government Water Schemes (GWSs). A number of strategic water resource infrastructure projects were implemented during the period of reporting.

4.1 Augmentation Projects Progress

Table 4-1indicates the augmentation projects and their various project phases as well as project start and completion date. The phase percentage is included and green highlight indicating 100% phase completion and red indicating 0% or no progress for the particular phase. The Trans Caledon Tunnel Authority (TCTA) has been directed by the Minister of Human Settlements, Water and Sanitation to fund and implement a portfolio of projects which are at various phases and are reported in Table 4-1 under external projects.

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Table 4-1 Augmentation Project Summary (March 2021)

No.	**Project Name**	**Project Start Date**	**Project Completion Date**	**Phase Percentage Complete (%)**
PROJECTS AT CLOSE-OUT PHASE				
1.1	De Hoop Dam	2004	October 2018	80%
PROJECTS AT CONSTRUCTION PHASE				
2.1	Raising of Hazelmere Dam	April 2004	August 2022	96%
2.2	Raising of Tzaneen Dam	February 2016	June 2023	10%
2.3	Raising of Clanwilliam Dam	2014	April 2026	12%
PROJECTS AT DESIGN PHASE				
3.1	Nwamitwa Dam	Octover 2015	TBC*	0%
3.2	ORWRDP 2D	March 2015	April 2024	100%
3.3	ORWRDP 2E & 2F	April 2015	September 2025	80%
3.4	Cwabeni OCS Dam	June 2017	TBC*	25%
3.5	Zalu Dam	April 2018	TBC*	20%
PROJECTS AT PREPARATION PHASE				
4.1	Stephen Dlamini Dam	2013	TBC*	40%
4.2	Foxwood Dam	TBC*	TBC*	0%
4.3	Coemey Dam	October 2020	December 2015	0%
PROJECTS AT OPERATIONAL PHASE				

5.1	Die Hoop Dam	April 2020	March 2021	0%
EXTERNAL PROJECTS (TCTA)				
6.1	uMkhomazi Water Projects – Phase 1	February 2019	2028	
6.2	Berg River Voelvlei Augmentation Scheme (BRVAS)	May 2017	June 2015	
6.3	Mzimvubu Water Project (MWP)	2019	2022	
6.4	Mokolo and Crocodile River Water Augmentation Project- Phase 2A	August 2018	April 2018	
6.5	Olifants River Water Resources Development project –Phase 2C	March 2012	2022	
6.6	Olifants River Water Resources Development Project – Phase 2B	On Hold	On Hold	
6.7	Acid Mine Drainage-Long Term Solution (AMD-LTS)	On Hold	On Hold	
6.8	Off-take to the town of Kriel from the Komati Water Supply Augmentation Project	On Hold	On Hold	
6.9	ORWRDP 2D, 2E and 2F	Potential Project	Potential Project	
6.10	Mwamita Dam	Potential Project	Potential Project	
6.11	Acid Mine Drainage Treatment Plants in the Western , Central and Eastern Basins			
6.12	Delivery Tunnel North (DTN) of the Lesotho Highlands Water Project (LHWP)			

*TBC subject to funding availability

5 CONCLUSIONS

As a developing country, South Africa requires additional water resources in order to support the growing economy. With 98% of the country's available water resources already allocated, opportunities to supplement future surface water supply are limited in the wake of climate change. Monitoring of water resources has become increasingly crucial now more than ever before. To strengthen water security against this backdrop of increasing demand, water scarcity and growing population; Investment into information management and collection is necessary to provide the intelligence to make informed decisions on how to manage our shrinking surface water resources.

As part of the Department's turnaround strategy in establishing CMAs, the extension of the boundary of the existing Breede-Gouritz CMA to incorporate the Berg-Olifants water management area has been gazetted for public comments in terms of section 78(1) of the National Water Act, 1998 (Act No. 36 of 1998) to establish the Breede-Olifants in September 2020. Furthermore, in March 2021, the extension of Vaal CMA to include the Orange water management area was also gazetted for public consultation in terms of section 78(4) of the National Water Act, 1998 (Act No. 36 of 1998).

The National Chemical Monitoring Programme (NCMP) was established in 1970s based on the state of knowledge and national priorities at the time. This is the longest running water quality monitoring programme which has provided data and information for the last 48 years for inorganic chemical quality of surface water resources. The monitoring programme has not been in full operation since 2018 resulting in data gaps. The challenges include the need for reagents and the replacement of aging analytical instruments for the RQIS inorganic laboratory to be fully functional.

In general, most of the central and northern parts of the country received seasonal rainfall that is above normal. Notably, the western parts of the country in the lower Vaal and lower Orange WMA experienced the highest above normal rainfalls by between 150% - 2000%. In South Africa, dry conditions persisted over large parts of the west of the country and in some parts the dry conditions have continued for approximately seven years. Tropical cyclone Eloise made landfall in the early morning hours of 23 January 2021 resulting in flooding in the Lowveld region of Limpopo and Mpumalanga that received significant rainfall. On the medium term observation (12-month) SPI map, extremely dry conditions are most noticeable over the south-eastern parts of the Eastern Cape, while severe drought conditions are noticeable on some central parts of the Northern Cape.

Provincially, the Gauteng, Northern Cape and Free State Provinces had for the whole period of reporting experienced storage levels above the national storage levels. Limpopo, North-West, KwaZulu-Natal and Eastern Cape have notably even after the cyclone, continued to experience storage levels below the national storage.

The number of groundwater monitoring sites that has data available during the summer season (October 2020 to March 2021) has decreased as compared to the past two hydrological years (HY). This is as a result of the monitoring interruption by the Covid-19 pandemic which emerged in South Africa in March 2020 and the nationwide lockdown which followed. According to the grouped groundwater level classes across the country, majority of water levels reported are within the 0 to 30 meters below ground level (mbgl). The proposed regulations are called *Regulations for the Use of Water for Exploration and Production of Onshore Naturally Occurring Hydrocarbons that Require Stimulation Including Hydraulic Fracturing and Underground Coal Gasification to Extract and any Activity Incidental Thereto that may Impact Detrimentally on the Water Resource* with the aim of soliciting public comments.

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, also responsible for the management of Government Water Schemes (GWSs). A number of strategic water resource infrastructure projects were implemented during the period of reporting some of which include raising of Dam walls and several external projects funded and implemented by Trans Caledon Tunnel Authority.

6 RECOMMENDATIONS

South Africa's water resources are increasingly under pressure with climate change only set to exacerbate the challenges ahead. Pahl-Wostl (2009), describes water management as the activities to analyse and monitor resources along with measures developed and implemented to keep the resources within a desirable condition, and water governance as a social function that helps regulate development and management of the water resources and services along with providing guidance towards a desirable state and away from an undesirable state.

The country's water monitoring systems need serious attention and financial support to ensure that they operate optimally and provide monitoring data for the optimal management of the country's water resources. The National Chemical Monitoring Programme (NCMP) is an example of surface water quality monitoring programme that is dire and requires financial resources to deliver its intended objective. All of the sites, except those sampled by the Boskop office, are currently inactive due to financial constraints within the DWS. A similar fate is shared by other monitoring programmes but to a lesser extent. In an effort to overcome these obstacles, scientists within the DWS have identified the key challenges and solutions to these problems and financial support is integral in solving some of these challenges.

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APPENDICES

Appendix A: Augmentation Projects Monthly Progress Report. Chief Directorate: Infrastructure Development. March 2021.