4

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4.1 Streamflow

It would not be an easy task to derive the difference between the natural streamflow and present-day streamflow, which is passing a specific point within a river system without configuring a rainfall-runoff model such as the WRSM2000. Total natural runoff of water flowing and present-day streamflow has been predicted up to September 2010 primarily based on the WRSM2000 / Pitman Model from the Water Resource Study of 2012.

In the absence of the most current model simulations, the surface water monitoring points that are of strategic importance (outlet of catchments, international obligations importance) and contain long-term continuous data were selected to assess the deviation of streamflow during the reporting period from the normal. A normal mean period was chosen to be from October 1981 to September 2010. A streamflow anomaly was then derived based on the total annual volumes of streamflow at each selected site, and this is presented in Figure 4.1 below.

Below normal streamflow is observed downstream the Vaal-Orange River confluence through to the Augrabies Falls. The flow is lower than normal by between 332- 346 million cubic metres per annum. This below-normal streamflow is likely due to the large dams in the Orange and the Vaal Rivers to facilitate water abstractions and transfers in and out and the highly controlled systems that exist upstream. Higher than normal streamflow has been experienced during the reporting period on the Olifants River at Witbank (eMalahleni), Renoster River at Arriesrus, Great Fish River at Rietfontyn, and Bree River at Wolvendrift.

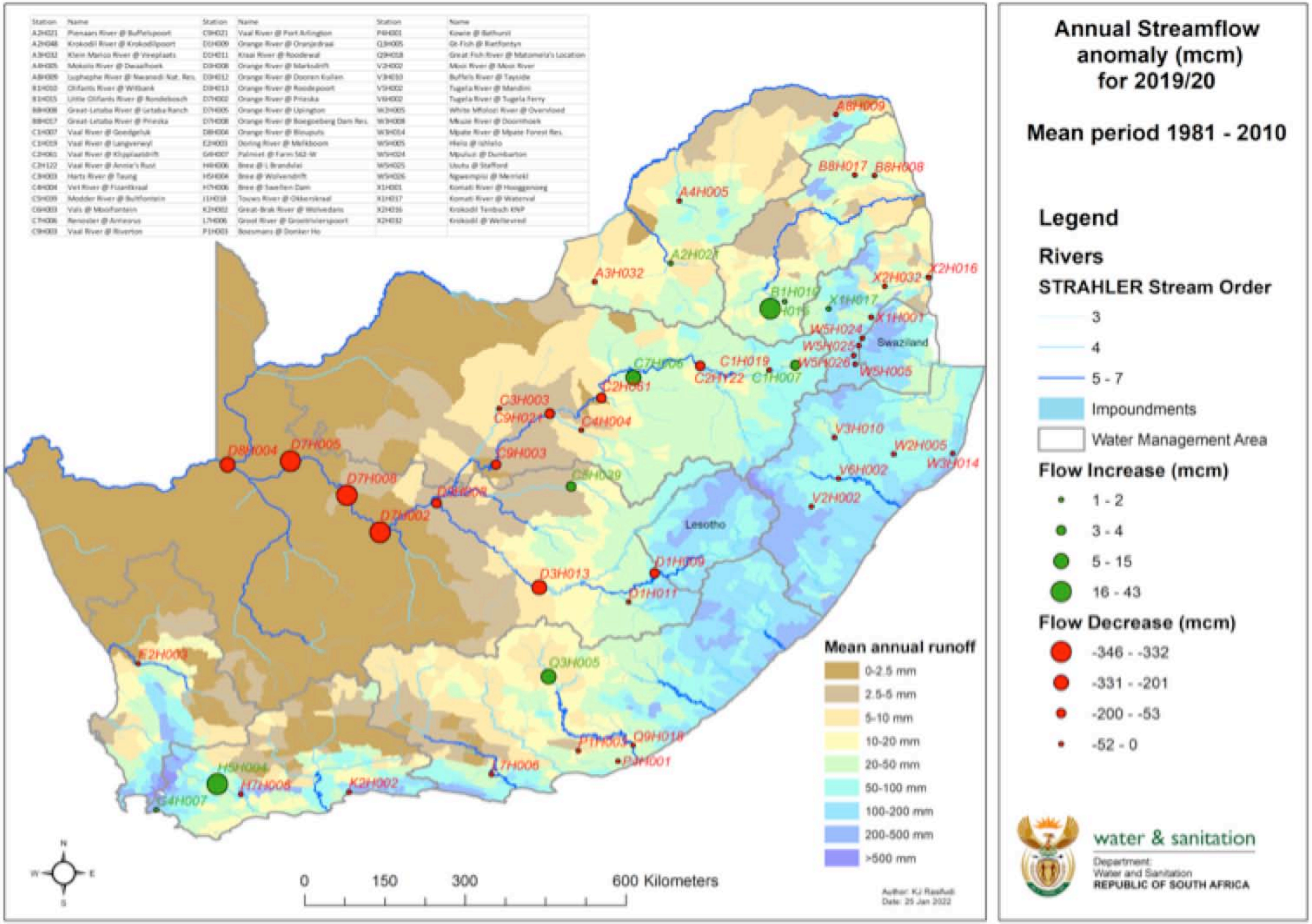


Figure 4.1 Annual Streamflow Anomaly for Strategic River Flow Monitoring Stations

4.2 Surface Water Resource Quality

4.2.1 Eutrophication

Eutrophication is the process of enrichment of water bodies with plant nutrients, particularly phosphorous and nitrogen compounds. It is a natural occurrence during the life of an impoundment (Dam) that can take thousands of years to reach environmentally harmful levels. Intensive human activities and associated water pollution impacts lead to accelerated eutrophication (cultural eutrophication) which results in water quality deterioration in water bodies. This leads to the emergence of eutrophication symptoms such as explosive growth of animal and plant life (algae and macrophytes), leading to negative impacts such as health risks to people and animals, ecosystem degradation, and nuisance during recreational activities, and increased water treatment costs.

This section assesses the trophic status and the potential for eutrophication symptoms for dams and rivers during the reporting period of 01 October 2020 – 30 September 2021. The list of trophic status classes and criterion used to assign the trophic status are given in Table 4-1 and Table 4-2 below, while Table 4-3 provides a summary of the trophic status classes within the monitored provinces.

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

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

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

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

The current trophic status for sites monitored during the reporting period is shown in Figure 4.2. Forty-one sites were assigned trophic levels status as part of the National Eutrophication Monitoring Programme (NEMP) for 01 October 2020 to 30 September 2021 period. These lakes, dams, and rivers in Gauteng, Limpopo, Mpumalanga, and North-West Provinces were monitored for nutrient enrichment. Of the 41 dam/lake sites were assigned trophic status of which: *12 were hypertrophic*, *3 eutrophic*, *6 mesotrophic* and *20 oligotrophic.*

In Gauteng, five sites were hypertrophic, two eutrophic, one mesotrophic, and five sites had an oligotrophic status. The hypertrophic sites were Roodeplat Dam, Bon Accord Dam, Leeukraal Dam, Bronkhorstspruit Dam and Rietvlei Dam. The eutrophic sites were Centurion Lake and Florida Lake; the mesotrophic site was Homestead Lake, and the oligotrophic sites were Blaaupan Lake, Civic Lake, Kleinfontein Lake, Victoria Lake, and Vaal Dam. The Homestead Lake was the only mesotrophic.

The North-West region had seven sites with a hypertrophic status, one eutrophic, three with a mesotrophic status, and four had an oligotrophic status. The hypertrophic sites were Hartebeespoort Dam, Roodekopjes Dam, Vaalkop Dam, Klipvoor Dam, Klein-Maricopoort Dam, Lotlamoreng Dam and Modimola Dam. The eutrophic status was noted for Bospoort Dam, and mesotrophic sites were Buffelspoort Dam, Koster Dam, and Olifantsnek Dam, and oligotrophic sites included Lindleyspoort Dam, Marico-Bosveld Dam, and Disaneng Dam.

