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4.1 Streamflow

The Department of Water and Sanitation (DWS) is mandated by the National Water Act (No. 36 of 1998) Chapter 14, Section 137, to establish and monitor streamflow in the South African rivers. The Department monitors 628 river flow gauging stations across South Africa. Several streamflow monitoring stations are equipped with data loggers that measure the amount of water passing through a point over time in cubic meters per second (m^3 /s). The NWRS-2 indicated that streamflow monitoring aims to address our national concerns and is also in response to our obligations within international river basins (DWS, 2013). Transboundary water systems account for approximately 60% of South African river streamflow. Therefore, it is critical that South Africa implements Integrated Water Resource Management (IWRM) in accordance with international water conventions and treaties and the legislation governing water resource management in South Africa.

The international agreements have guidelines and limits on the quantities of water that South Africa may use out of the rivers and the amount of water the country must release to the neighbouring countries. The South African rivers demonstrate variations in flow regimes or flow patterns, continuously deviating from the historical flows. The flow regime changes are both natural and anthropogenically driven, with high variability in rainfall, population growth, and land and water use changes playing significant roles. Some catchments demonstrate increased streamflow, while other catchments also observe declining trends. 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.

4.1.1 Annual Streamflow Anomaly at Strategic Points

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

Some strategic points demonstrated a significant decrease in total annual flow volume in the current hydrological year compared to the previous year. South Africa experienced mostly below-average rainfall during the 2023/24 summer season, except for December 2023. In a recent report, the World Meteorological Organization (WMO) also confirmed that 2024 was the warmest year on record, with a global average surface temperature of 1.55 °C (with a margin of uncertainty of ± 0.13 °C)

(WMO,2024). These conditions (low rainfall and high surface temperatures) promote high evaporation rates in river systems and water bodies, resulting in significantly lower water levels and decreased river flow, while in some catchments, this decrease may be attributed to increased water abstractions. Figure 4.1 illustrates the streamflow anomaly maps, which show the deviation of annual streamflow during the 2023/24 hydrological year from the long-term median (1981-2010), as well as streamflow anomalies from the previous year (2022/23 HY), while Figure 4.2 and Figure 4.3 present streamflow anomalies at two strategic stations.

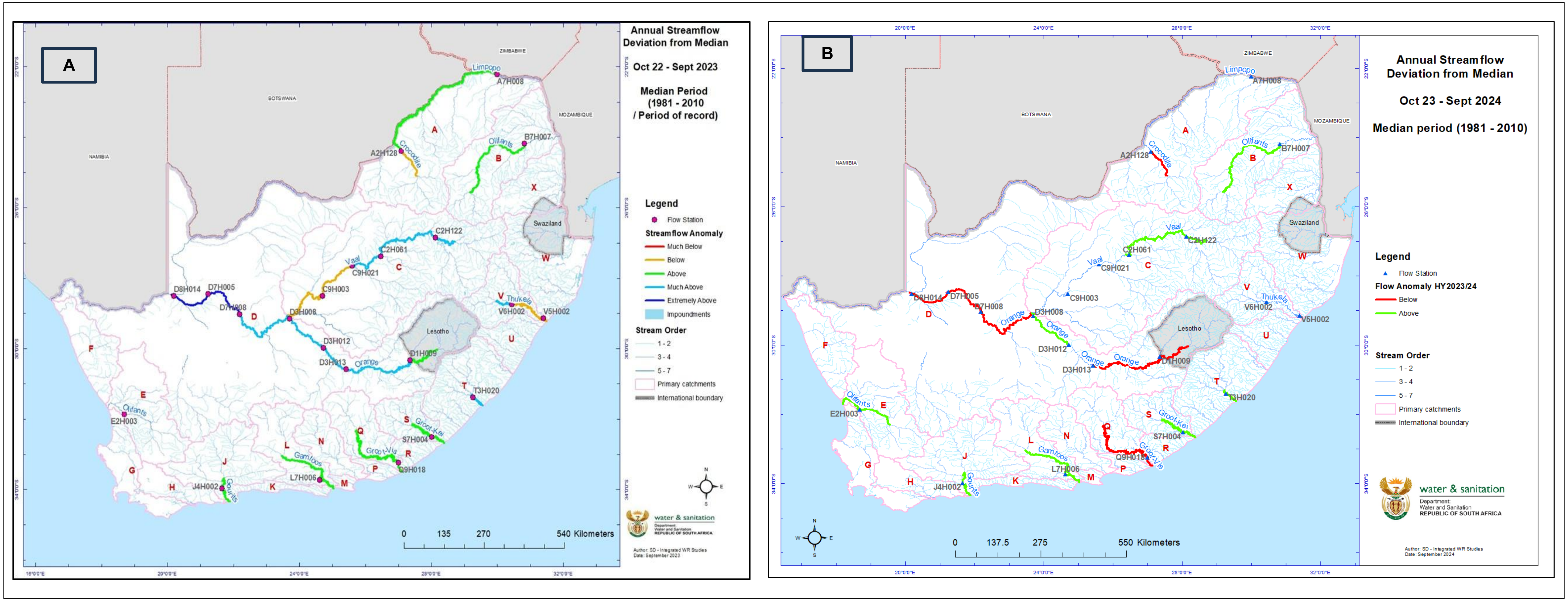


Figure 4.1: Annual Streamflow Anomaly for Strategic River Flow Monitoring Stations for the (A) 2022/23 hydrological year and (B) 2023/24 hydrological year.

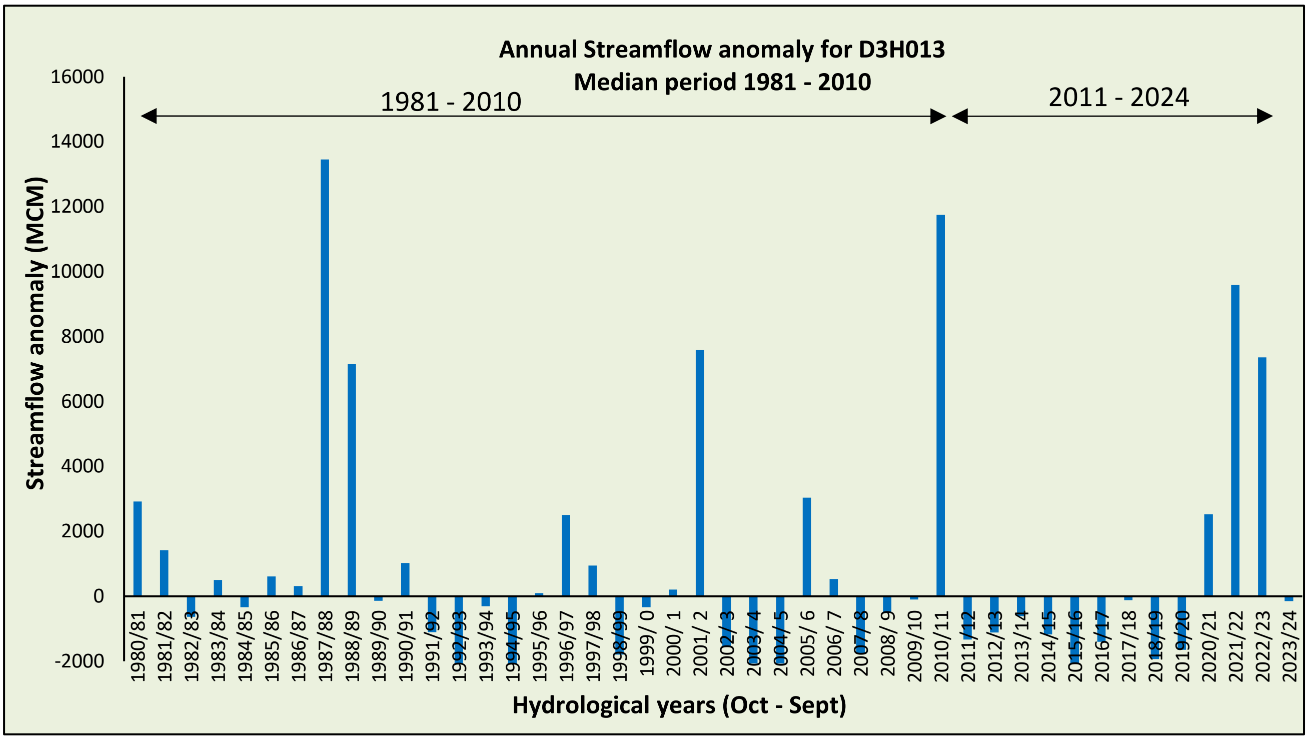


Figure 4.2: Annual streamflow deviation from the long-term median at station D3H013.

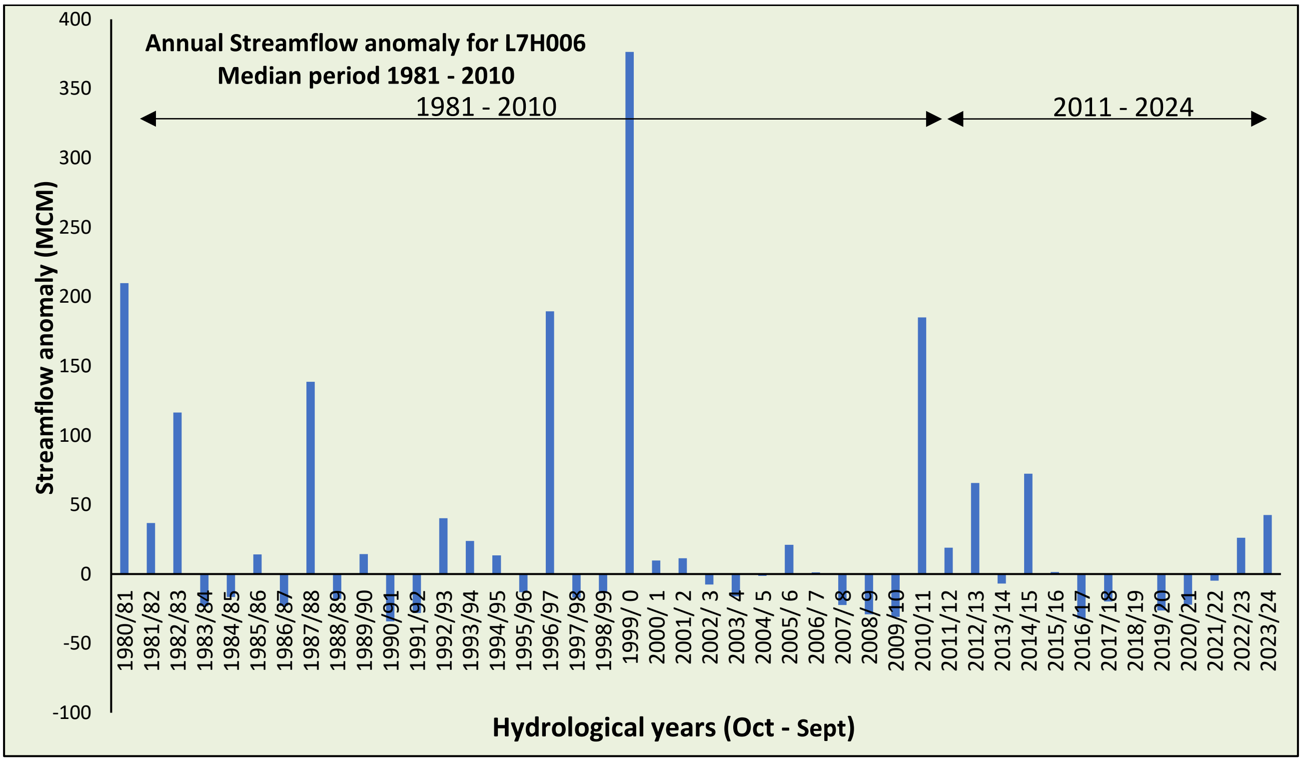


Figure 4.3: Annual streamflow deviation from the long-term median at station L7H006.

