forestry, fisheries & the environment

Department:
Forestry, Fisheries and the Environment
REPUBLIC OF SOUTH AFRICA

South African Environment 2023

SAE 2023

The 2023 summary of South African state of environment and environmental outlook information

Archive Edition

(No live links to source documents, definitions, glossary, references, or information sheets)

Contents

INTRODUCTION

1.1 Purpose

The 1997 White Paper on Environmental Management Policy notes that –

> *Information on the state of the environment and activities with an adverse or damaging effect on it is essential for effective environmental management, protection and coordination. This information is necessary for developing and implementing environmental standards and legislation. The availability and accessibility of such information allows for prevention and mitigation. It also facilitates compliance monitoring and successful participation by interested and affected parties. Information may influence consumer behaviour and raise public and business awareness, encouraging compliance and the prioritisation of environmental issues.*

With this, the policy requires the Department of Forestry, Fisheries and the Environment (DFFE) to report periodically on the state of the South African environment in order to:

- provide accurate, timely and accessible information about the condition and prospects of the South African environment;
- increase public understanding of these issues; and
- report on the effectiveness of policies and programmes designed to respond to environmental change, including progress towards achieving environmental standards and targets.

To this end, the South African Environment 2023 provides decision-makers and the South African public in general with the most recent, accurate, complete, and relevant state of environment information as envisaged by South Africa's Environmental Management Policy.

1.2 The annual SAE update and maintenance cycle

The SAE attempts to provide a summary of, and links to, the most recent information on the state of South Africa's environment and the environmental outlook.

The SAE is updated annually by the State of Environment Report Drafting Team made up of representatives of: (i) all the DFFE's line function branches (climate change and air quality management, chemicals and waste management, biodiversity and conservation, oceans and coasts, fisheries management, forestry management, etc.); (ii) the Department of Water and Sanitation; (iii) the Department's entities – the South African National Biodiversity Institute (SANBI) and the South African Weather Service (SAWS); South African Environmental Observatory Network (SAEON); CapeNature; Water Research Commission (WRC) and (iv) all provincial environmental management departments.

Every year the Drafting Team meets to review the previous year's edition of the SAE, removes any information that is more than four years old and identifies and collects all newly published information for inclusion in the update. This information is, where possible, organised and structured using the international Driver-Pressure-State-Impact-Response (DPSIR) Framework for state of environment reporting.

Annual editions of the SAE are made available on the web in Government's 1st business quarter – April to June – every year.

1.3 SAE 2023 components and content

As noted above, the annual SAE updates exclude components and content that is older than four years although this information is always available in the archive. With this, the SAE 2023 provides a summary of, and links to, the following reports and articles (content contained in earlier SAE updates in *italics*) –

- A Framework for a Just Transition in South Africa: A Presidential Climate Commission Report, 2022;
- Annual Report for Mitigation Action Quantification, 2023;
- Annual State of the Climate South Africa, 2022;
- *Blue Drop Progress Report, 2022;*
- Blue Drop Watch Report, 2023;
- Carbon Budget Methodology Document: A Guideline to Implementing the Tiered Methodological Approach, 2021;
- Changes in Extreme Daily Rainfall Characteristics in South Africa: 1921–2020;
- Country Climate and Development Report, 2022;
- Draft Framework for Sectoral Emission Targets, 2021;
- *Free State Province State of Environment Report, 2019;*
- Gauteng Environmental Sustainability Report, 2022;
- *General Household Survey, 2021;*
- *Green Drop National Report, 2022;*
- *Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6), 2022;*
- *KwaZulu-Natal State of Coast Report, 2022;*
- KwaZulu-Natal Estuary Observer Programme: Summary of Conditions, Pressures and Recommended Management Actions for KwaZulu-Natal Estuaries, 2022;
- *Limpopo Environmental Implementation Plan, 2020-2025;*
- Limpopo Climate Change Strategy, 2022;
- Limpopo Climate Change Response Actions, 2022;
- Major Climate Change-induced Risks to Human Health in South Africa, 2021;
- Mpumalanga Biodiversity Sector Plan, 2023;
- *Municipal Landfill Site Compliance Report of August 2022;*
- *National Air Quality Officer's Report, October 2022;*
- National Climate Risk & Vulnerability Assessment Framework, 2020;
- *National Coastal Climate Change Vulnerability Assessment: Vulnerability Indices, 2020;*
- *National Data Information Report for Marine Spatial Planning, 2021;*
- National Environmental Compliance and Enforcement Report, 2021/22;
- National Greenhouse Gas Inventory Report, South Africa, 2000 – 2020;
- National State of Water Report for South Africa, 2022;
- *North West Climate Risk and Vulnerability Assessment Report, 2021;*
- North West Environmental Implementation Plan Annual Compliance Report, 2022 - 23;
- *North West Greenhouse Gas Emission Inventory, 2020;*