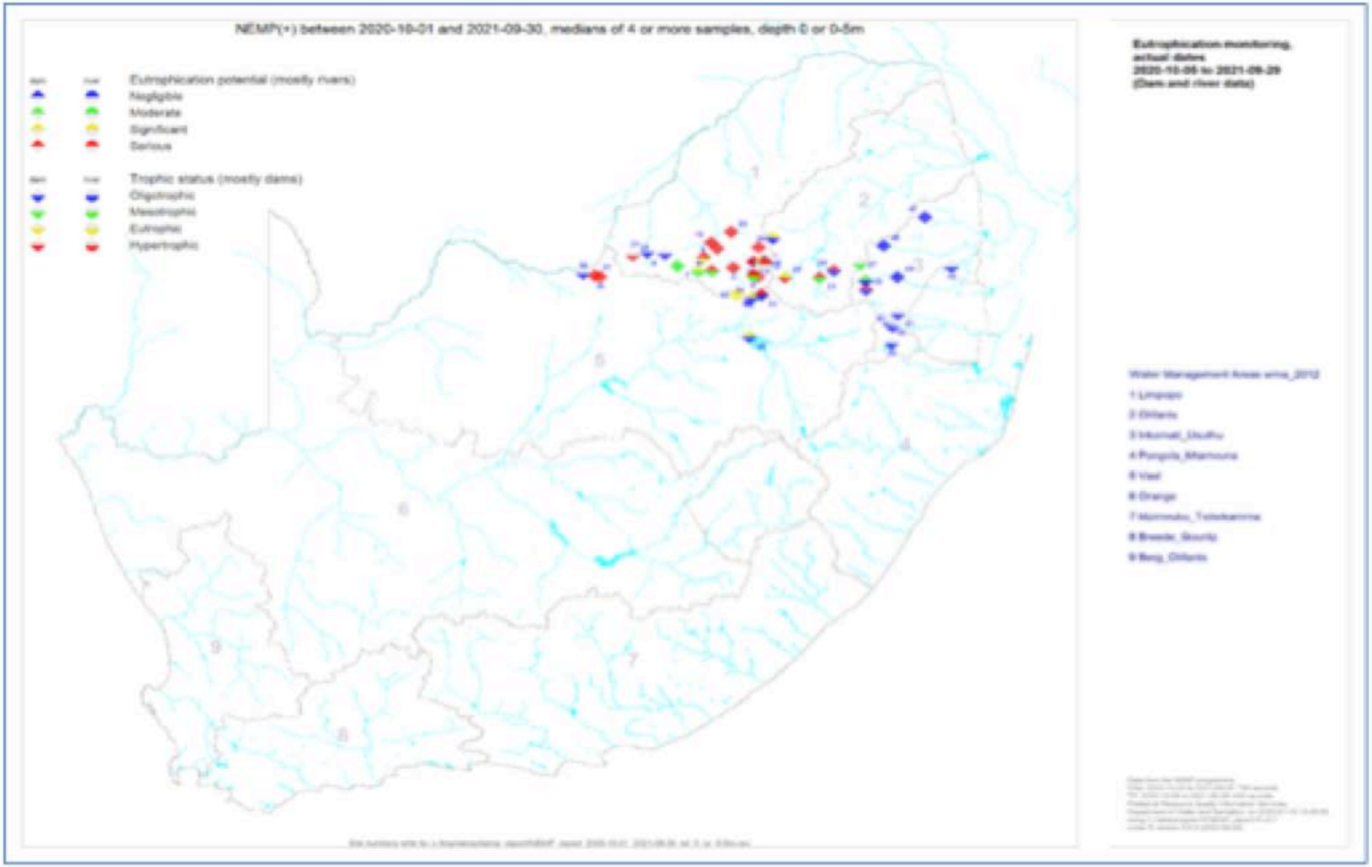


Figure 4.2 Eutrophication monitoring results based on the data collected during the 2020 to 2021 hydrological year

Table 4-3 Summary of NEMP monitoring in South African provinces for 01 October 2020 to 30 September 2021 period

Province	Hypertrophic	Eutrophic	Mesotrophic	Oligotrophic
Gauteng	5	2	1	5
North West	7	1	3	3
Mpumalanga	0	0	2	11
Limpopo	0	0	0	1
Total	12	3	6	20

In Mpumalanga, eleven sites had an oligotrophic status, and two had a mesotrophic status. The oligotrophic sites included Middleburg Dam, Heyshope Dam, Jericho Dam, Morgenstond Dam, Westoe Dam, Boesmanspruit Dam, Nooitgedacht Dam, Vygeboom Dam, Driekoppies Dam, Kwena Dam and Inyaka Dam. Mesotrophic sites were Witbank and Belfast Dam. Limpopo had one mesotrophic status at the Rust De Winter Dam.

This eutrophication report shows incidences of nutrient enrichment for some of the sampled water resources. The high levels of nutrients can be attributed to sewage (domestic and industrial wastewater effluent) inflows into water bodies, agricultural runoff, and untreated effluent from wastewater treatment plants. The symptoms of eutrophication, such as algal blooms and outbreaks of alien aquatic weeds (water hyacinth), have been prevalent in most water resources. Although water hyacinth can absorb nitrogen and phosphorus, the secondary pollution caused by water hyacinth decay increases the level of eutrophication in water bodies (Zheng *et al.,* 2009). The NEMP data acquisition is improving as more monitoring stations get reactivated. This will provide a countrywide view of nutrient enrichment.

4.2.2 Microbial Pollution

Water pollution can have harmful effects on drinking water, recreation and agriculture. Significant sources of pollution of surface waters include agricultural and urban run-off, municipal and industrial effluent, and run-off from rural and informal settlements with insufficient sanitation. Surface water can carry these pollutants into nearby streams, rivers, and coastal waters.

According to the World Health Organisation, 159 million people depend on surface water globally, and at least 1.8 billion people use drinking water sources that are contaminated with faeces. Microbial water quality measures the microbiological conditions of water in relation to human health. The overall purpose of the microbial monitoring programme is to assess and manage the health risks to water users due to faecal pollution of water resources.

Bacterial analyses provide an indication of any contamination from sewage or animal faecal matter. Faecal coliforms and *E. coli* are the best indicators for the assessment of recent faecal pollution, and they also indicate the potential presence of pathogenic bacteria, viruses, and parasites. Faecal coliform and *E. coli* are measured, and results compared to the South African Water Quality Guidelines.

The microbiological data represented on the map (Figure 4.3) shows that surface water resources are not suitable for drinking without any treatment processes. 91% of the collected samples indicate that there was a high risk to human health if the water was consumed directly from the source. This risk is significantly reduced to a low risk if the water is treated before consumption. Limited treatment includes treating water at household level, such as boiling. 9% of the monitored sites still indicate a potential high risk even after limited treatment, which means that those water resources are highly polluted. 71 % of the sampled sites showed a low health risk if water from the source was used for irrigating crops that were eaten raw. Only 49% of the 536 sampled sites were associated with a low Health risk when used for recreational activities. This includes such activities as swimming, washing laundry in the rivers etc., and these activities should be discouraged in some of these monitoring sites that are highly polluted and pose potential health risks to the users. Some of the monitoring sites are highly polluted sporadically located in the Western Cape, Eastern Cape, and Gauteng, and the use of these water resources for domestic and recreational use should be discouraged.

National Microbial Monitoring Programme guidelines in Table 4-4, were used, and there was a high potential health risk if the water was used for drinking purposes with no treatment..