The maps presented indicate that in the previous hydrological year (2022/23), the flow volume in most strategic points exceeded the long-term median, with certain stations, such as D8H014 and D7H005 (Orange River at Upington), classified extremely above the long-term median. However, for the current hydrological year, it is noteworthy that the map key only shows the flow volume that is "above" and "below" the median. The rationale for this is that all stations above the median demonstrated only a slight positive deviation, with no deviations that could be classified as "much above" or "extremely above" the median.

A flow gauging station located along the Eastern Cape province's coastal area, within the Fish to Tsitsikama WMA (Q9H018- Great Fish River @ Matomela's Location) demonstrated a negative deviation in the 2023/24 HY compared to the 2022/23 HY when it reported a 550.4 MCM in total flow volume. The total streamflow volume recorded in the HY 2023/24 at Q9H018 was 275 MCM lower than the previous year.

Moreover, the three stations with higher negative deviations from the long-term median are all located in the Upper Orange Water Management area (D3H013- Outflow from Gariep Dam; D3H008- Orange at Marksdrift) and the Lower Orange Water Management area (D7H008- Outflow from Boegoeberg Dam). These stations had consistently deviated positively from the median over the last four hydrological years; however, in the 2023/24 HY they all experienced a decline in total flow volume and consequently negatively deviated from the median. In particular, the D3H013 (Figure 4.2) station had an annual flow volume of 4583 MCM in the current reporting period compared to 12090 MCM in the previous HY. It demonstrated a deviation of -151 MCM from the long-term median.

The streamflow anomaly for L7H006 (Groot River @ Grootrivierspoort) in the Fish to Tsitsikama WMA, shown in Figure 4.3 has also improved significantly over the last two HYs. In 2023/24, the total flow volume at this station was 78.9 MCM, which was 16.5 MCM higher than the previous year. The Olifants WMA station (B7H007 - Olifants River at Oxford) had the least improvement in annual flow volume, deviating by only (+4.4 MCM) from the median. The station is of international significance as it flows into Mozambique. The total annual volume recorded at this station in the 2022/23 hydrological year was 2601 MCM, the highest ever recorded; however, the total flow volume at this station dropped significantly to 579.1 MCM in the 2023/24 HY.

Sustaining Water Resources in a Changing Climate: Lessons from Quaternary Catchment W70A in Northern KwaZulu-Natal

Water scarcity limits economic activity and reduces community resilience, especially in impoverished areas facing global change. One such area is Quaternary Catchment W70A, located in the uMhlabuyalingana Local Municipality (ULM) in the northern Maputaland Coastal Plain (MCP), KwaZulu-Natal (KZN). This region faces high unemployment, poverty, and environmental challenges such as invasive species, habitat degradation, and declining water resources. Quaternary Catchment W70A is a rainfall-dependent, groundwater-driven system with no surface water rivers supplying it. South Africa's largest freshwater lake, Lake Sibaya, falls within this catchment and relies on groundwater for both its water levels and the health of its diverse ecosystem (Figure 1).

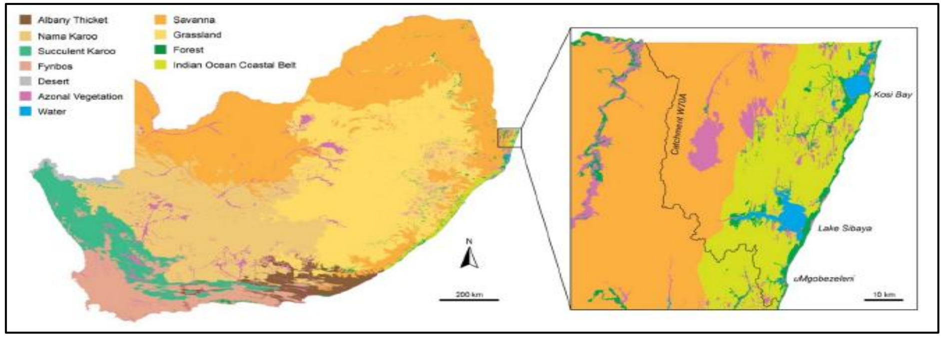


Figure 1: *The location of the study area relative to South Africa, as shown on the National Vegetation Map 2012 Biomes.*

Since 2001, Lake Sibaya's water level has continuously declined, reflecting a decrease in groundwater availability. The lake reached a record low in HY 2014/15, and this decline has persisted through 2021. For the past 14 years, Lake Sibaya has remained below its ecological drought reserve level of 16.5 m AMSL. The primary causes of this decline have been suggested to be below-average rainfall and commercial forestry, which impact groundwater recharge. Currently, there is no available water available to support population growth in the area.

To address water and economic security challenges, the Grassland node of the South African Environmental Observation Network, in collaboration with researchers from UKZN, ASSET, and UCT, conducted a Water Research Commission funded project (C2020/2021-00430). This project used an integrated, multi-scale approach to evaluate how different land-use scenarios, identified by local communities, might impact water resources under various climate change scenarios. The project integrated hydrological, climatological and economic modelling to provide a decision support tool for land custodians. A surface water hydrological model was loosely coupled with a groundwater model to simulate historical, current, and future water resource conditions under different land-use and climate scenarios. These included projections of a hotter climate with either increased or decreased rainfall.

The key findings from the research in terms of water resources for the area were:

- ❖ Rainfall is the primary driver of the system. For groundwater recharge to occur, a minimum of 30 mm of rainfall has to fall in a single event. Since 2001, rainfall events exceeding 20 mm have declined, reducing recharge rates. Hydrological modelling confirmed that reduced rainfall is the main driver of groundwater depletion, both historically and in future projections.
- ❖ Land use has a significant impact on water availability. Scenarios involving different land uses—such as reduced commercial forestry, bush encroachment, irrigated and dryland cropping, and macadamia/marula cultivation—were assessed. A "No Forestry" scenario showed that without commercial forestry, current lake levels would be approximately 1.5 meters higher, even with two decades of low rainfall. Furthermore, the 14-year current breach in drought reserve would not have occurred. This suggests that afforestation has significantly contributed to groundwater depletion.
- ❖ Alternative land uses need to be water-wise. Irrigation is not a feasible option due to insufficient water availability. Dryland crops, such as cassava and marula, were identified as water-wise alternatives that warrant further exploration.
- ❖ Grasslands play a critical role in groundwater recharge and should be prioritised for conservation and protection.

Thus, from a water perspective, to minimize water scarcity, a least-regret strategy should as a priority be adopted. The remaining grassland areas within the region must be protected and managed to support groundwater recharge. Further options which need to be explored include a conversion of commercial plantation forestry to water-wise, climate-smart alternatives, e.g. cassava and Marula, combined with improving animal husbandry, commercial processing of high value products from these, as well as optimising benefits from tourism.

Case Study Prepared by: Michele Toucher, Susan Janse van Rensburg, Mkholo Maseko

Affiliated institution: South African Environmental Observation Network Foundation

4.2 Surface Water Resource Quality

The Department of Water and Sanitation seeks to ensure that surface water is suitable for designated uses ("fitness-for-use") while protecting and preserving aquatic ecosystems. The department implements various programmes to monitor water quality and the health of aquatic environments across the country. These efforts aim to provide essential data, information, and expertise nationally, serving as crucial inputs for national and international water resource management and planning.

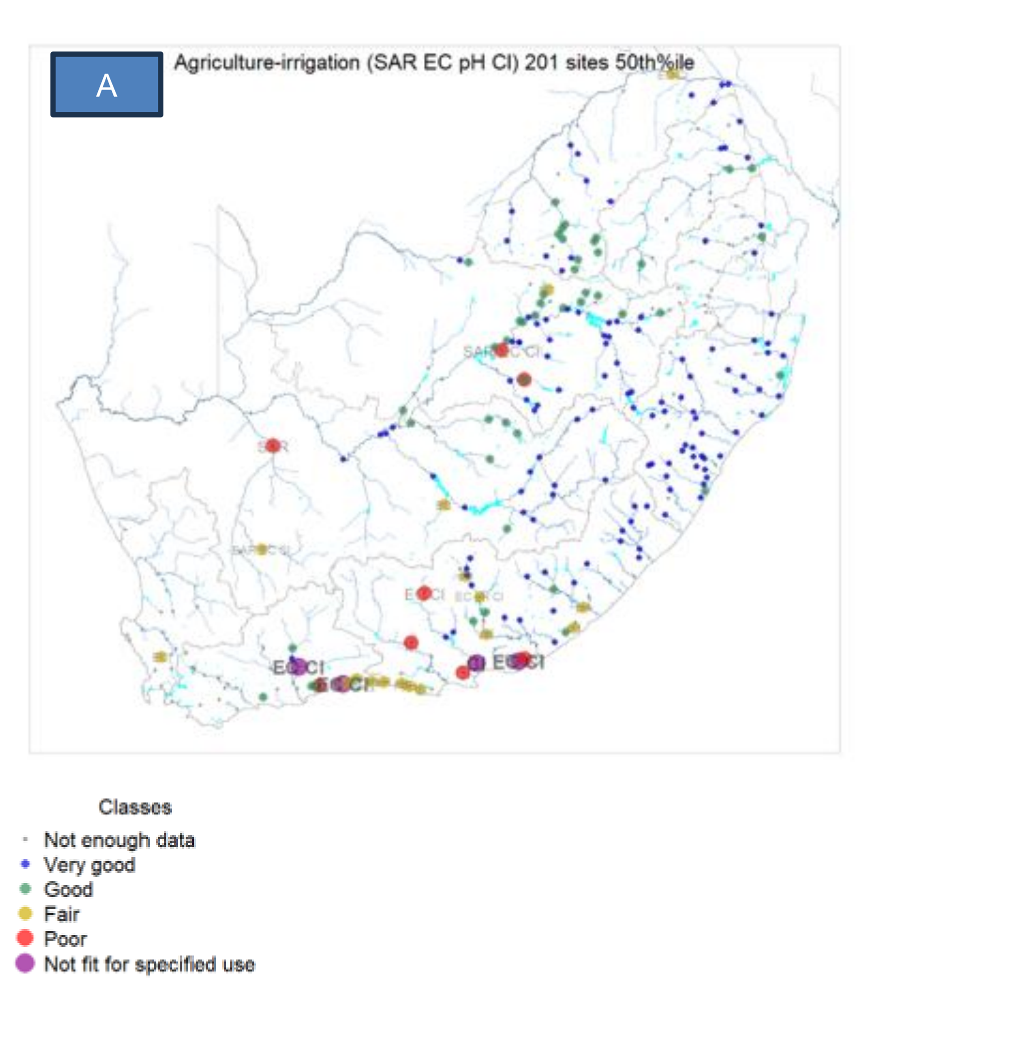
This section will present an overview of the country's surface water quality and ecological conditions based on selected national monitoring programs during the current reporting period.

4.2.1 Inorganic Surface Water Chemical Pollution

Salinity: Salinity is measured using various water quality indicators, such as Total Dissolved Solids (TDS), Electrical Conductivity (EC), and concentrations of ions like sodium, chloride, magnesium, potassium, and sulphate. High concentrations of salt have an adverse effect on the taste and freshness of water. Furthermore, excessive salt can cause corrosion in water distribution pipes, increasing maintenance costs.