- Oceans and Coasts Annual Science Report, 2022;
- Report of the International Review Panel Regarding Fishing Closures Adjacent to South Africa's African Penguin Breeding Colonies and Declines in the Penguin Population, 2023;
- *South Africa's Protected Area Accounts, 1900 – 2020;*
- South Africa's Natural Capital 3: Accounts for Strategic Water Source Areas, 1990 to 2020;
- *South African National Coastal Assessment Technical Report 1: Hotspot Detection, 2020;*
- *South African National Coastal Assessment Technical Report 2: Case Study Analysis, 2020*
- *Status of Biological Invasion and their Management in South Africa Report, 2019;*
- *Status of the South African Marine Fishery Resources, 2020;*
- Trends in Extreme Climate Indices South Africa, 2022;
- The Effect of Changes in Human Drivers on the Fire Regimes of South African Grassland and Savanna Environments Over the Past 100 years, 2022;
- The Fourth South African Climate Change Tracking Report, 2021;
- The State of Provincial Reserves in South Africa, 2023;
- United Nations Convention to Combat Desertification: Technical Report for South Africa, 2022;
- *Western Cape 2050 Emission Pathway Analysis, 2018;*
- *Western Cape Air Quality Management Report, 2021;*
- *Western Cape Annual State of Waste Report, 2020;*
- *Western Cape Climate Change Response Strategy Vision 2050: A Vision for a Resilient Western Cape, 2022;*
- *Western Cape Climate Change Response Strategy: 3rd Biennial Monitoring and Evaluation Report, 2019/20;*
- *Western Cape Green Economy Report, 2022;*
- *Western Cape Provincial Coastal Management Programme: Annual Implementation Report, 2021/22; and*
- Western Cape State of Conservation Report, 2022.

1.4 The South African Environment website structure

Annual SAE editions are published on the South African Environment website which has been designed to provide the user with an immediate insight into the current state of the South African environment and environmental outlook as well as an overview of, and access to, the detailed sector components of the SAE 2023. Furthermore, given the interconnectedness of the environment, this site also identifies the links and dependencies between the sector reports using the Driver-Pressure-State-Impact-Response (DPSIR) analytical framework. The SAE 2023 also provides convenient 'live-links' to various source documents, definitions and information sheets that provide more detailed information on key subjects. Finally, the SAE attempts to analyse the implications of the findings of the detailed sector components and provides an environmental outlook for the future.

To this end, this website contains –

- ***Key Indicators*** – a series of up-to-date infographics for key environmental indicators that serve as a state of environment 'dashboard' and graphical SAE 2023 'table of contents';
- A brief answer to the question – ***what is the environment?***;
- A brief answer to the question – ***why is the environment important?***;

- An insight into the answer to the question – ***what is the state of our environment?*** This is done through contextualised and edited versions of the executive summaries of each of the detailed sector components and includes sub-sections on - Climate change; State of forests; Biodiversity; Land degradation; Oceans and Coasts; Biological invasions; Air quality; State of water; Marine fisheries resources; Gauteng Province; KwaZulu-Natal Province; Mpumalanga Province; North West Province; Frees State Province; Limpopo Province and Western Cape Province.
- A brief answer to the question – ***why is the environment in this state?***;
- A brief answer to the question – ***what are the implications?***;
- A brief answer to the question – ***what is the outlook?***;
- A brief answer to the question – ***what are we doing about it and is it working?***;
- ***Information Sheets*** – a list of 'live-linked' details of specific indicators, concepts, pollutants, etc. that are too complex to explain in a glossary.

2 WHAT IS THE ENVIRONMENT?

Before we can understand the state of our environment or environmental outlook, we should share a common understanding of what is meant by 'the environment'. Although many South Africans think that 'the environment' is the same as 'nature' – the bushveld with its wildlife and wild natural landscapes – government and most people involved in the environmental sector see the environment as something far more encompassing. For this reason, South Africa's policy on the environment, the 1998 White Paper on Environmental Management Policy, notes the following –