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

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

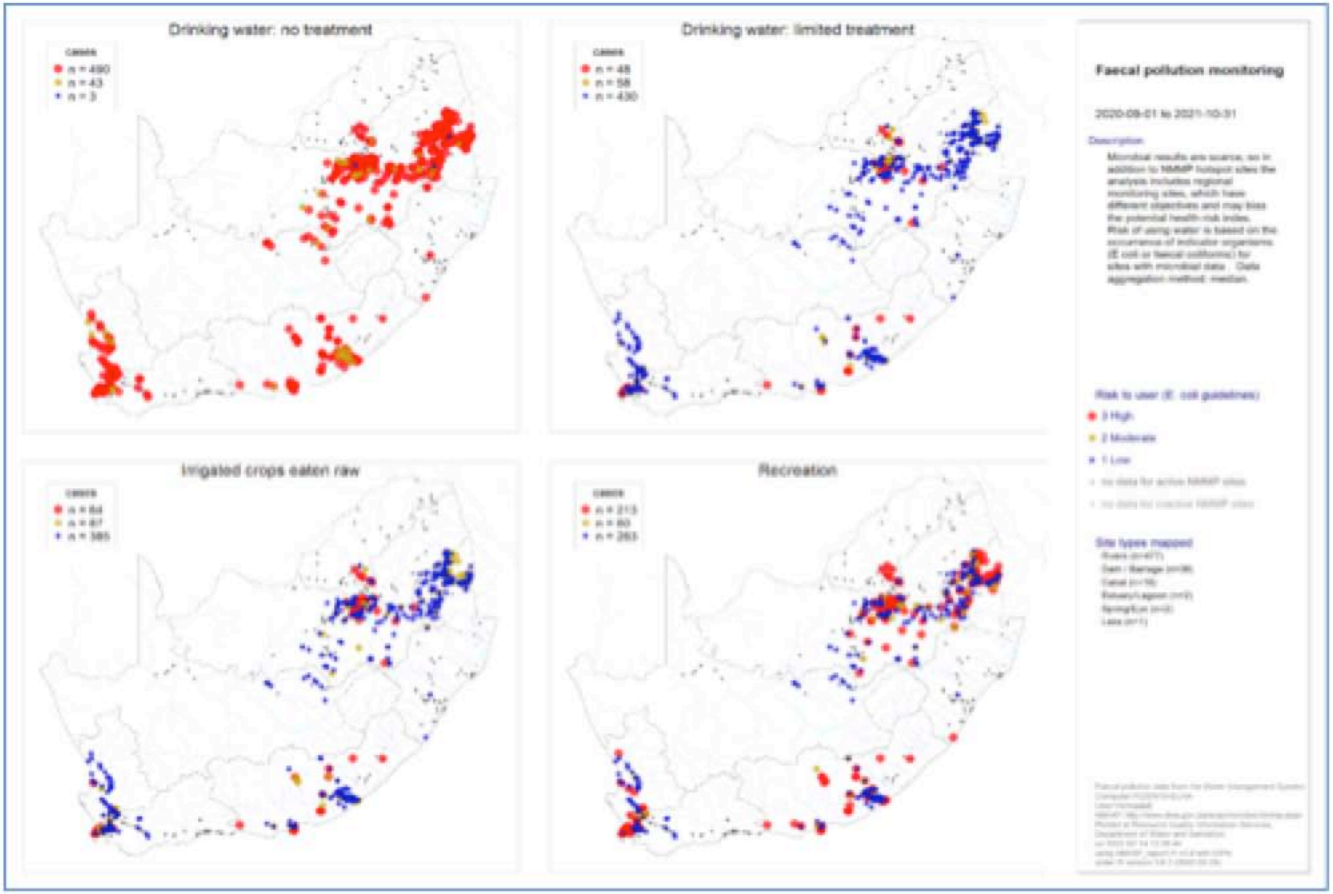


Figure 4.3 Spread of human health risks associated with microbiological pollution in priority hotspots

4.2.3 Chemical

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

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

Due to various ongoing significant constraints, the water quality picture able to be represented is currently lacking or incomplete in many areas of the country. Pre-existing problems at a Department of Water and Sanitation laboratory level to perform maintenance on equipment, purchase new equipment, and obtain the required reagents and other supplies had already contributed to a significant backlog in samples to be discarded when they exceeded their preservative lifespan.

Figure 4.4 represents the water quality situation in **2017-2018** as the most recent period for which there was at least adequate data to provide a water quality depiction of the situation across South Africa. In order to show any water quality fitness-for-use on the presented map, a less stringent requirement of data points per site for the entire year had to be implemented in the above-mentioned assessment. This is clearly not scientifically defensible but needed to be done to represent inorganic chemical water quality on a map.

The information depicted on the map should have been even sparser if scientifically defensible criteria were used (Figure 4.4). Refer to Figure 4.5 for the representation of the 2019-2020 hydrological year. The data are very sparse and do not cover the country well at a spatial level. There is no map available for the 2020-2021 hydrological year.

However, since several inorganic chemical water quality attributes are of a conservative nature, the broad trends evident in previous years are likely to continue unless a major change in land use or management practice takes place.

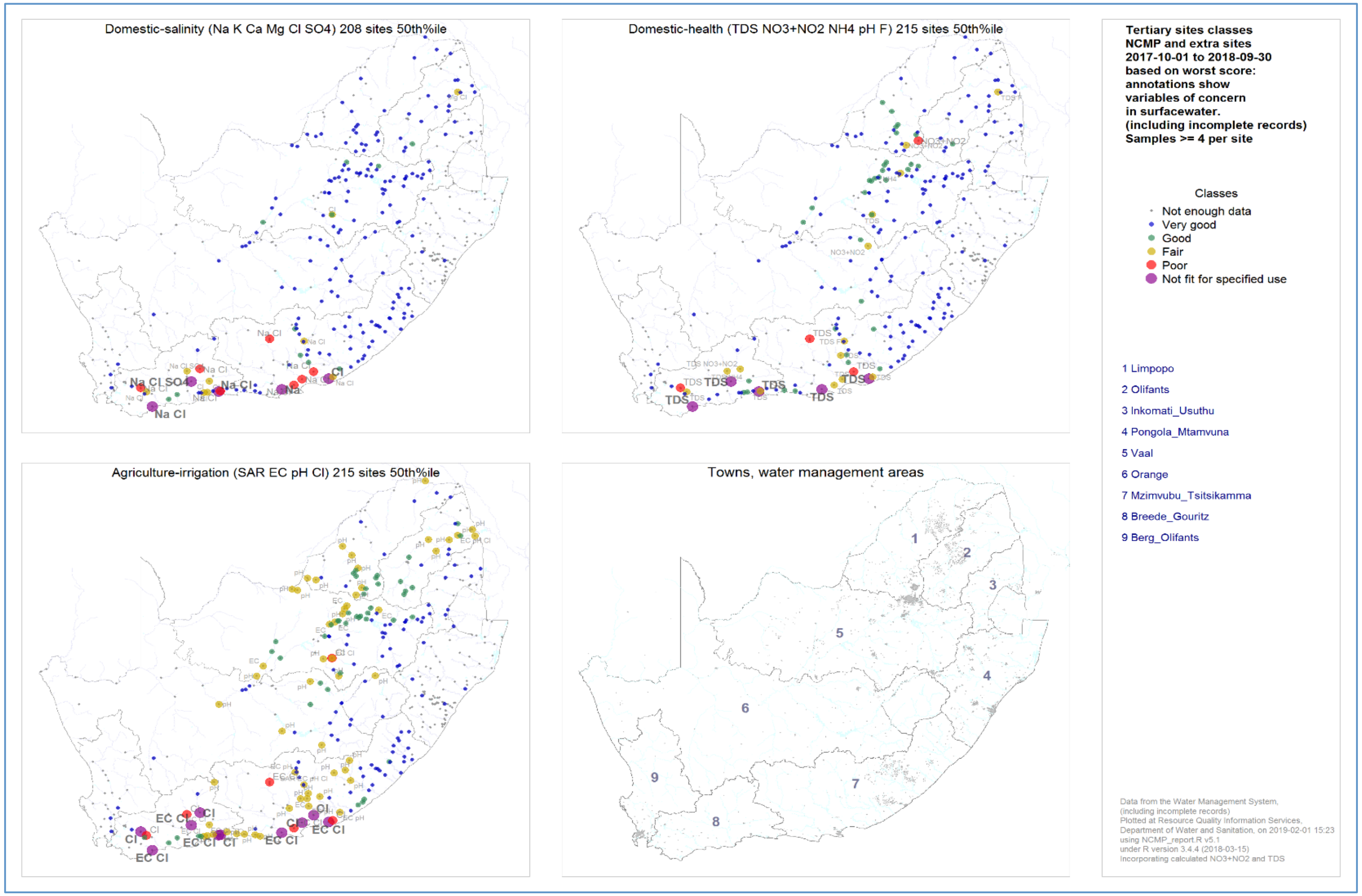


Figure 4.4 The inorganic chemical water quality situation in South Africa during the 2017/2018 period as an example that is still likely to be broadly true of the 2019/2020 situation that has even less data to assess and report on.