Figure 4.4 presents the "Irrigated Agriculture Fitness-for-Use" which includes a limited number of relevant variables for the current and previous reporting period. The observations regarding Electrical Conductivity (EC) were made as follows:

- In the lower Olifants Water Management Area (WMA), a site on the Ga-Selati River was observed to have elevated EC levels, categorising it within the fair range. However, it is important to clarify that this is not the same site reported last year (Figure 4.4A) with elevated EC levels, as it has since improved and is now classified within a "good" range.
- Nine sites within the Vaal WMA displayed elevated EC levels that were categorised in the fair range, indicating an improvement from the previous year when some sites were noted as being in the poor range. The remaining sites in the Vaal fell within the "good" category.
- One site each in the Berg-Olifants WMA and the Inkomati-Usuthu WMA were recorded to be within the same range. These sites have demonstrated persistent elevation, as illustrated in Figure 4.4a, which indicates a similar case to the one reported in the previous year.
- Several sites in the Orange, Breede-Gouritz, and Mzimvubu-Tsitsikamma WMAs are categorised as fair, while others are classified as poor or not suitable for irrigation. The Breede-Gouritz, and Mzimvubu-Tsitsikamma WMAs are showing a decline in terms of EC, as illustrated in Figure 4.4B, indicating that during the current reporting period, a greater number of sites were classified as either poor or Not Fit for irrigation compared to the previous reporting period.



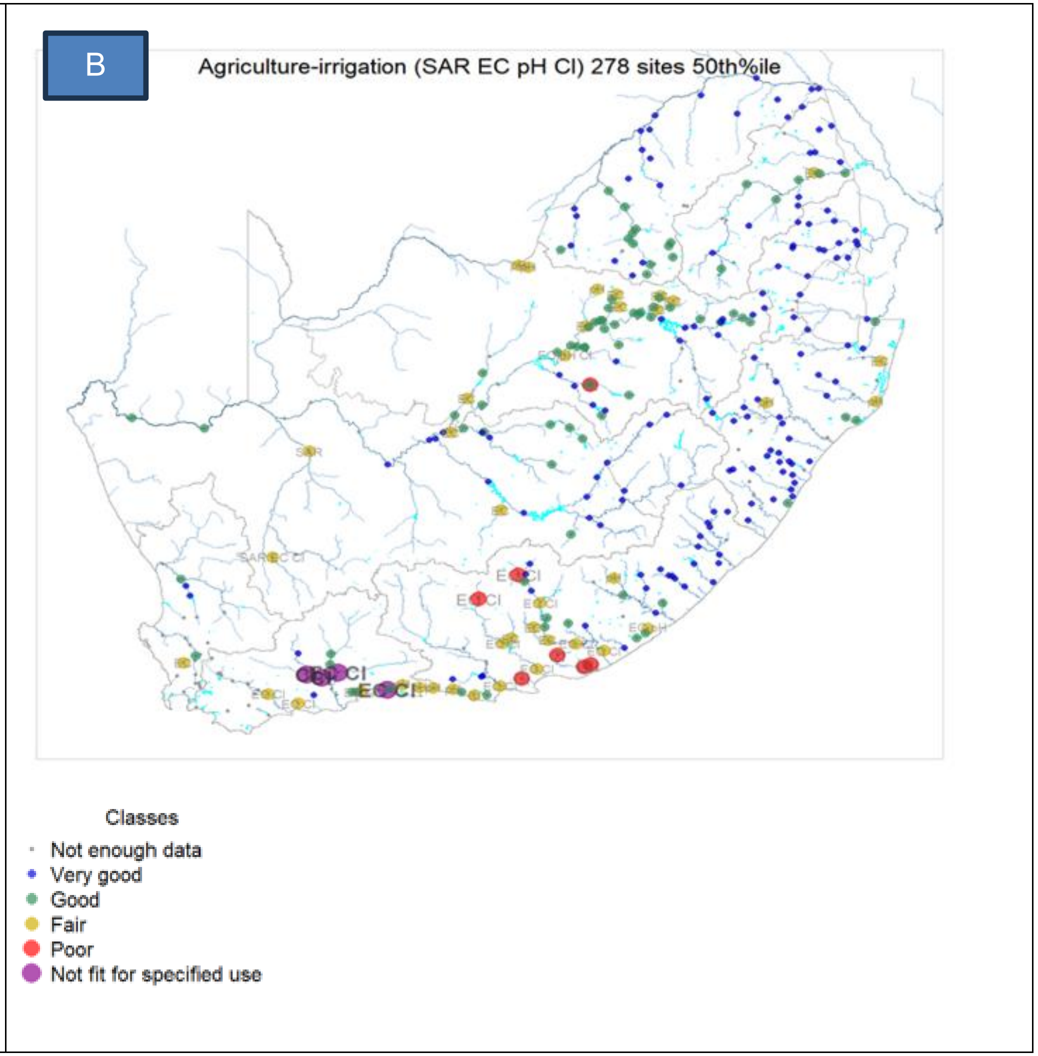


Figure 4.4: The salinity concentrations and suitability "for agricultural use" for (a) 2022/23 HY, and (b) 2023/24 HY.

NOTE: In the fair range, a low-frequency irrigation system can maintain a 90% relative yield of moderately salt-tolerant crops, while in the poor range, low-frequency irrigation can still achieve an 80% relative yield. Beyond this range, specific crops may be irrigated with sound management practices and acceptable yield reductions.

The Sodium Adsorption Ratio (SAR) indicates the likelihood of irrigation water creating sodic soil conditions, which can negatively affect crop yield and quality by increasing sodium uptake in sensitive plants and reducing soil permeability. Chloride (Cl) is a crucial micronutrient for plants but can cause injury, such as leaf burn, when levels are too high. In the Vaal WMA, two sites had elevated chloride levels, which were categorized as Fair and Poor. The lower Orange WMA had one site in the Fair range, and twelve sites in Mzimvubu-Tsitsikamma were classified as Fair or Poor. The Breede-Gouritz WMA had four sites rated Fair and four others that were not fit for irrigation.

Extreme pH levels can adversely affect crops by solubilizing toxic heavy metals. While pH does not directly affect crops, caution is advised for values outside the Ideal range. Notable high pH levels were found at two sites in the Vaal WMA, while significantly low levels were recorded at three sites in the Breede-Gouritz WMA.

These low pH levels may be naturally occurring and not indicative of water quality problems.

Case Study: Contribution of the Vaal Dam, Klip, Rietspruit and Suikerbosrand Rivers to Increased Nutrient Levels at the Vaal Barrage: A Historical Overview

The section of the Vaal River between the Vaal Dam and the Vaal Barrage is known for high nutrient levels, which have resulted in excessive growth of algae and aquatic plants. *Figure 4.5* indicate that both phosphate and nitrate concentrations are significantly higher at the Vaal Barrage compared to the Vaal Dam. This disparity between the two locations has become even more pronounced since the early 2000s.

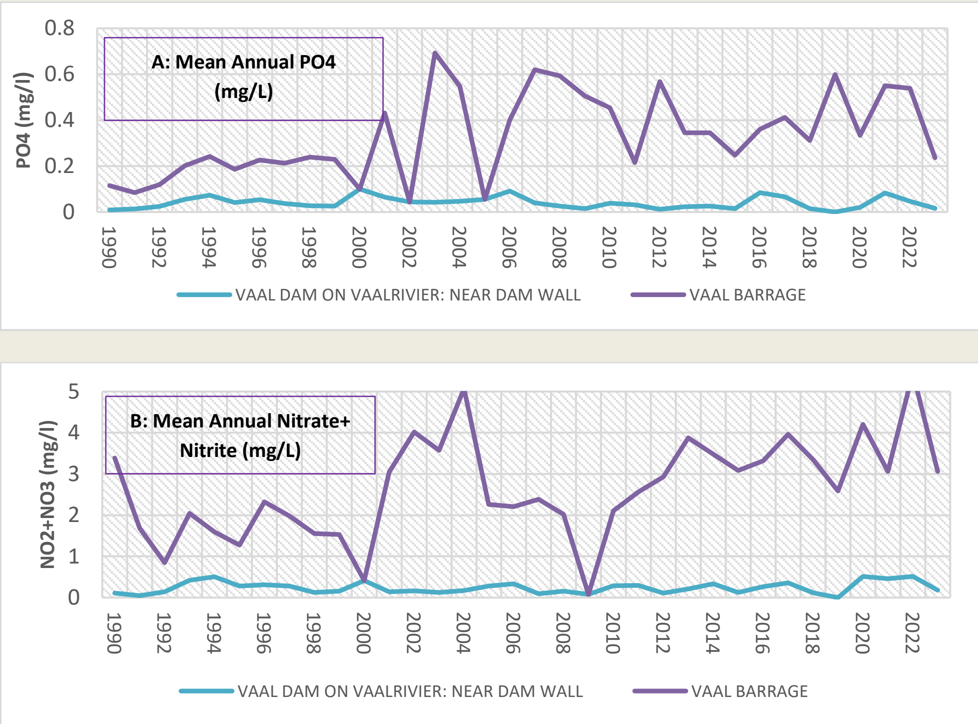


Figure 4.5: Ortho Phosphate and B) Nitrate Levels in the Vaal Dam and Vaal Barrage from 1990 to 2023.

The Vaal Barrage is primarily supplied by flows from the Vaal Dam, along with the Klip, Suikerbosrand, and Rietspruit rivers. These three rivers drain large urban areas, both formal and informal, as well as mining and industrial zones located to the east and southwest of Johannesburg. Consequently, there is an increased pollution load in the waters upstream of the Vaal Barrage. The long-term nutrient levels in these three tributaries, measured before they converge with the Vaal River, are illustrated in Figure 4.6. For reference, the nutrient levels in the Vaal Dam and the Vaal Barrage are also shown. Although the nutrient levels shown in the graphs indicate high pollution levels in these tributaries, it's essential to consider that differences in catchment size and characteristics affect the flow rates and volumes entering the Vaal River. The amount of nutrients (nutrient load) flowing into the Vaal from these tributaries depends on both the concentration of nutrients and the volume of water.

Comparing the general flow rates, the Klip River averages between 15-35 m³/s, while the Rietspruit and Suikerbosrand range from 2-4 m³/s and 2-15 m³/s, respectively. This suggests that, with similar nutrient levels, the nutrient loads from the Klip River could be significantly higher than those from the Rietspruit and Suikerbosrand. From Figure 4.6, ***it's evident that the Klip and Rietspruit rivers are the main contributors to nutrient loads***.