> *"Because the environment means different things to different people it is necessary to start by defining what it means. In this policy the word environment refers to the conditions and influences under which any individual or thing exists, lives or develops. These conditions and influences include: (i) the natural environment including renewable and non-renewable natural resources such as air, water, land and all forms of life; (ii) the social, political, cultural, economic, working and other factors that determine people's place in and influence on the environment; and (iii) natural and constructed spatial surroundings, including urban and rural landscapes and places of cultural significance, ecosystems and the qualities that contribute to their value.*
>
> *Culture, economic considerations, social systems, politics and value systems determine the interaction between people and the environment, the use of natural resources, and the values and meanings that people attach to life forms, ecological systems, physical and cultural landscapes and places. People are part of the environment and are at the centre of concerns for its sustainability."*

South Africa's principal piece of environmental legislation, the National Environmental Management Act No. 107 of 1998, uses the policy's broad definition to provide the legal definition of the environment as follows –

> *"1. Definitions (1)(xi) – 'environment' means the surroundings within which humans exist and that are made up of — (i) the land, water and atmosphere of the earth; (ii) micro-organisms, plant and animal life; (iii) any part or combination of (i) and (ii) and the interrelationships among and between them; and (iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being."*

What this means is that 'the environment' is far broader than 'nature'. The environment is the surroundings or conditions in which a person, animal, or plant lives or operates, i.e., it includes everything around us whether we are at home, work, or play.

Importantly, it is this broad definition of our environment that underpins our 'Environmental Right' outlined in South Africa's Constitution, the Constitution of the Republic of South Africa, Act No. 108 of 1996. Chapter 2 of our Constitution provides the South African 'Bill of Rights', what it refers to as "a cornerstone of democracy in South Africa", and Section 24 says that:

> *Everyone has the right –*
>
> *(a) to an environment that is not harmful to their health or well-being; and*
>
> *(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that-*
>
> > *(i) prevent pollution and ecological degradation;*
> >
> > *(ii) promote conservation; and*
> >
> > *(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.*

Our Environmental Right is sometimes framed positively as “everyone has a right to a safe and heathy environment that promotes and maintains well-being”. With this, the South African Environment 2023 report attempts to provide everyone with current (information published from 2018), accurate, complete and relevant information on the state of the environment and, by extension, it attempts to provide information on whether everyone’s right to a safe and heathy environment that promotes and maintains well-being is being realised.

3 WHY IS THE ENVIRONMENT IMPORTANT?

Good air, good water, good earth – the reason for of all life on this island in space we call Earth. A healthy thriving environment is essential for our personal health and well-being – indeed, our very survival depends on it. The relationship between the environment and humanity is one of interdependence – each affects the other. Therefore, just as our actions and choices affect the environment, the health of the planet influences our own personal health and well-being, as well as that of our families, communities, societies, and economies. Although modern practices, materials and technologies continue to distance humanity from its direct reliance on the natural living environment for food, fresh water, clothing and shelter, our basic dependence on good air, good water and good earth remains. Apart from these basic essentials for life, humans also have an innate connection to the natural environment. Research indicates that just being around greenery can boost mood and lower blood pressure, as well as improve attention and the ability to reflect upon a problem. The interdependence of society, economy and environment is the foundation of the concept of sustainable development, and this is what the late Hon. Peter R Mokaba MP said in his foreword to South Africa's Environmental Management Policy –

> *"When the Rio Earth Summit convened in 1992 the world came of age. The decision to adopt and promote Sustainable Development was a defining moment in the history of social progress, peace, and development. The seminal agreements reached at that august summit and the strategies adopted to achieve them in the 21st century and beyond, could not have come at a more opportune moment for the billions of people on the planet. They represented an idea whose time had come.*
>
> *The Rio agreements moved us, the world's people, closer to the objective of living in harmony with our environment. At Rio we affirmed the reality and truth that development and environmental issues and goals are one. Indeed, we demonstrated that the first principle of conservation is development; that sustainable development depends on good environmental management just as good environmental management depends on sustainable development. At the time Rio was convened the world was crying out for good governance, for democracy, for human rights and for an improved quality of life for our generation and those to come. At Rio the world woke up to the reality that unless we incorporate environmental considerations into our development planning, implementation and evaluation, the future of our species, and of all the other species that constitute the biodiversity and natural balance of our planet, cannot be assured."*

Our Constitution, the highest law of the land, fully recognises the interdependence of society, economy and environment through its Environmental Right– everyone's right to an environment that is not harmful to health and well-being. Despite this clear acknowledgement of the interdependence of society, economy and environment for our health and well-being, modern society appears to be increasingly forgetting why the environment is important.

In an attempt to reconnect modern society with the natural environment, many in the environment sector are attempting to use economic and development concepts and language to explain why the environment is important. Two examples of these attempts are the concepts of ecological infrastructure and ecosystem services.