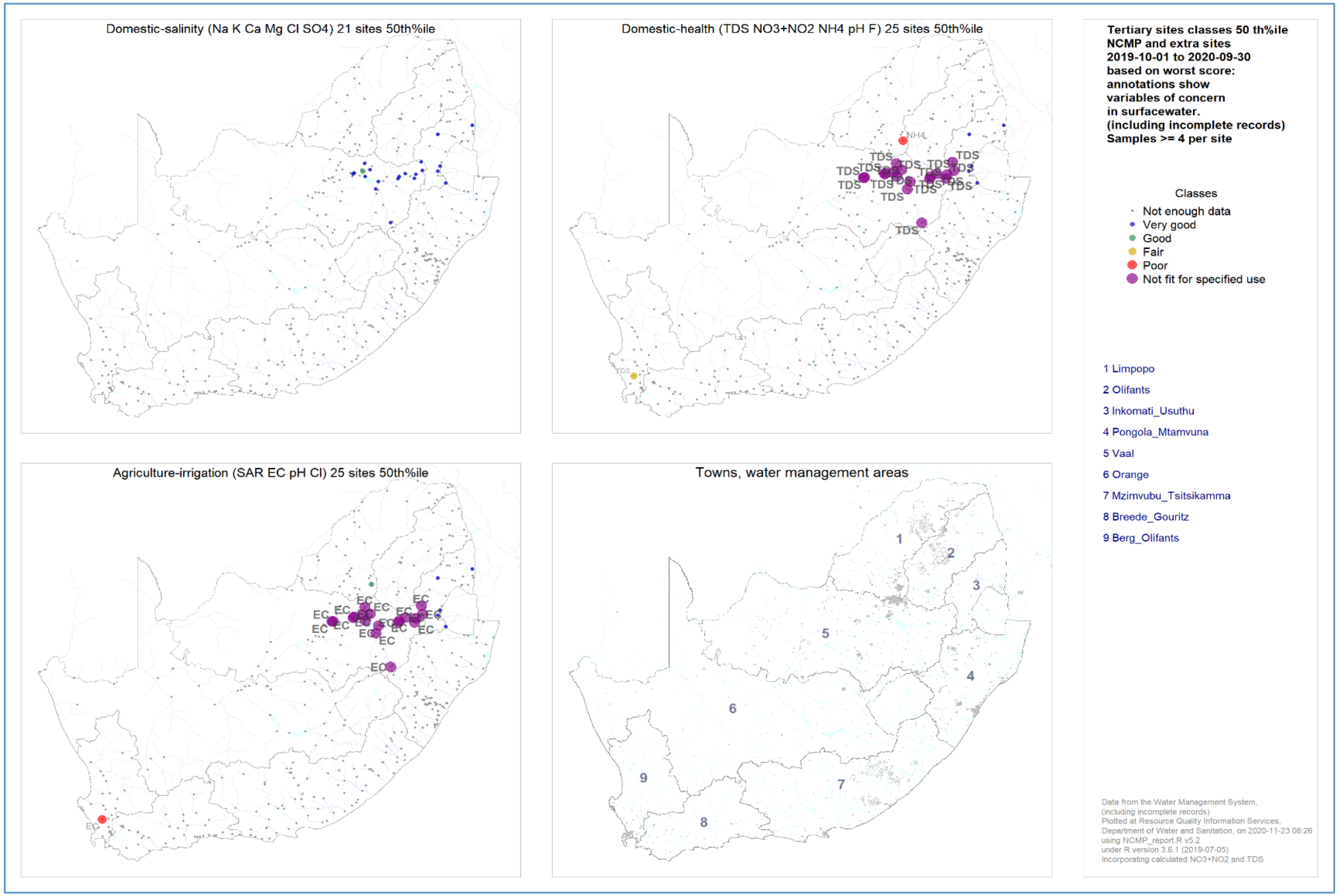


Figure 4.5 The very limited inorganic chemical water quality situation in South Africa during the 2019/2020 hydrological period.

- ***Salinity***

The salinity level of water resources is calculated as total dissolved solids (TDS) or measured as electrical conductivity (EC) and is also gauged from the concentrations of individual ions such as sodium, chloride, magnesium, potassium, and sulphate, amongst others.

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

According to Figure 4.4, which reflects the situation evident in 2017-2018, high salinity levels are concentrated around the Southern and Western Cape regions of the country due most likely to marine geology, with a limited occurrence of elevated chloride in the Vaal WMA. There was an isolated pocket of elevated magnesium, chloride, and fluoride in the Olifants Water Management Area (WMA) in the Ga-Selati River at Loole-Foskor (at a Fair level for Domestic Use), and elevated sulfate levels at selected sites within the Breede-Gouritz WMA.

For irrigated agricultural use, high levels of salts (chloride, EC, and the irrigation suitability indicator, the Sodium Adsorption Ratio –SAR) in water can have an impact on sensitive crops resulting in reduced crop yields and hence negatively affecting profitability. The result clearly showed poor to non-acceptable levels of variables impacting irrigated agricultural use in the Southern and Western Cape. There were many instances of elevated EC throughout the Vaal River WMA and Lower Olifants River WMA, where EC and chloride were seen to be within the Fair range. Throughout the rest of the country, there were also incidences of pH levels that are not ideal for irrigated agriculture.

In practical terms, though, the real-life situation may not be as severe as the water quality guidelines would suggest, and this is due to the abruptness of the transition between the Very Good and the Not Very Good water quality ranges that is not realistic. There should be a more gradual transition for it to be meaningful and practical. This is something that needs to be addressed in water quality assessment terms to accurately be able to represent the water's true fitness-for-use.

- ***Potential Problems with Wastewater Works***

Elevated ammonium ($NH4+$) and nitrate-nitrite ($NO3+NO2$) levels could be indicative of the poor performance of wastewater treatment works (WWTW) to meet discharge limits or direct discharge of untreated or minimally treated human or animal waste or agricultural return flows entering the water resource. Two sites within the upper

Crocodile-Marico WMA had elevated nitrate-nitrite levels, a site in the Upper reaches of the Orange River WMA and a site in the Breede-Gouritz WMA. A site in the Upper reaches of the Vaal River WMA had ammonium (NH4+) elevated into the Fair range for Domestic use purposes. Instances of poorly functioning or non-functional WWTW have been reported in the media, including the contamination of the Vaal River in the vicinity of Parys. This affects all classes of water use and has significant negative impacts. Ammonium was also elevated in a site in the Breede-Gouritz WMA.

- ***Acid Mine Drainage***

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

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

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

On a national scale, reduced pH levels are not necessarily seen to coincide with those areas (the Breede-Gouritz WMA) indicated in Figure 4.4 that have elevated sulphate (SO4) levels. Finer scale and more rigorous sampling will, however, most probably reveal a different picture. The isolated elevated salinity (chloride) levels within the Vaal River may be partially due to AMD. Irrigation return flows and the effects of discharge from urban areas. It must be borne in mind that due to a limited number of samples in many cases across the country, there are indeed water quality problems that are just not being revealed because there are no, or very limited, data. In this case a lack of findings does not necessarily indicate a good situation!

4.2.4 River Ecology

The River Eco-Status Monitoring Programme (REMP) monitors the ecological condition of river ecosystems as reflected by system drivers and biological responses. For the various indicators used in REMP, reference conditions derived from the best available information are determined. The current conditions (Ecological Category) for each indicator are calculated as a percentage change from the reference. The REMP is based on models that incorporate existing approved Eco-Status models. The assessment can be performed at the sub-quaternary reach or site level, and it includes the use of the Index of Habitat Integrity (IHI), Fish Response Assessment Index (FRAI), Macroinvertebrate Response Assessment Index (MIRAI), Vegetation Response Assessment Index (VEGRAI), and Integrated Ecological Condition (Eco-status). Monitoring is conducted on a quarterly basis and technical reports produced once a year.

Due to COVID-19 challenges, such as a lack of sufficient Personal Protective Equipment (PPE), social distancing, and difficulties in finding accommodation for distant sites, the program has been reduced to only monitoring macro-invertebrates during the 2020-21 hydrological year. This was because macro-invertebrate monitoring is rapid, which meant that less time would be spent at a site, and smaller teams would suffice.

Most of the presented results reflect the condition of the Macroinvertebrates, using the Macroinvertebrate Response Assessment Index (MIRAI), developed by RQIS as a tool to be used during Ecological Reserve Determinations, monitoring for water use license conditions, monitoring of Resource Quality Objectives (RQOs), and the River Ecostatus Monitoring Programme. (Thirion 2008, 2016). The macroinvertebrates were sampled quarterly according to the South African Scoring System version 5 (SASS5) protocol (Dickens and Graham 2002). The MIRAI v2 model (Thirion 2016) for each site was populated with the SASS5 results for the 2018- 2019 Hydrological year. These results were then used to run the model per site, and the condition of the river was expressed as an ecological category, reflecting a percentage change from reference. The Guidelines for interpreting River Ecostatus results are provided in Table 4-5.