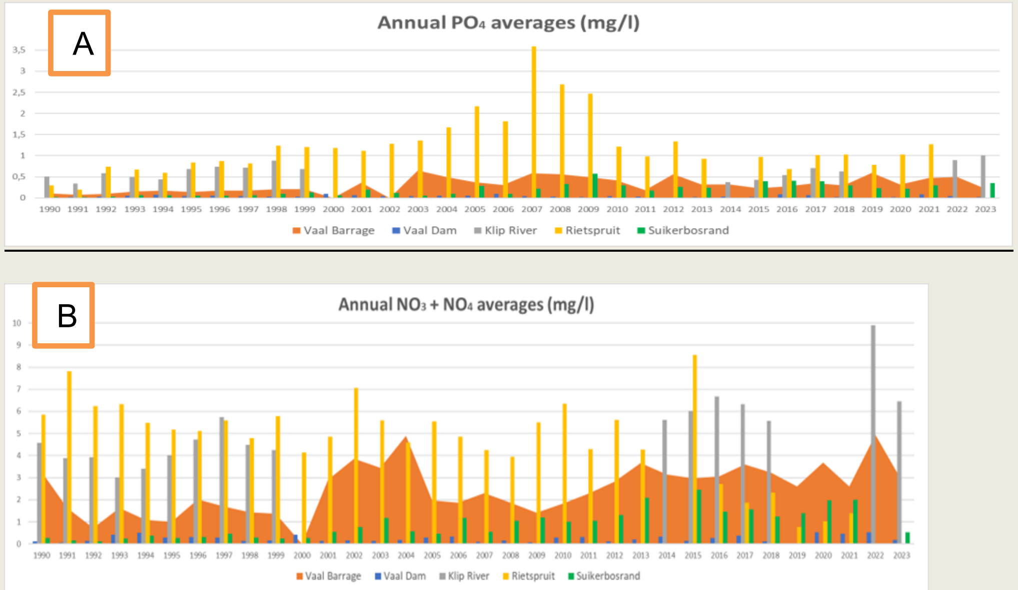


Figure 4.6: *Ortho Phosphate, B) Nitrate annual average levels in the Klip, Rietspruit and Suikerbosrand rivers from 1990 to 2023.*

4.2.2 Trophic Status

Eutrophication is the excessive enrichment of water with nutrients, particularly phosphorus and nitrogen, leading to water quality deterioration due to the overgrowth of macrophytes, algae, or cyanobacteria. In South Africa, the primary sources of these nutrients include sewage treatment plant discharges, agricultural and urban runoff, and industrial wastewater.

Eutrophication causes biodiversity loss, animal deaths, increased water treatment costs, chronic health issues from toxins in drinking water, and unpleasant taste and odour that affects recreational use. Table 4-1 below summarizes the various trophic status classes of water bodies, while Table 4-2 outlines the criteria for assigning trophic status based on median Chlorophyll-*a* concentration values and the percentage of time concentrations exceeding 30 µg/L. The annual median total phosphorus values also indicate the potential for algal and plant productivity across trophic classes. The comparison of trophic status and trophic potential in the current and previous Hydrological Years (HYs) for all ONEMP sites is presented in Figure 4.7 and Figure 4.8, respectively.

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

Oligotrophic	Mesotrophic	Eutrophic	Hypertrophic
Low in nutrients and not productive in terms of aquatic animals and plant life.	Intermediate levels of nutrients, fairly productive in terms of aquatic animal and plant life, and showing emerging signs of water quality problems.	Rich in nutrients, very productive in terms of aquatic animal and plant life, and showing increasing signs of water quality problems.	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

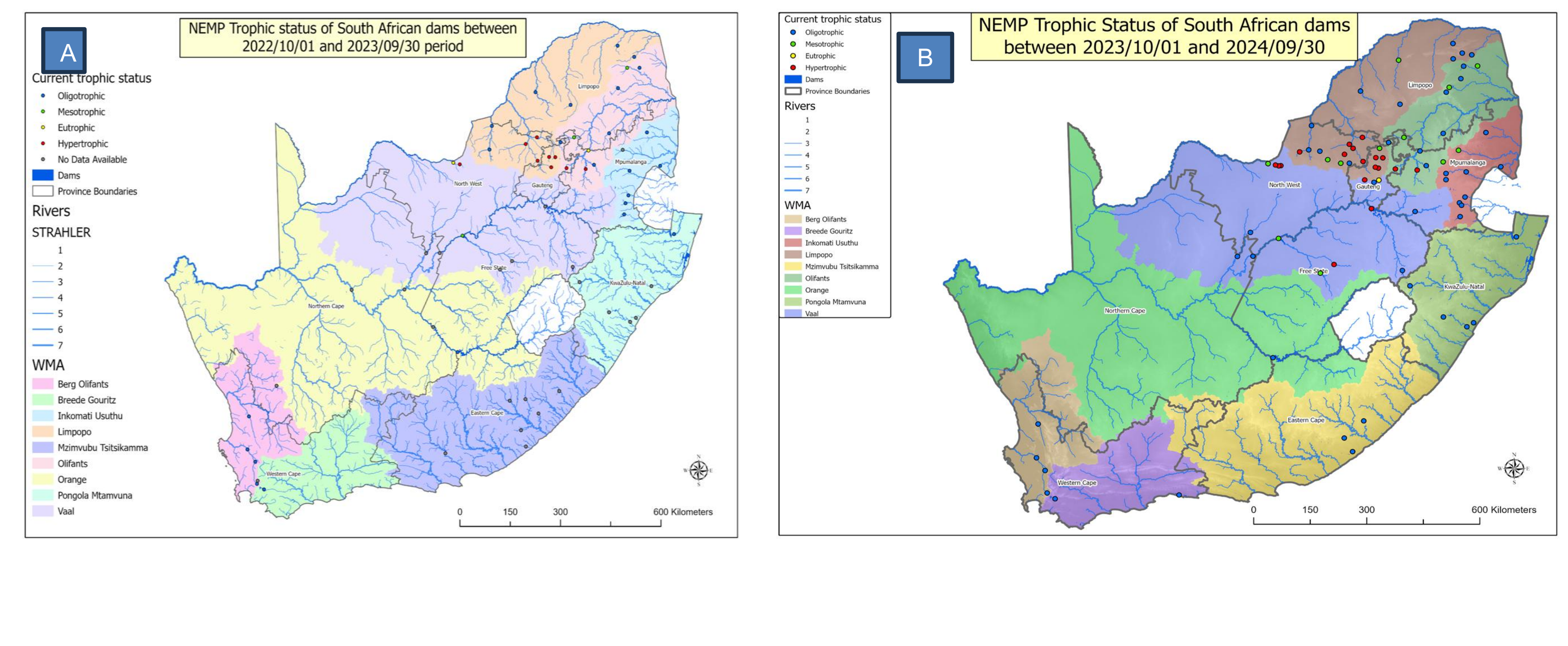


Figure 4.7: NEMP Trophic status analysis for the sites monitored between October 2023 and September 2024.

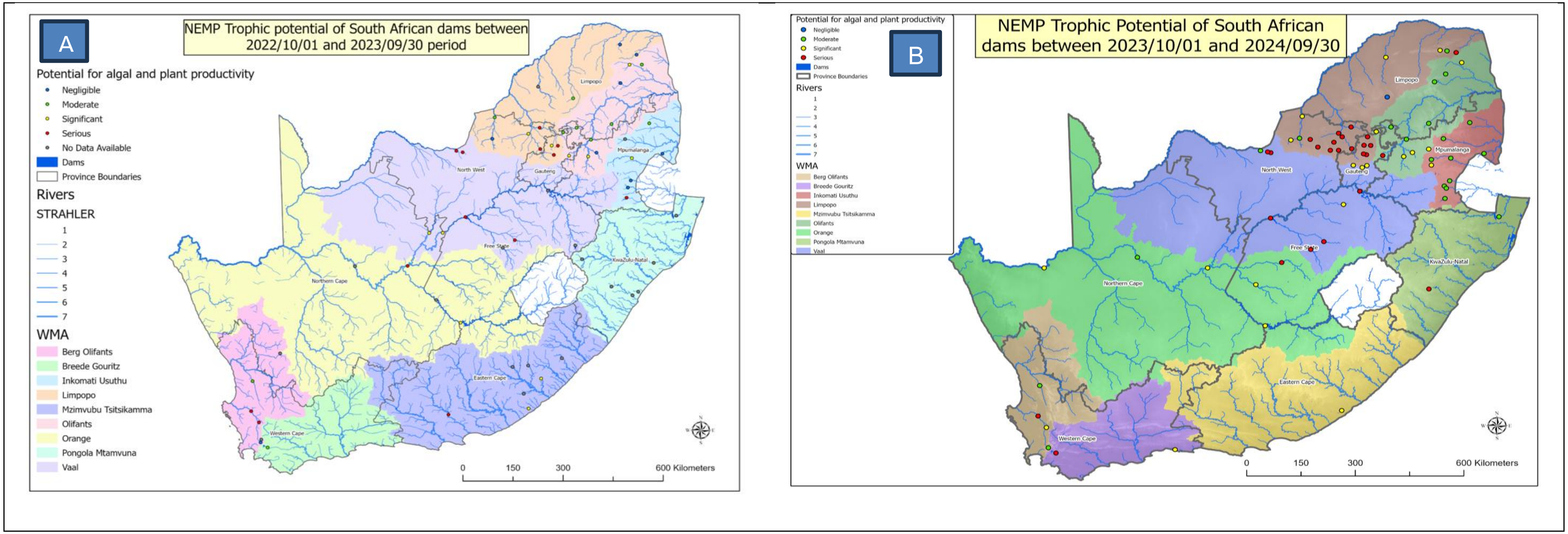


Figure 4.8: Trophic potential of the ONEMP sites for the (a) 2022/23 HY and (b) 2023/24 HY.

Trophic status and eutrophication potential were assessed at 78 of the 82 ONEMP sites. The chlorophyll-a concentration was used to determine trophic status, while the total phosphorus (TP) concentration determined trophic potential from October 2023 to September 2024. Eighteen sites were deemed hypertrophic, one eutrophic (Homestead Lake in Benoni), twelve mesotrophic, and 47 oligotrophic. It is worth noting that the hypertrophic status of the Rietvlei Dam and Hartbeespoort Dam has not changed since the previous hydrological year, whereas mesotrophic sites included the Koster Dam and Olifantsnek Dam. Oligotrophic sites showed low nutrient levels and reduced aquatic productivity.

Twenty-six of the sixty-nine sites analysed had a high potential for eutrophication, an improvement over the previous year when 49 sites across the country had high nutrient levels with significant to serious algae and potential plant productivity. Moreover, twenty-one (21) sites had significant potential, twenty-one had moderate potential, and one had negligible potential. The majority of sites with serious eutrophication issues are located in densely populated areas with overburdened sewage systems as a result of rapid population growth, inadequate infrastructure, and industrial activity.

High nutrient levels in hypertrophic and eutrophic sites increase the risk of algae and plant growth.

4.2.3 Microbial Pollution

Microbial pollution of surface waters is a major public health concern, particularly in areas with inadequate wastewater management and sanitation facilities. The National Microbiological Monitoring Programme (NMMP) seeks to assess the extent of faecal pollution in surface waters and the potential health risks associated with its use. The program employs E. *coli* as an indicator organism due to its strong association with faecal contamination and associated health risks. The E. *coli* testing results are compared to the South African Water Quality Guidelines (Table 4-3) to analyse potential microbial health risks.

Figure 4.9 compares microbiological data collected in hotspots across the country for the analysis of suitability for recreational activities and irrigating crops that are eaten raw, for the 2022/23 and 2023/24 HYs.

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

	Potential health risk		
	Low	**Medium**	**High**
Water use	***E. coli* counts/ 100ml**		
Full-contact recreational	< 130	130 – 400	> 400
Irrigation of crops to be eaten raw	< 1 000	1 000 – 4 000	> 4 000

A total of 75 hotspot sites across the country were monitored to assess the microbial quality of the water during the current reporting period. Microbiological data collected from October 2023 to September 2024 indicate that 70% of the sampled sites were deemed unsafe for recreational activities, an increase of 3% compared to the previous HY (Figure 4.9 A and Figure 4.9 B).

Similarly, in the current reporting period, the number of sites deemed unsuitable for irrigating crops intended for raw consumption increased from 41% reported in the previous year (Figure 4.9C and Figure 4.9D) to 48% in the 2023/24 HY. This poses a high risk of infection for individuals engaging in such activities, which include full-contact events like swimming, washing laundry, and traditional practices such as baptisms that are common in NMMP hotspot sites. The increase in sites deemed unsuitable for irrigation and recreational activities, indicated by E. *coli* in water, points to recent faecal contamination. This situation raises concerns regarding the effectiveness of wastewater treatment, potentially highlighting inadequate removal of pathogens or insufficient disinfection processes in the treated water discharged into the river system near these sites.