Table 4-5 Generic guidelines for interpreting change in ecological categories for REMP (modified from Kleynhans 1996 & Kleynhans 1999). Each category has been colour-coded and correlates to the national and regional maps

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

During this reporting period, the number of sites where macroinvertebrate monitoring could be conducted increased to 401, from 369 in the 2019-20 hydrological year. This increase in the number of sites monitored was mostly due to increased monitoring by the IUCMA. During the 2019-20 hydrological year the IUCMA could not monitor the Sabie catchment at all. It is worth noting, however, that the program appears to be stabilizing, as 321 of these sites were the same as those monitored during the 2019-20 hydrological year; the 80 percent repetition rate aids in the development of trends and a better understanding of our river systems. These trends are depicted in Figure 4.6 below. Approximately 60.5% of sites remained in the same category as the previous reporting period; most of these were sites in the C category (see Table 4-5) for an explanation of ecological categories). Sites in this moderately modified condition (C category) seem to be resilient and not easily respond to changes. They could maintain basic ecosystem functions, provided the catchments around them do not get subjected to severe disturbances. There was an improvement at 22% of the sites and a decline in ecological condition at 17.5%.

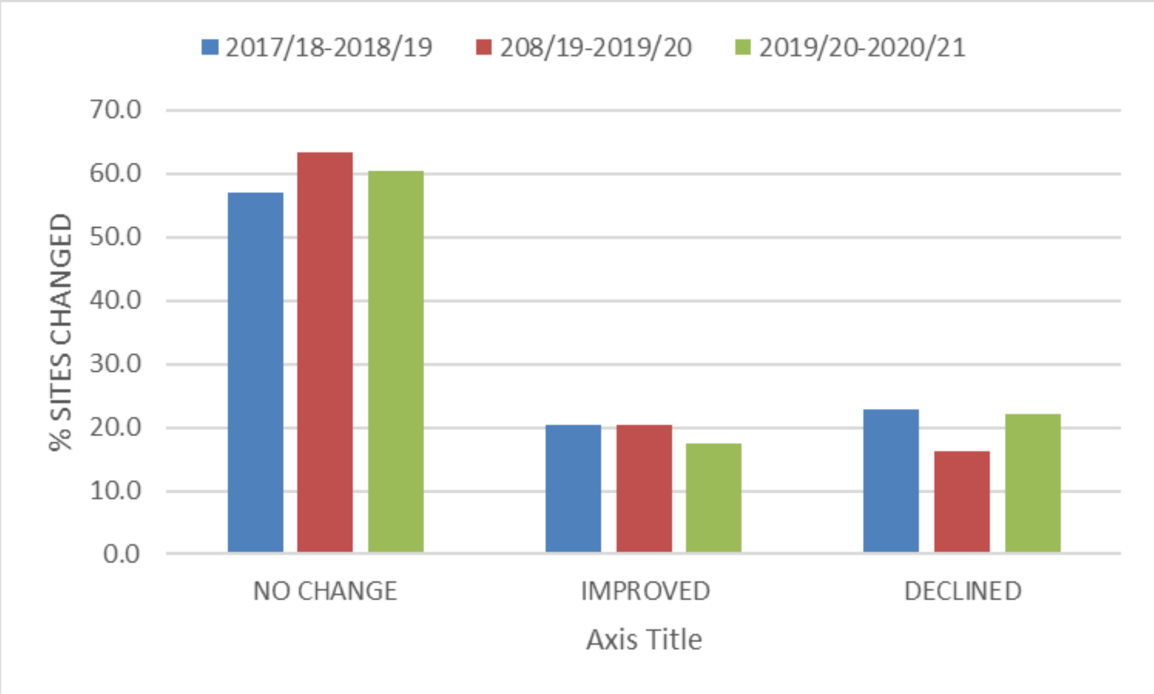


Figure 4.6 Rate of change in the macroinvertebrate ecological condition at sites monitored from 2017-18 to the 2020-21 hydrological years

Figure 4.7 indicates the distribution of the monitored sites and their condition. Almost 60% of the sites were moderately in a moderately modified (C) category C. Approximately 2% of the sites were in an unsustainable seriously modified (E category) or close to seriously modified (D/E) condition. As can be seen from Figure 4.7 these sites were mostly located in the urban areas of Gauteng. Approximately 15% of the sites were in a Largely Natural (B) and close to Largely Natural (B/C) condition. These sites were mostly located near the source or in rural areas. The Lotterings river, which was in the BC category in the 2019-20 hydrological year, deteriorated to a moderately modified (C) category, while most of the sites in the Apies, Hennops, Crocodile, Jukskei, and Pienaars rivers were in a largely modified condition (D – D/E). Because these rivers are mostly located in densely populated areas or run through cities and towns, they deteriorate because of impacts. The Kromme River flows through a drought-affected area of the Eastern Cape, and the Vaal River has ongoing water quality issues.

Most (72%) of the largely modified (D category) to seriously modified (E) sites were in the upper Crocodile and upper Vaal sub-catchments, which are subjected to intensive urban and industrial development Figure 4.8. As can be seen in Figure 4.9, almost 50% of the sites in near-natural conditions (B and B/C categories) occurred in the Inkomati (X) drainage region. The other largely natural sites were either in the upper of rivers and in smaller tributaries.

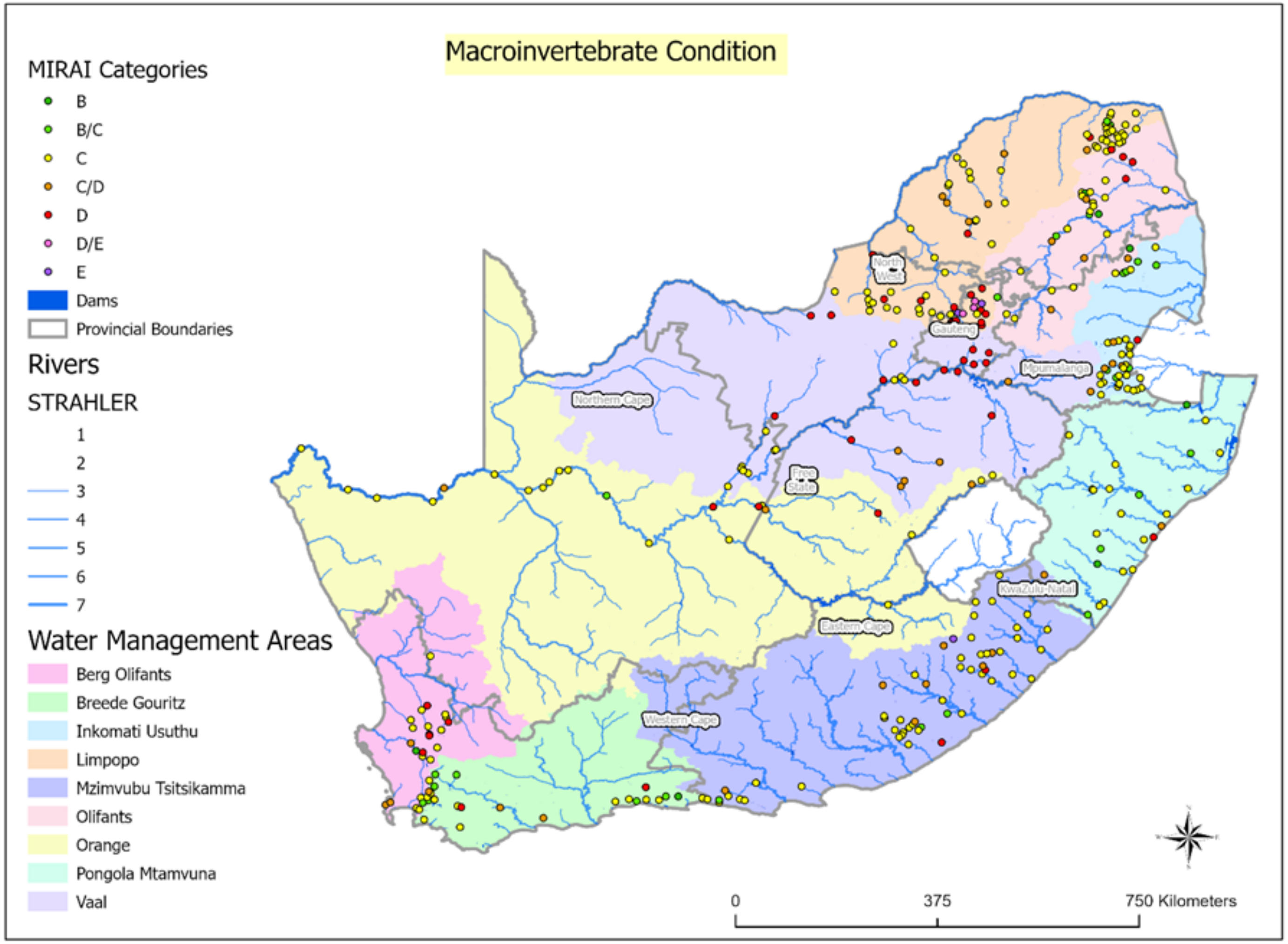


Figure 4.7 Summary Ecological Categories reflecting the macroinvertebrate condition for 401 sites in selected rivers monitored during the 2020/2021 hydrological year

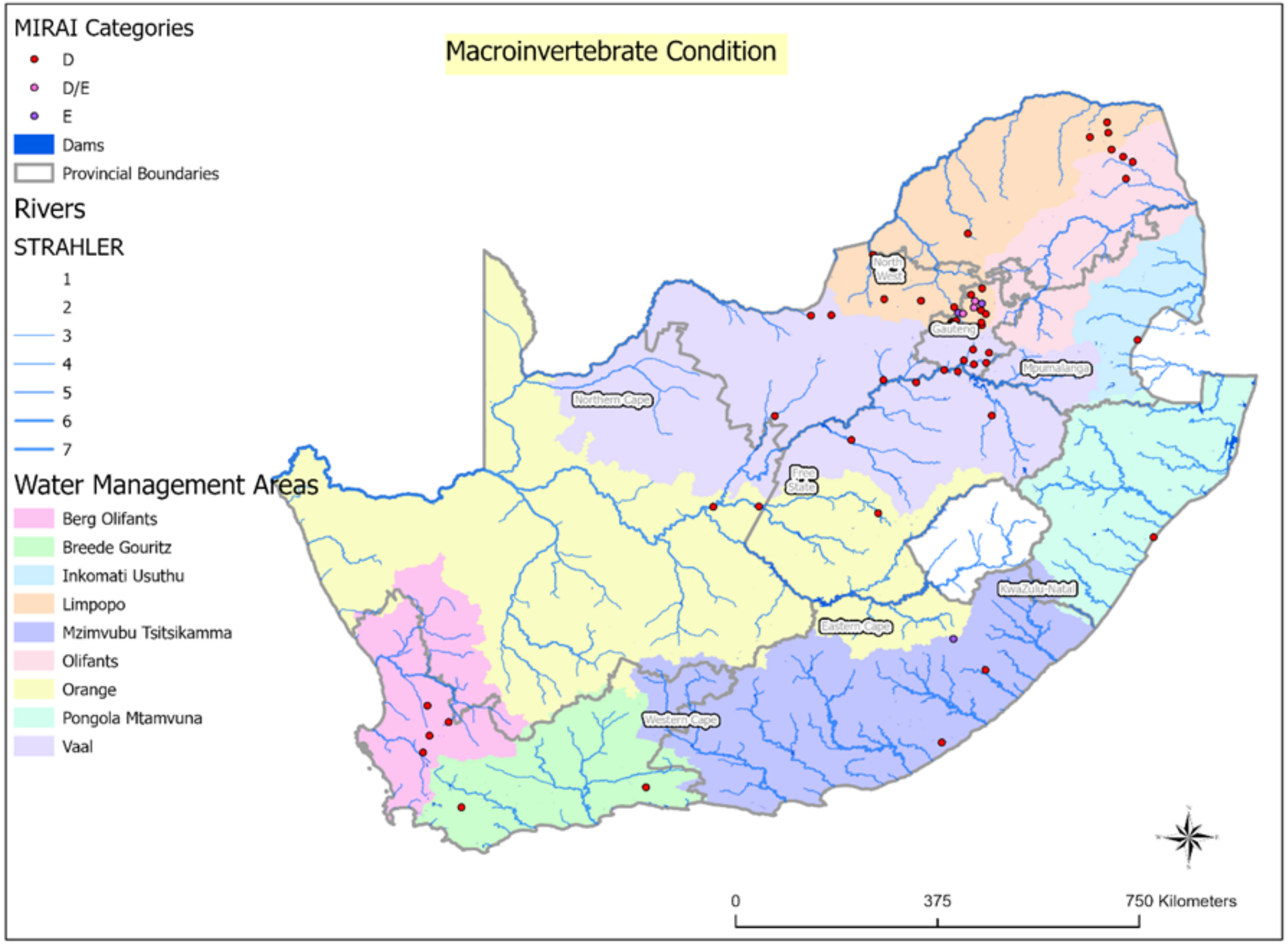


Figure 4.8 Ecological Categories reflecting the macroinvertebrate condition for sites in poor condition in selected rivers monitored during the 2019/2020 hydrological year

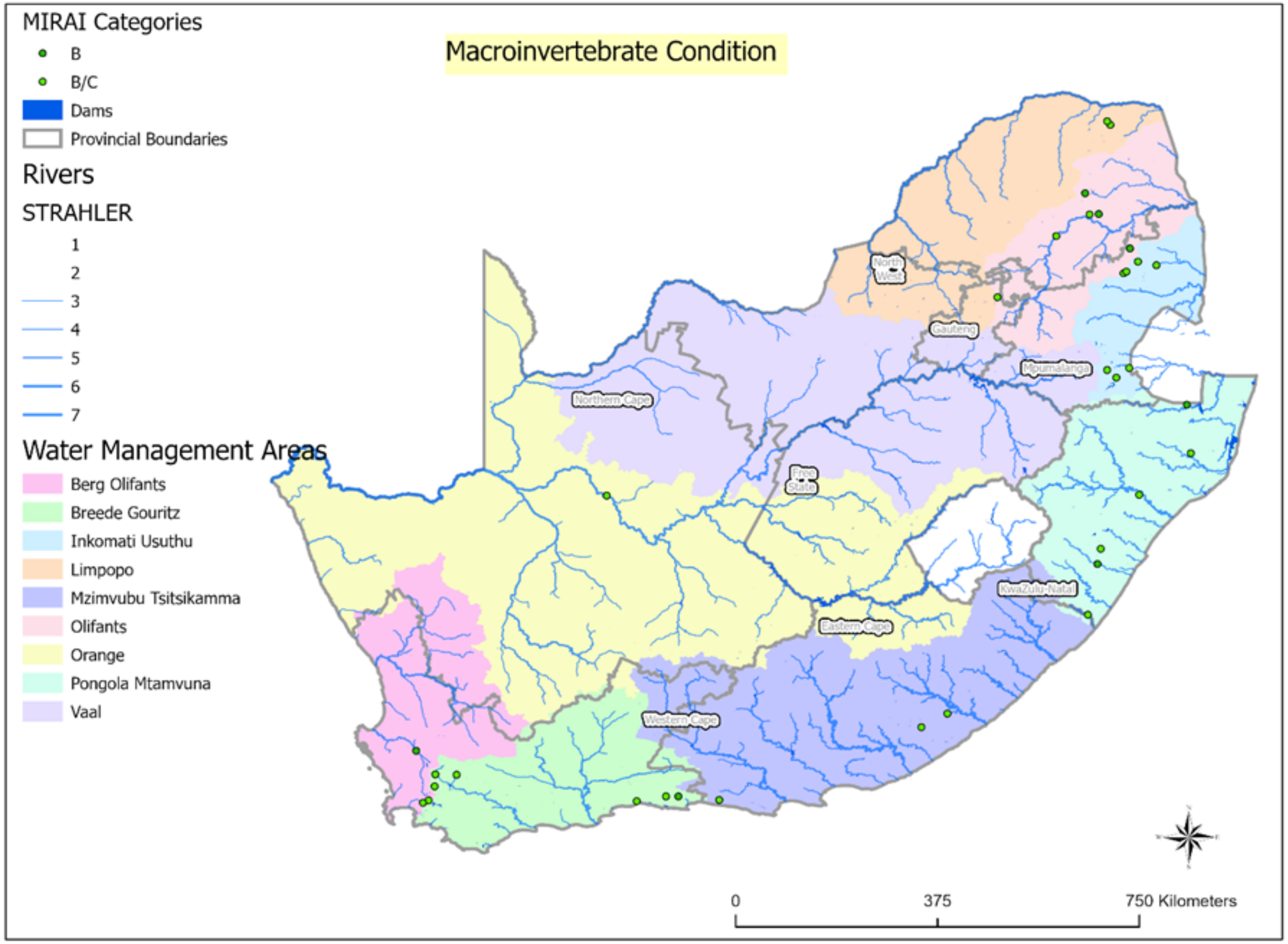


Figure 4.9 Ecological Categories reflecting the macroinvertebrate condition for sites in good condition in selected rivers monitored during the 2019/2020 hydrological year

Compared to the previous hydrological year, the proportion of sites in a seriously (E) modified and close to largely natural (D/E) condition remained at about 2% of the sites. Unfortunately, the number of sites in a largely natural (B) or close to largely natural (B/C) decreased compared to the previous year. There was a slight increase in the number of sites in a moderately modified (C) and close to moderately modified (C/D) condition while the sites in a largely modified (D) condition decreased from about 17.5% to 13 % (Figure 4.10).