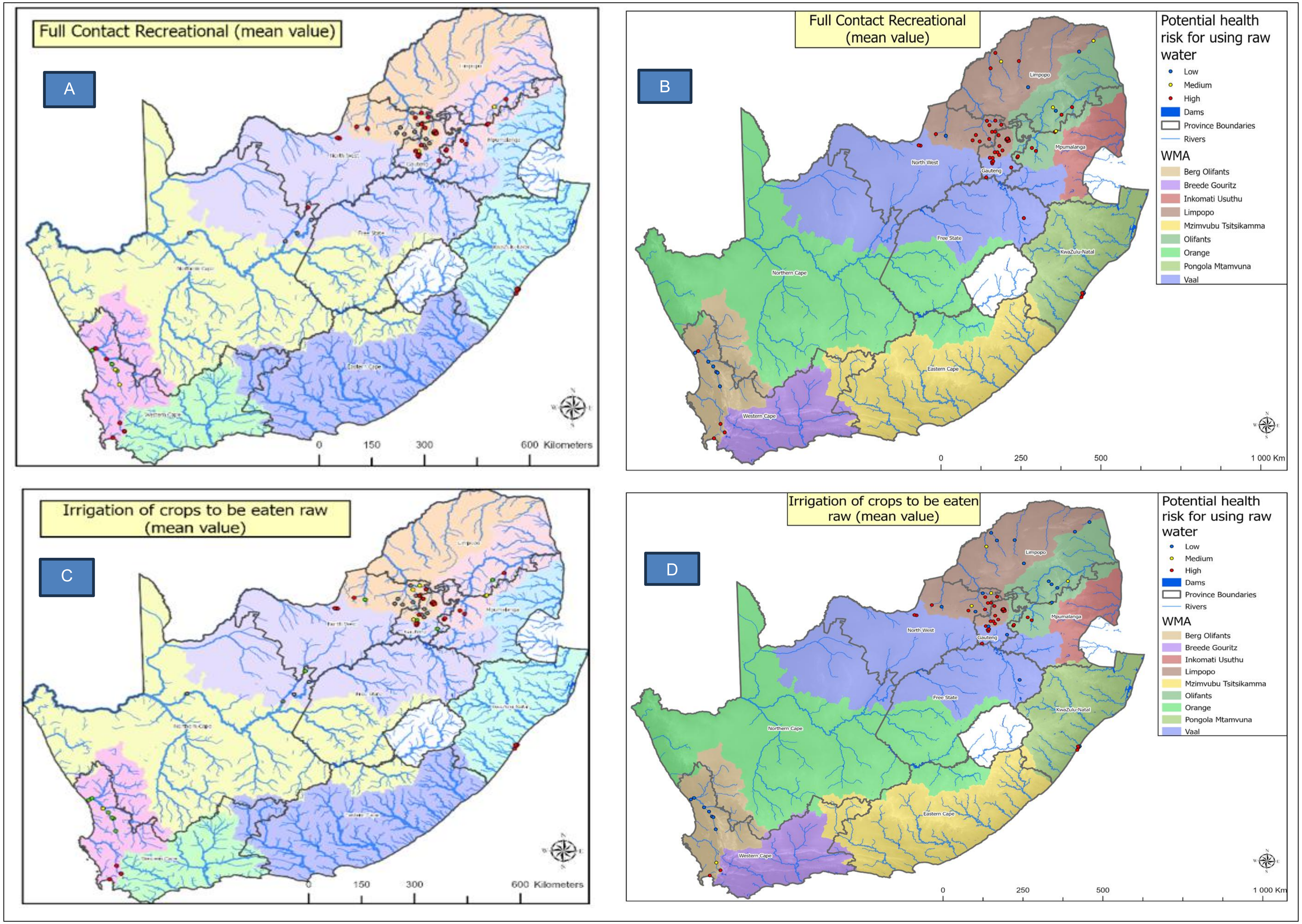


Figure 4.9: Faecal pollution data for (A&C) HY 2022/23 and (B&D) HY 2023/24.

4.3 Estuaries Water Quality

The data for the National Estuarine Monitoring Programme (NESMP) was interpreted using a variety of information sources, including the South African Water Quality Guidelines for Coastal Marine Waters (DWAF, 1996), guidelines for establishing environmental quality objectives and targets in the coastal zone of the Western Indian Ocean Region (UNEP/Nairobi Convention Secretariat and CSIR, 2009), recreational use guidelines (DEA, 2012), and the significance of the River-Estuary Interface (REI) Zone (Bate *et al*., 2002). The results are shown in Figure 4.10, the values on the map represent the data range for medium to high concentrations of the variables listed.

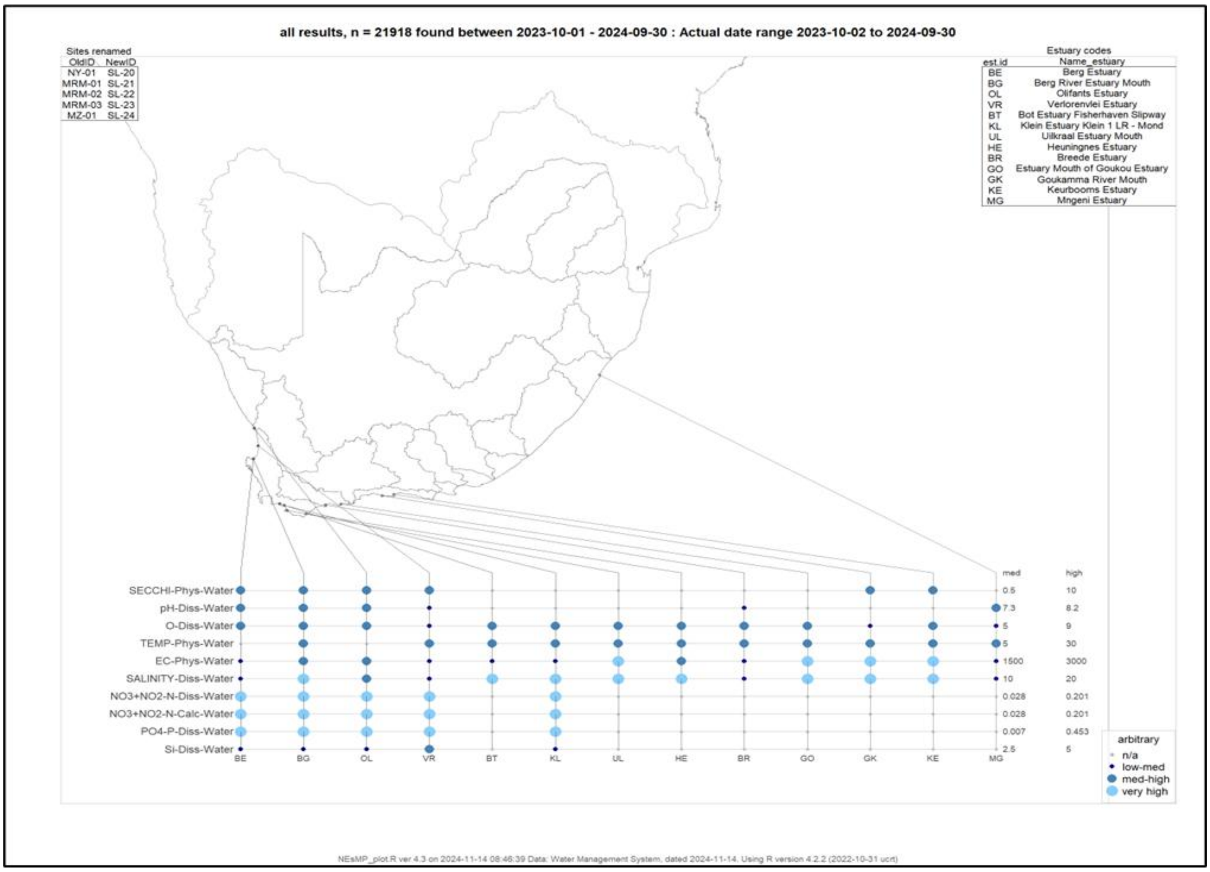


Figure 4.10: Summary of findings from 12 estuaries monitored during the 2023/2024 hydrological cycle.

The Berg, Bot, Uilkraal, Heuningnes, Goukou, Goukamma, and Keurbooms estuaries have high salinity concentrations, reflecting seawater penetration and creating a salinity gradient that influences the biodiversity of these estuarine systems. In contrast, the Olifants, Verlorenvlei, Breede, and uMngeni estuaries have low salinity levels, indicating a high flow of freshwater from upstream areas into the estuary.

The pH levels in the Berg, Olifants, and uMngeni estuaries varied between 7.3 and 8.2. However, low pH levels were detected in the Verlorenvlei and uMngeni estuaries. The Verlorenvlei Estuary has been experiencing drought since 2017, with no freshwater flowing into it until June 2023. This prolonged drought resulted in acidic conditions in the estuary. Currently, water is flowing into Verlorenvlei, but the system is still recovering.Low pH levels in the uMngeni Estuary are the result of industrial effluent discharges.

Temperatures in the estuaries varied from 5 to 29 °C over the hydrological year, reflecting seasonal variations. Verlorenvlei, Goukamma, and uMngeni estuaries had relatively low dissolved oxygen levels (less than 4 mg/L). These low oxygen levels are caused by insufficient system flushing, particularly in the estuary's deeper pockets, which increases stress on the biota and causes fish kills. In contrast, the remaining estuarine systems are well-oxygenated, with oxygen concentrations exceeding 5 mg/L.

The Berg, Olifants, Verlorenvlei, and Klein estuaries had relatively high nutrient levels for nitrate + nitrite and orthophosphate (above 0.201 mg/L for nitrogen and 0.453 mg/L for phosphorus). The elevated nutrient concentrations could be due to agricultural runoff from activities higher up in the catchment areas. It is worth noting that no nutrient samples were collected from the Bot, Uilkraal, Heuningnes, Breede, Goukou, Goukamma, Keurbooms, or uMngeni estuaries.

4.4 River Ecological Status

In the 2023/24 hydrological year, riverine macroinvertebrates were evaluated at 480 sites using the Macroinvertebrate Response Assessment Index Version 2 (MIRAI v2). Alongside MIRAI, various other indices were utilized to assess certain sites. The Riparian Vegetation Response Assessment Index (VEGRAI) was implemented at 267 locations, fish indices were employed at 194 locations, the Index of Habitat Integrity (IHI) was evaluated at 198 locations, and the Geomorphology Driver Assessment Index (GAI) was applied at 53 locations. The guidelines for interpreting River Eco-status results are provided in Table 4-4, and the results for 2023/24 are shown in Figure 4.11.