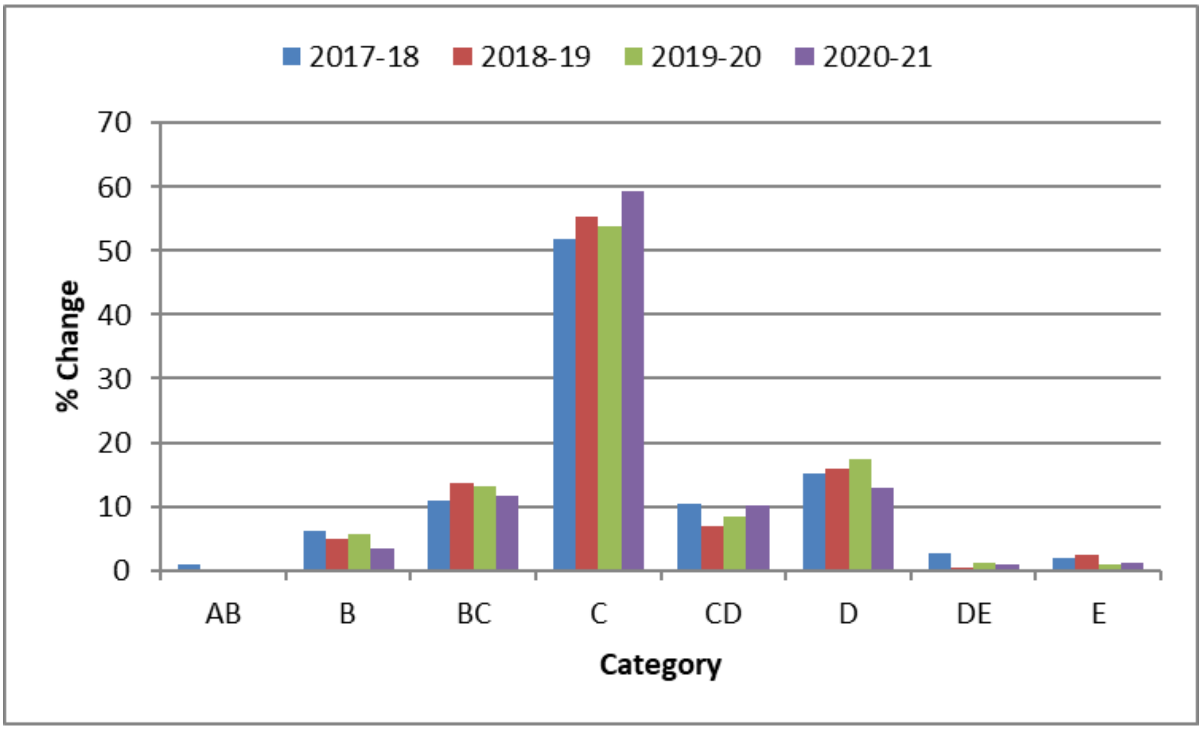


Figure 4.10 Comparison of changes in the ecological categories reflecting the macroinvertebrate condition from the 2017-2018 to the 2019-2020 hydrological year

In conclusion, the Crocodile West River Catchment, particularly in its upper reaches, requires close monitoring and intervention. Almost all the severely altered sites (D/E and E) occurred in the upper Crocodile West catchment. The sites along the Jukskei River were in disrepair. Due to ongoing sewage contamination, the main stem Hennops River is no longer sampled. The Apies River, downstream of the Daspoort Wastewater Treatment Plant, is also severely altered. Malfunctioning Wastewater Treatment Works in Gauteng pose a significant threat to environmental integrity, and enforcement is required.

4.2.5 Estuaries.

The South African coastline is subdivided into four bio-geographical zones according to the National Biodiversity Assessment (Van Niekerk, 2019) as presented in Figure 4.11 below.

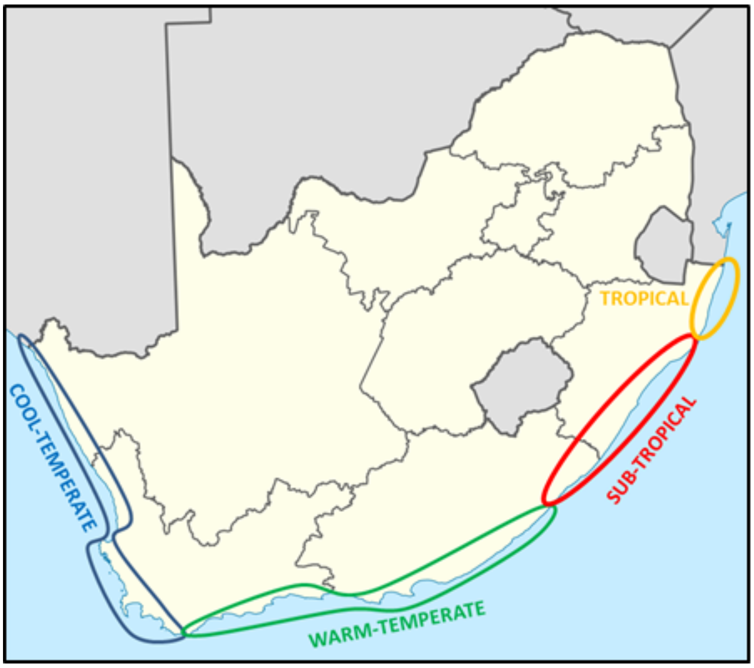
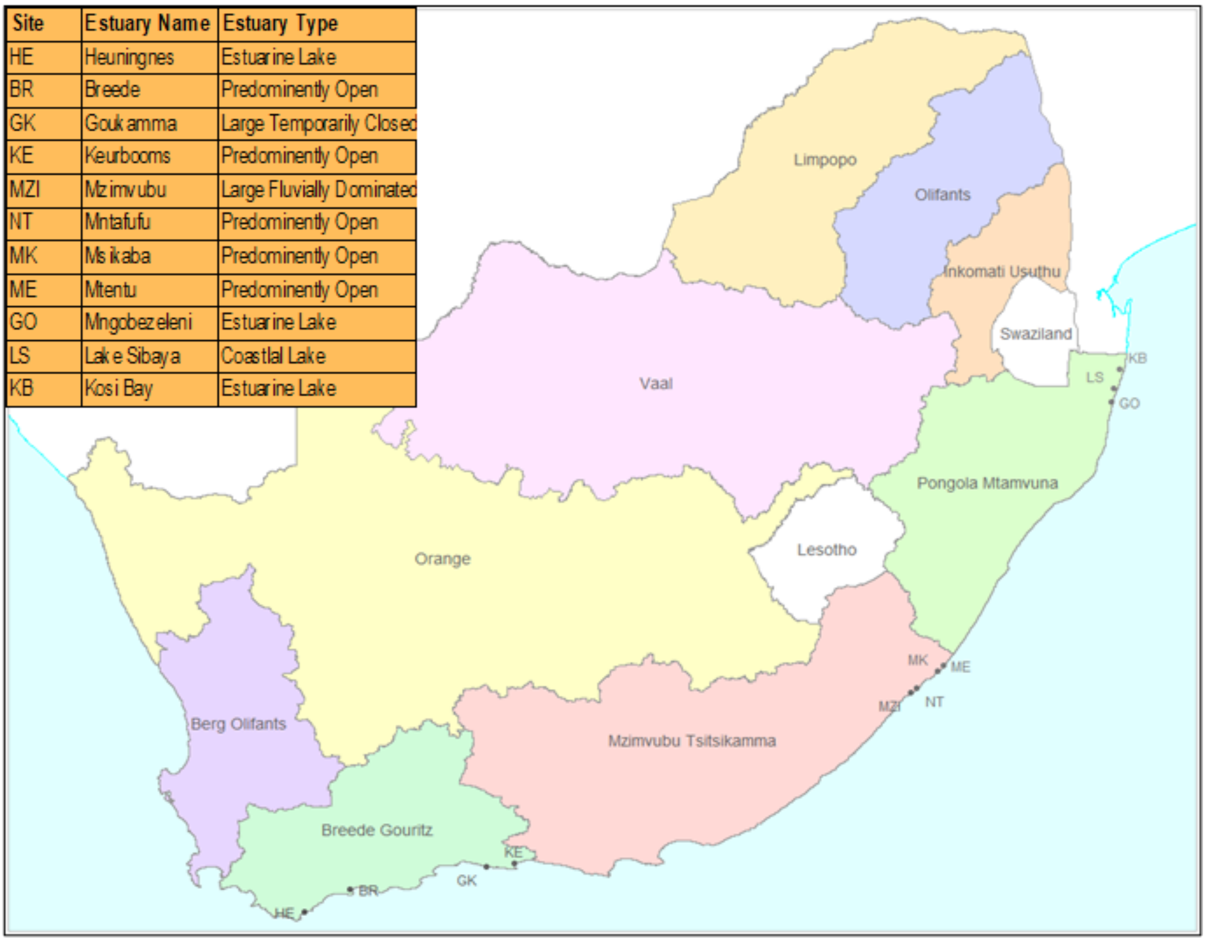


Figure 4.11 The four biogeographical regions (Van Niekerk et al. (2019).