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

ECOLOGICAL CATEGORY	GENERIC DESCRIPTION OF ECOLOGICAL CONDITIONS	GUIDELINE SCORE (% OF MAXIMUM THEORETICAL TOTAL)
A	**Unmodified/natural.** Close to natural or close to predevelopment conditions within the natural variability of the system drivers: hydrology, physico-chemical and geomorphology. The habitat template and biological components can be considered close to natural or pre-development conditions. The resilience of the system has not been compromised.	>92 - 100

ECOLOGICAL CATEGORY	GENERIC DESCRIPTION OF ECOLOGICAL CONDITIONS	GUIDELINE SCORE (% OF MAXIMUM THEORETICAL TOTAL)
A/B	The system and its components are in a close to natural condition most of the time. Conditions may rarely and temporarily decrease below the upper boundary of a B category.	>88 - ≤92
B	**Largely natural with few modifications**. A small change in the attributes of natural habitats and biota may have taken place in terms of frequencies of occurrence and abundance. Ecosystem functions and resilience are essentially unchanged.	>82 - ≤88
B/C	Close to largely natural most of the time. Conditions may rarely and temporarily decrease below the upper boundary of a C category.	>78 - ≤82
C	**Moderately modified.** Loss and change of natural habitat and biota have occurred in terms of frequencies of occurrence and abundance. Basic ecosystem functions are still predominantly unchanged. The resilience of the system to recover from human impacts has not been lost and it is ability to recover to a moderately modified condition following disturbance has been maintained.	>62 - ≤78
C/D	**The system is in a close to moderately modified condition most of the time.** Conditions may rarely and temporarily decrease below the upper boundary of a D category.	>58 - ≤62
D	**Largely modified.** A large change or loss of natural habitat, biota and basic ecosystem functions has occurred. The resilience of the system to sustain this category has not been compromised and the ability to deliver Ecosystem Services has been maintained.	>42 -≤58
D/E	**The system is in a close to largely modified condition most of the time.** Conditions may rarely and temporarily decrease below the upper boundary of an E category. The resilience of the system is often under severe stress and may be lost permanently if adverse impacts continue.	>38 - ≤42
E	**Seriously modified.** The changes in the natural habitat template, biota and basic ecosystem functions are extensive. Only resilient biota may survive and invasive and problem (pest) species may likely dominate. The resilience of the system is severely compromised as is the capacity to provide Ecosystem Services. However, geomorphological conditions are largely intact but extensive restoration may be required to improve the system's hydrology and physico-chemical conditions.	20 - ≤38

ECOLOGICAL CATEGORY	GENERIC DESCRIPTION OF ECOLOGICAL CONDITIONS	GUIDELINE SCORE (% OF MAXIMUM THEORETICAL TOTAL)
F	**Critically / Extremely modified.** Modifications have reached a critical level and the system has been modified completely with an almost complete change of the natural habitat template, biota and basic ecosystem functions. Ecosystem Services have largely been lost This is likely to include severe catchment changes as well as hydrological, physico-chemical and geomorphological changes. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible. Restoration of the system to a synthetic but sustainable condition acceptable for human purposes and to limit downstream impacts is the only option.	<20

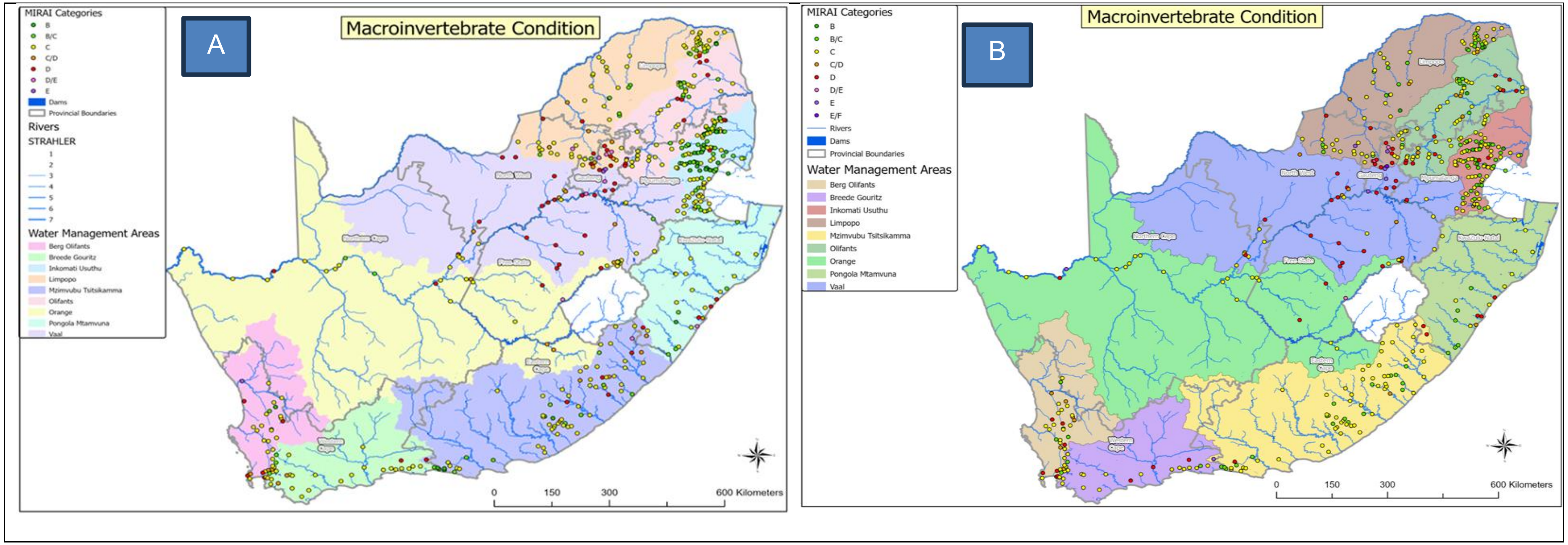


Figure 4.11: Summary of Ecological Categories illustrating the macroinvertebrate conditions for sites monitored during the (a)2022/23 HY, and (b) 2023/24 HY.

The moderately modified conditions have consistently been dominant in most river systems. In the previous hydrological year, 54% were identified as moderately modified (Category C), whereas in the current reporting period, this figure has risen to 59%. Furthermore, this report highlights a concern regarding the upper sections of the Crocodile West catchment, situated in Gauteng's industrial and urban zones. This includes the Jukskei River, Modderfonteinspruit River, and Crocodile River upstream of Hartbeespoort Dam, along with Hartebeesspruit just upstream of Roodeplaat Dam, as well as the Apies and Hennops Rivers, which have been assessed as being in very poor condition (Categories D/E and E) since the last HY.

Similarly, in alignment with the 2022/23 report, 20 sites in the Sabie catchment, 14 sites in the Komati catchment, and 13 sites in the Usuthu catchment demonstrated a significant number of sites categorized as being in largely or nearly largely natural conditions (B and B/C categories) in the current HY. The largely natural sites in the country are primarily located in the upper reaches near their sources, such as the Magalies, Debengeni, Berg, and Breede-Gouritz sites. Additionally, some sites were found in protected areas, including Eerste, Klerkspruit, Perskeboomspruit, Glen Reenenspruit, and Ribbokspruit, as well as in rural regions like the former Transkei, Mkomazi, Mhlatuze, and Pongola catchments.

Additionally, the riparian health data (Figure 4.12) collected from sites mainly in Gauteng province between August 2023 and March 2025 through the Citizen Science (CS) program aligns with the REMP data. The recent CS data reveal that only 2 of the 68 sites indicated good riparian health, while the remainder predominantly reported poor to very poor conditions. Similarly, data from 72 CS observations measuring water clarity from June 2023 to March 2025 indicated that 24% of the sites had very good water clarity, with the Apies at Groen Kloof site demonstrating exceptionally good water clarity. 75% of the monitored sites indicated water clarity ranging from poor to extremely poor.

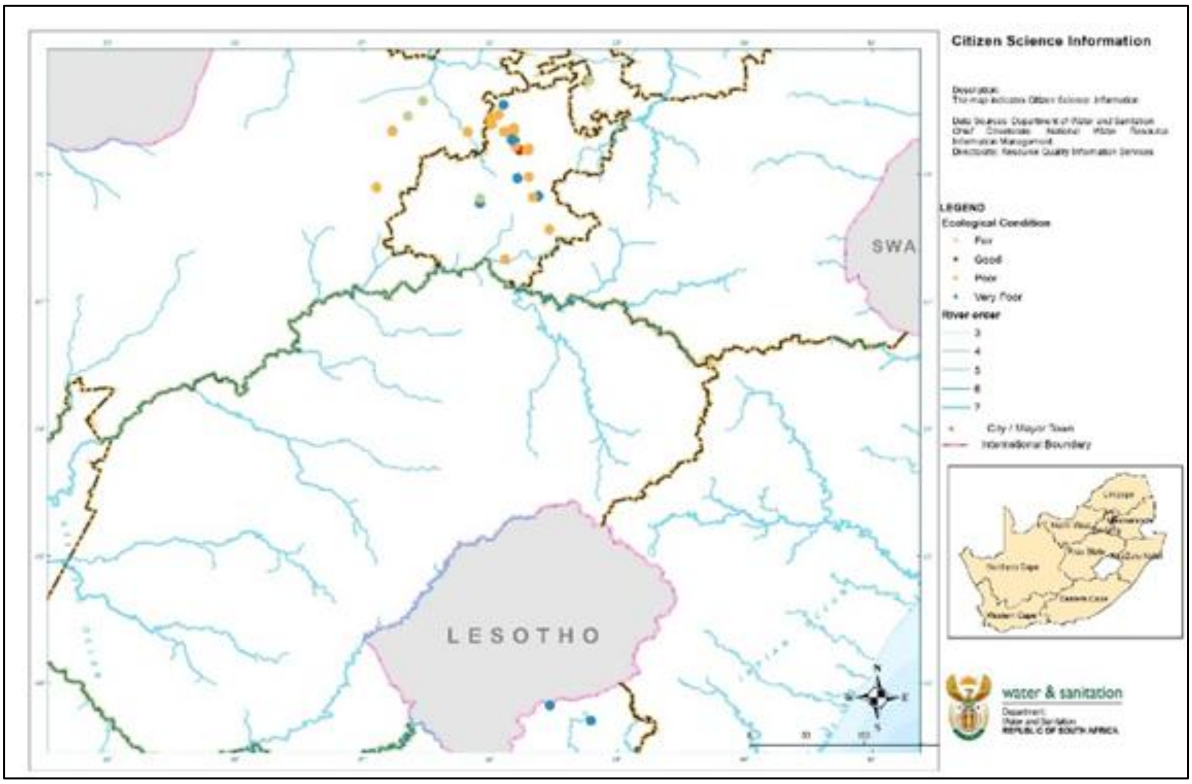


Figure 4.12: River ecological condition data collected from the Citizen Science programme.

The river condition trends illustrated in Figure 4.13 indicate there was an observed improvement in ecological conditions at 18% of the sites, while 23% experienced a decline. It is good to notice that although the proportion of sites remaining in the same condition has been relatively stable over the last four years, there has been an increase in the proportion of sites showing improvement over the last two hydrological years.

Figure 4.13: Trends in the Ecological Condition of macroinvertebrates at monitored sites

Case Study: Crocodile-West Marico Catchment: A Historical Ecological Conditions Overview

Fluctuations in the diversity of the macroinvertebrate community in the Crocodile-West River Catchment of North West Province have long indicated the impact of human activities. In most of the upper sub-catchments of the Crocodile-West River, macroinvertebrate conditions are primarily categorized between ***a largely modified (D) and a critically modified (F) state,*** particularly as they flow through cities and highly developed areas.

A study conducted by Gao *et al*. (2023) revealed an increase in pollution-resistant macroinvertebrates, such as *Chironomidae*, as urban water bodies continue to degrade. This trend signals declining water quality and a reduction in sensitive taxa. Contributing factors include discharges from wastewater treatment facilities, overflowing manholes, and return flows from various sources.

Agricultural activities and industrial effluents contribute to the deterioration of the ecological quality of water resources. This includes rivers such as the Jukskei, Pienaars, Apies, and Hennops, which all drain into the Crocodile River. Figure 4.14 below illustrates the trends and fluctuations in the ecological condition of macroinvertebrate populations from 2017/2018 to 2022/2023 HYs.

Most sites appear to be in stable condition, a success largely attributed to improved catchment management strategies and enforcement practices. These strategies include the implementation of citizen science activities, particularly in the upper parts of the catchment. This program encourages community involvement in river cleanups and the rehabilitation of riparian areas.

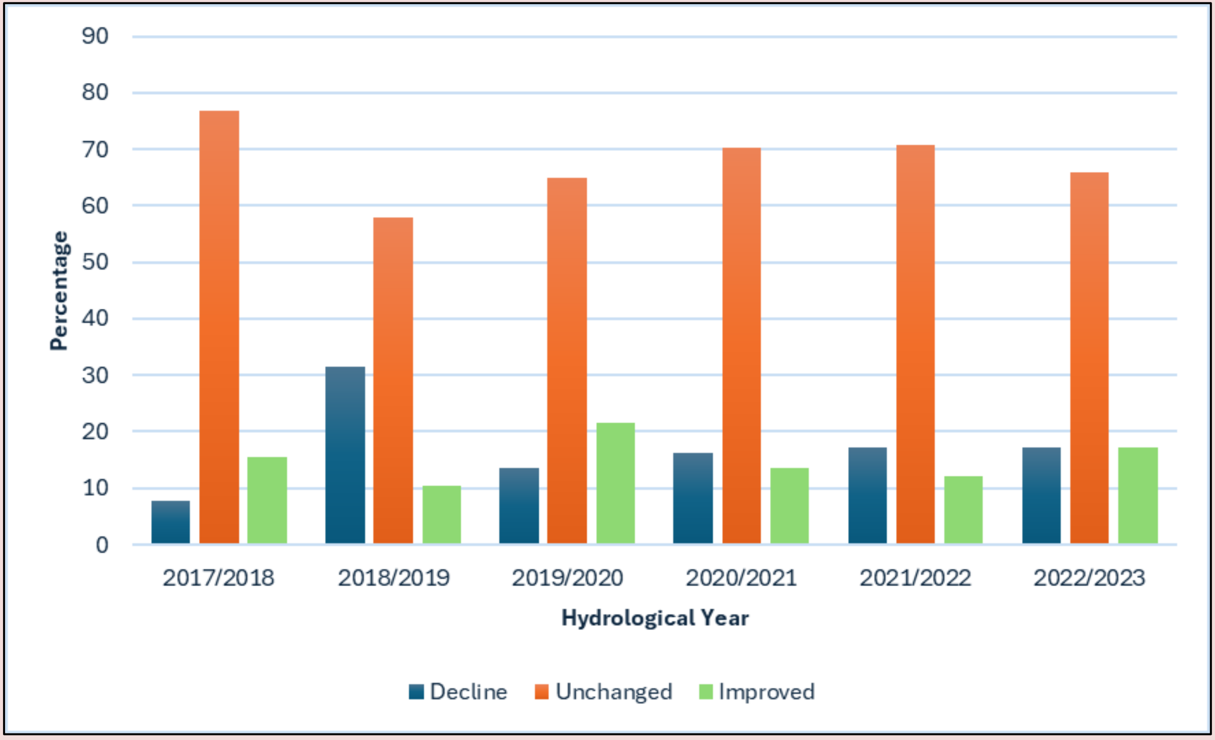


Figure 4.14: Crocodile-West Marico Catchment Macroinvertebrates Trends from 2017-2023

The sites located in the upper reaches of the catchment area, including the Magalies, Pienaars, Elands, Skeerpoort, and Sterkstroom rivers, generally maintain a better ecological condition. They range from close to natural (B/C) to moderately modified (C) due to limited human interference. A study conducted by Orozco-González and Ocasio-Torres in 2023 found that river sections located in the upper reaches, within nature reserves or protected areas with minimal human interference, typically have better ecological conditions compared to river stretches that are urbanized, developed, or outside of nature reserve.

4.5 National Wetland Desktop Assessment Indicators

Due to limited data availability on the national ownership dataset surrounding wetlands, this section will focus on three of the Tier 1 indicators. Additionally, while data is available for nine Water Management Areas (WMAs), this report will use the Limpopo WMA to demonstrate the methodology used to determine the overall national picture concerning the extent of landcover in and surrounding the country's wetlands and the level of protection. The National Wetland Map 6 (Figure 4.15) will be used as a baseline dataset for each national assessment indicator.

Tier 1 indicators provide a comprehensive overview of the wetlands across the country. For instance, the wetlands in the Limpopo Water Management Area (WMA) cover only a small portion of the country's total water management areas (2.13%) but enjoy a moderate to high level of legislative protection. It is noteworthy that 92% of these wetlands are located in areas officially designated as protected under several laws, including the National Environmental Management: Protected Areas Act, the World Heritage Convention Act (Act 49 of 1999), and the Mountain Catchment Areas Act (Act 63 of 1970).

4.5.1 National extent of wetlands in South Africa

The map presented in Figure 4.15 displays the most recent coordination of wetland mapping conducted by the South African National Biodiversity Institute (SANBI) on behalf of the country's water sector. The total wetlands in South Africa is estimated to be 3,856,000 hectares (approximately 38,560 km²), representing 3.15% of the country's total land area. Table 4-5 below breaks down the extent (size) of wetlands by water management areas across the country.

Table 4-5: The National Wetlands Map 6 areas of the different WMAs and their percentage coverage

WMA	NWM 6 (km^2)	WMA Area (km^2)	% of WMA
Limpopo	2342	109978	2.129858758
Olifants	2051	73713	2.782368717
Inkomati Usuthu	1383	36639	3.775994376
Orange	14938	355588	4.200890041
Vaal	7539	246622	3.056919736
Pongola Mtamvuna	5004	93764	5.336294088
Berg Olifants	1466	70543	2.078408134
Mzimvubu Tsitsikamma	1528	163590	0.933789639
Breede Gouritz	2309	72612	3.179842145

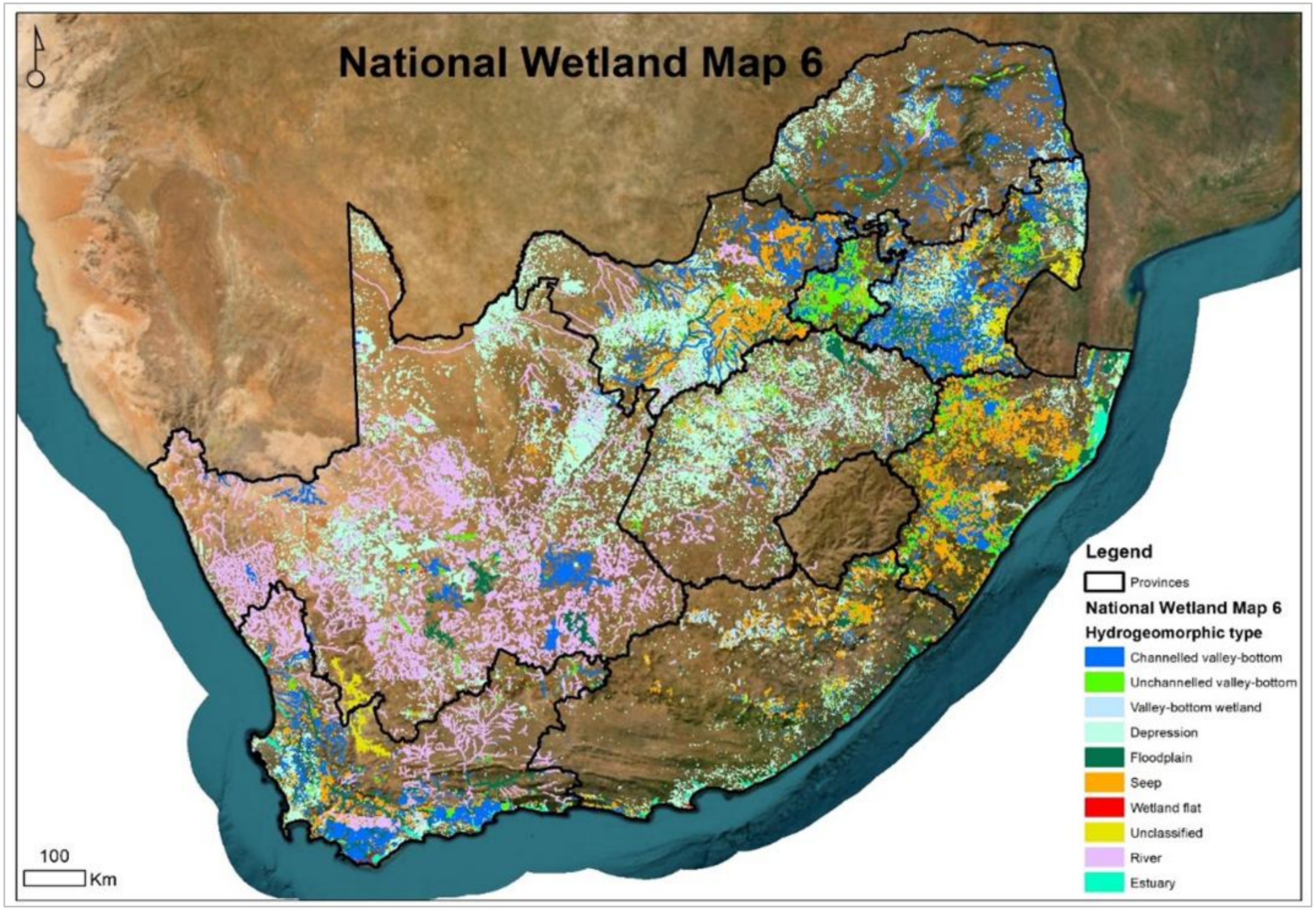


Figure 4.15 National Wetland Map (NWM) Version 06 showing the extent of wetlands (based on Hydrogeomorphic type, HGM) in South Africa

- *National extent of land cover types in and around wetlands in South Africa*

A total area of 259,102 hectares was reported for various land cover types including wetlands, in the Limpopo Water Management Area (WMA) (Table 4-6). Within a 100-meter radius around the wetlands in this WMA, the most common land cover type was forest land, comprising 48.23% of the area, while shrubland was the least common, accounting for only 0.01%. Figure 4.16, provides a national picture when all the information from different water management areas is aggregated.