The Tropical sub-region extends from Kosi Bay Estuary to uMgobezeleni Estuary, the Subtropical from St Lucia Estuary to Mbashe Estuary, the Warm Temperate zone is from the Mendwana Estuary to Heuningnes Estuary near Cape Agulhas, and the Cool Temperate zone from Ratel Estuary and ends at the Orange River mouth in the Northern Cape.

South African estuaries were classified into five categories (Whitfield, 1992) and have been refined into nine categories (Van Niekerk, 2019), i.e., estuarine lakes, estuarine bay, estuarine lagoon, predominantly open estuaries, large temporary closed estuaries, small temporary closed estuaries, large fluvial dominated river mouth, small fluvial dominated river mouth, arid predominantly closed. The individual systems may change from one type to another under the influence of natural events or anthropogenic influences.

In the current reporting period, eleven estuaries were monitored as part of tier one (Figure 4.12). Tier 1 involves the collection of basic physico-chemical data to develop a long-term database and establish baseline dataset of the most important drivers within estuaries.



Site	Estuary Name	Estuary Type
HE	Heuningnes	Estuarine Lake
BR	Breede	Predominently Open
GK	Goukamma	Large Temporarily Closed
KE	Keurbooms	Predominently Open
MZI	Mzimvubu	Large Fluvially Dominated
NT	Mntafufu	Predominently Open
MK	Msikaba	Predominently Open
ME	Mtentu	Predominently Open
GO	Mngobezeleni	Estuarine Lake
LS	Lake Sibaya	Coastlal Lake
KB	Kosi Bay	Estuarine Lake

Figure 4.12 Estuaries monitored during 2020/21 hydrological year

The Breede estuary experienced moderately low pH levels during the year 2020/2021 while Mzimvubu, Mntafufu, and Msikaba estuaries experienced high pH levels (Figure 4.13). High pH levels are an attribute of runoff from palm tree plantations higher up in the catchment. Temperatures remained between medium to high throughout the hydrological cycle. All estuaries were well-oxygenated with an oxygen concentration of greater than 5 mg/L, apart from Goukamma, which had less than 4 mg/L of oxygen. Low oxygen concentrations impact heavily on the biota and may cause a fish kill.

High salinity and electrical conductivity values are due to seawater intrusion into these estuarine systems. Heuningnes, Keurbooms, Mntafufu, Msikaba, and Mtentu estuaries experienced high salinity concentrations; indicative of seawater penetration, thus creating a salinity gradient that drives the biodiversity of estuarine systems. Breede and Mzimvubu estuaries experienced low salinity concentrations, indicative of high freshwater flow from higher up the catchment into the estuary.

Chlorophyll-a concentrations in the water column (proportional to phytoplankton biomass) remain moderately low to medium throughout the cycle, indicative of low nutrient uptake for phytoplankton growth. Nutrient results remained fairly high in all systems. High ammonium concentrations were detected in all estuaries. Extremely high values were recorded for nitrates + nitrites in all recorded systems. All recorded estuaries exhibited medium concentrations of orthophosphates. These medium nutrient concentrates can be attributed to runoff from agricultural activities from higher up the catchments. Mntafufu, Msikaba, and Mtentu estuaries form part of Pondoland Marine Protected Area, with a high diversity priority rating. High nutrient load in these systems can be attributed to agricultural runoff from higher up the catchments.

Monitoring of estuaries has shown that the southern coastline estuaries of South Africa are exposed to similar pressures as estuaries on the east coast, although on a smaller scale due to catchment size and the nature of the estuarine systems. Southern coastline catchments and estuaries are also exposed to intensive farming and rapid developments with resulting environmental perturbation, thus requiring immediate management intervention.

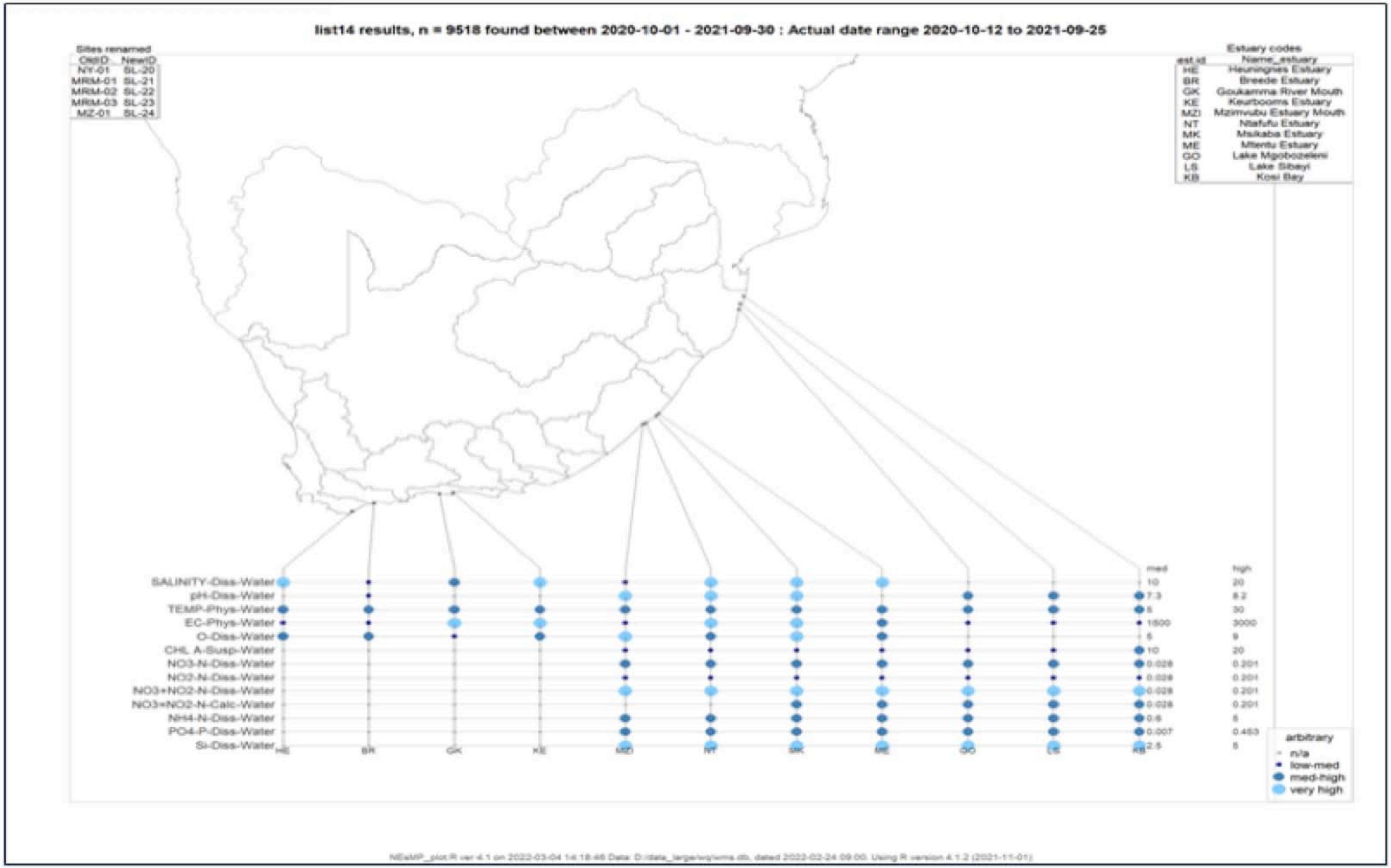


Figure 4.13 Summary findings from 11 estuaries monitored during 2020/2021 hydrological cycle. Right hand side values indicate data range for what would be medium to high concentrations/levels of the variables on the left-hand side