Table 4-6: Area and percentage of land cover types within 100 meters of wetlands in the Limpopo WMA

Landcover Type (level1)	**Area km^2**	**Area (%)**
Grassland	461.006192	17.8
Waterbodies	14.979192	0.58
Barren Land	15.735411	0.61
Wetlands	94.723753	3.66
Built-up	283.338062	10.94
Cultivated	466.131572	18.0
Mines & Quarries	5.162245	0.20
Shrubland	0.253578	0.01
Forested Land	1249.692618	48.23

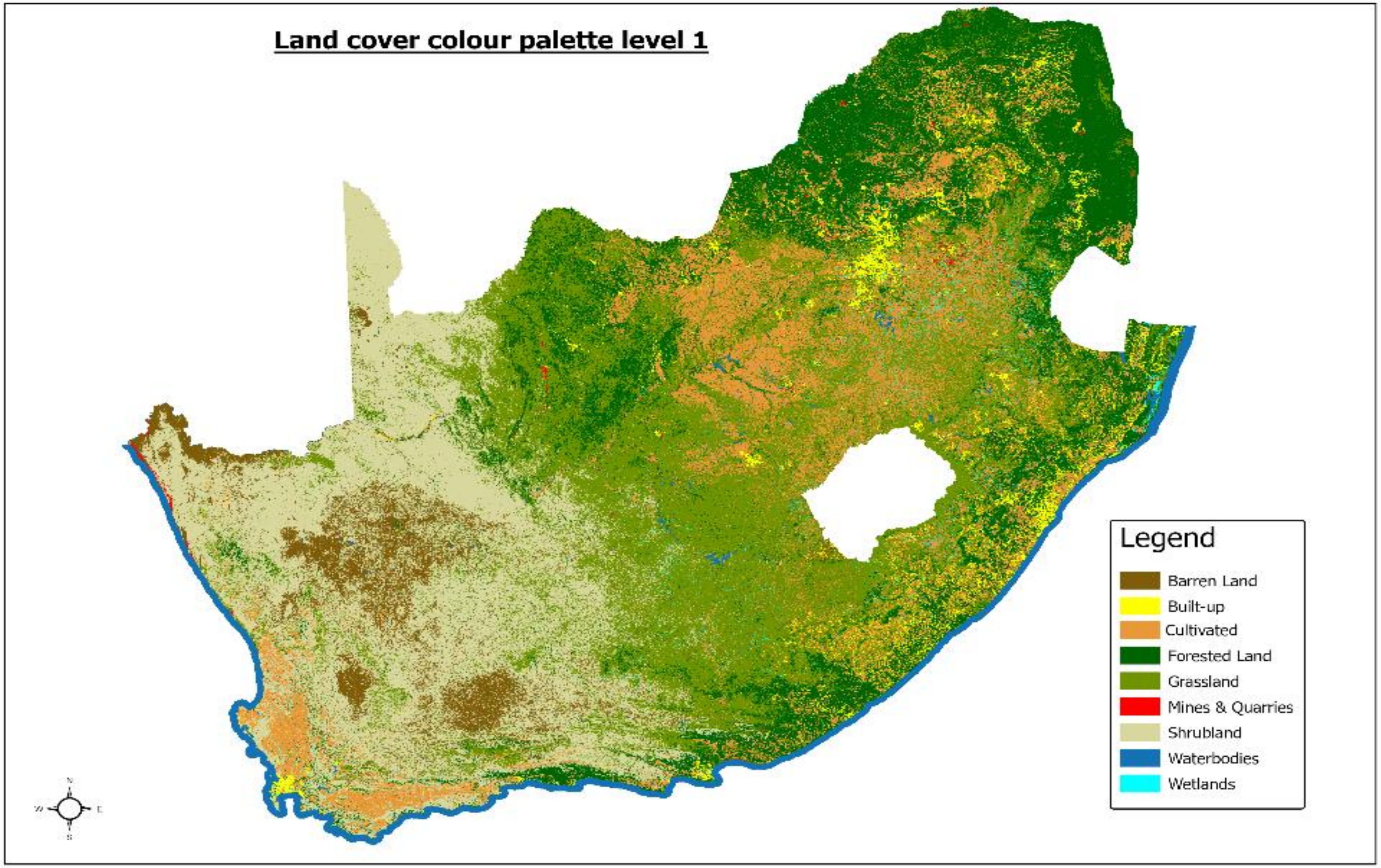


Figure 4.16: Final landcover palette level 1 (Ngcofe et al., 2020)

- *National extent of wetlands in various categories of protection in South Africa*

The layers of protection (SAPAD) and conservation (SACAD) were obtained to differentiate between various sub-types of protection and conservation areas, as shown in Table 4-7.

Table 4-7: Different types of protected and conservation areas

PROTECTED AREA TYPES	CONSERVATION AREA TYPES
National Parks	Biosphere Reserves
Nature Reserves	Conservancies
Special Nature Reserves	Botanical Gardens
Mountain Catchment Areas	
World Heritage Sites	
Protected Environments	
Forest Nature Reserves	
Forest Wilderness Areas	
Marine Protected Areas	

The total area of wetlands within conservation areas in the Limpopo Water Management Area (WMA) was reported to be 74740.80 hectares, while protected areas accounted for 116206.98 hectares (Table 4-8). Most of the wetlands in the Limpopo WMA are located in conservation areas designated as Biosphere Reserves, covering 46812.2 hectares, as well as in protected areas identified as Nature Reserves, totalling 107096.9 hectares (Table 4-9).

Table 4-8: Area and percentage of wetlands within various conservation areas in the Limpopo WMA

Site Type	Area km^2	Area ha	Area (%)
Biosphere Reserve	468.121588	46812.15875	62.65
Ramsar Site	278.742644	27874.26436	37.22
Botanical Garden	0.54377	54.376968	0.072
	747.408002	**74740.80008**	

Table 4-9: Area and percentage of wetlands within various protected areas in the Limpopo WMA

Site Type	Area km2	Area ha	Area (%)
Nature Reserve	1070.969171	107096.9171	92.08
Protected Environment	19.575767	1957.576731	1.69
World Heritage Site	21.852103	2185.210336	1.88
National Park	49.672743	4967.27427	4.27

Are wetlands in protected areas less vulnerable to land-based activities? A case study of the Kgaswane and Blesbokspruit Nature Reserve wetlands.

Kgaswane and Blesbokspruit Wetlands are Ramsar wetlands (Ramsar, 2019). Both wetlands are located within Nature Reserves, which are primarily governed by the National Environmental Management: Protected Areas Act of 2003 (Act 57 of 2003) and the Nature Conservation Ordinance No. 19 of 1974. As Ramsar sites, they have international conservation status under the Ramsar Convention of 1971 (Ambani, 2013), which aims to protect endangered species and threatened ecosystems in order to preserve biological diversity. However, a water quality assessment of the Kgaswane and Blesbokspruit wetlands suggests otherwise.

The physical, chemical, and microbiological properties of both wetlands were assessed. The electrical conductivity of the Kgaswane wetland was measured at ≤ 40 mS/m, which indicates very good water quality according to the Target Water Quality Ranges (TWQR) for aquatic ecosystems, agricultural, and domestic use (Figure 4.17A and B). In contrast, Blesbokspruit wetland showed TWQRs ranging from 40 to 90 mS/m, indicating good water quality, and from 90 to 270 mS/m, indicating fair water quality (Figure 4.17A).

The electrical conductivity of the Kgaswane wetland was measured at ≤ 40 mS/m, which indicates very good water quality according to the Target Water Quality Ranges (TWQR) for aquatic ecosystems, agricultural, and domestic use (Figure 4.17B).

A similar trend was observed for nitrogen where the Kgaswane wetland had nitrogen levels below 1.0 mg/l for NO3 + NO2 across all sites, reflecting very good water quality. In comparison, the Blesbokspruit wetland exhibited a range of nitrogen levels that included both good water quality (6 - 10 mg/l) and very good water quality (Figure 4.17C).

E. *coli* counts, which are typically indicative of faecal contamination, were found to be alarmingly high in March and April 2024 at Blesbokspruit wetland (Figure 4.17E), indicating extremely poor water quality. The elevated E. *Coli* levels were most noticeable at the wetland's two inlet sites, but decreased at the outlet site, indicating that the wetland's natural filtration properties are still in effect, despite the poor water quality.

In April 2024, Kgaswane wetland reported E. *Coli* counts of 400 to 800 MPN/100mL, indicating poor water quality. The evaluation of these two wetlands shows that the water quality varies despite existing legislation designed to protect them. Several factors can have an impact on water quality, including mining and industrial effluents, changes in land use that harm the environment, and sewage treatment plants that contribute to water pollution (Ambani and Annegarn, 2015). Finally, data on water quality indicate that, despite protective legislation for nature reserves, wetlands within these areas may remain vulnerable to land use practices occurring upstream and within the catchment area.

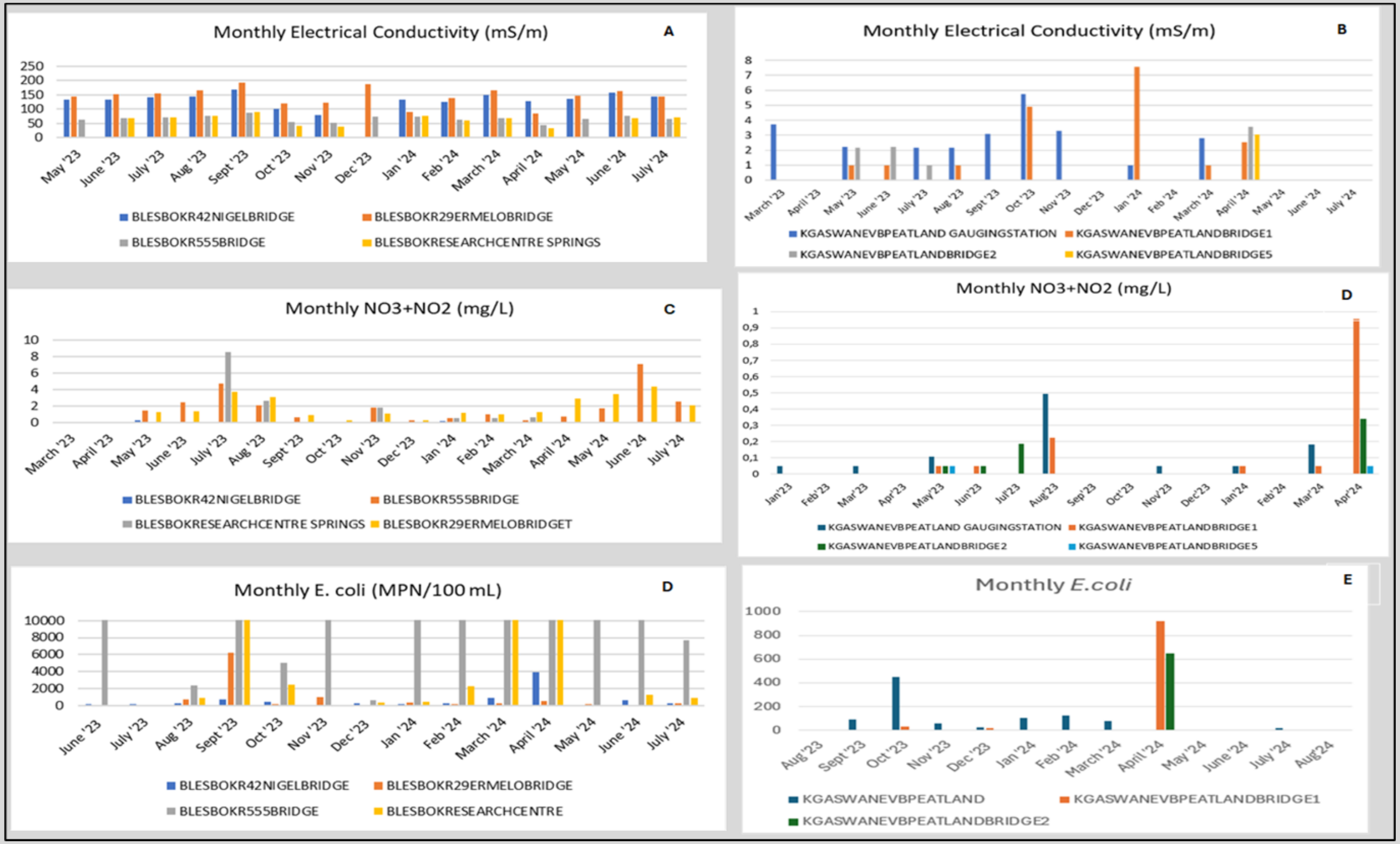


Figure 4.17: Comparison of the physical (electrical conductivity), chemical (Nitrate (NO3) and Nitrite (NO2)) and microbiological properties (E. coli) of Blesbokspruit and Kgaswane Wetlands.