With respect to the former, infrastructure is often broadly defined as the substructure or underlying foundation on which the continuance or growth of a community or state depends. Similarly, ecological infrastructure is the networks of natural lands, working landscapes and other open spaces that are the substructure or underlying foundation on which the continuance or growth of essential life-supporting and life-enhancing ecosystem goods and services depends. Ecological infrastructure refers to naturally functioning ecosystems that deliver valuable services to people, such as fresh water, climate regulation, soil formation and disaster risk reduction. It is the nature-based equivalent of built or hard infrastructure, and it is just as important for providing services and

underpinning socio-economic development. Ecological infrastructure includes, for instance, healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat, which together form a network of interconnected structural elements in the landscape.

Ecosystem services are the many and varied benefits that we get for free from the natural environment and properly-functioning ecosystems – ecological infrastructure. While scientists and environmentalists are still debating the concept, for simplicity, ecosystem services may be grouped into four broad categories: provisioning, such as the production of food and water; regulating, such as the control of climate and disease; cultural, such as spiritual and recreational benefits; and supporting, such as nutrient cycles and oxygen production - where the so-called supporting services are regarded as the basis for the services of the other three categories. In terms of supporting services, these include services such as nutrient recycling, primary production, soil formation, habitat provision and pollination. These services make it possible for ecosystems to continue providing services such as food supply, flood regulation, and water purification.

Provisioning services include: food (e.g. seafood and game), crops, wild foods, and spices; raw materials (including timber, skins, fuel wood, organic matter, fodder, and fertilizer); genetic resources (including crop improvement genes, and health care); water; biogenic minerals; medicinal resources (including medicinal plants, pharmaceuticals, chemical models, and test and assay organisms); energy (hydropower, biomass fuels); ornamental resources (including fashion, handicraft, jewellery, pets, worship, decoration and souvenirs like furs, feathers, ivory, orchids, butterflies, aquarium fish, shells, etc.).

Regulating services include: carbon sequestration and climate regulation; predation that regulates prey populations (including so-called pest populations); waste decomposition and detoxification; purification of water and air; and pest and disease control.

Cultural services include: cultural (including use of nature as motif in books, film, painting, folklore, national symbols, architect, advertising, etc.); spiritual and historical (including use of nature for religious or heritage value or natural); recreational experiences (including ecotourism, outdoor sports, and recreation); science and education (including use of natural systems for school excursions, and scientific discovery); Therapeutic (including Ecotherapy, social forestry and animal assisted therapy)

In summary, and put very simply – the environment is important because if it gets sicker and sadder, we get sicker and sadder. If it is healthy and happy, we are healthy and happy.

4 WHAT IS THE STATE OF OUR ENVIRONMENT?

4.1 Climate change

The following section comprises edited extracts from the Intergovernmental Panel on Climate Change's Sixth Assessment Report, South Africa's 8th National Greenhouse Gas (GHG) Inventory Report 2000 to 2020, the Annual State of Climate 2022 report and the Trends in Extreme Climate Indices in South Africa 2022 report. Although the following is an attempt to provide the reader with the key points covered in these reports, readers are encouraged to read the reports themselves for more, in-depth, fully referenced, information on the state of South Africa's climate.

4.1.1 Global climate change

The following section is an edited extract of the Intergovernmental Panel on Climate Change's 2022 Sixth Assessment Report with a focus on information relevant to Africa, southern Africa, and South Africa in particular. Readers are encouraged to read the report for more, in-depth, fully referenced information.

The Intergovernmental Panel on Climate Change (IPCC) periodically prepares comprehensive assessment reports related to climate change including the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place. It also produces special reports on topics agreed to by its member governments, as well as methodology reports that provide guidelines for the preparation of greenhouse gas inventories. As with previous IPCC assessment reports, the 6th report consists of contributions from three Working Groups and a Synthesis Report. The Working Group I contribution was finalized in August 2021 and the Working Group II contribution in February 2022 and the Working Group III contribution was finalised in April 2022.

4.1.1.1 Working Group I: The physical science basis

The Working Group I (WG I) contribution to the Sixth Assessment Report provides the most up-to-date physical understanding of the climate system and climate change, bringing together the latest advances in climate science (https://www.ipcc.ch/report/ar6/wg1/). The following headline statements summarise the main conclusions of the WG I report (https://www.ipcc.ch/report/ar6/wg1/resources/spm-headline-statements/):

- It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.
- The scale of recent changes across the climate system as a whole – and the present state of many aspects of the climate system – are unprecedented over many centuries to many thousands of years.
- Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since the Fifth Assessment Report (AR5).
- Improved knowledge of climate processes, paleoclimate evidence and the response of the climate system to increasing radiative forcing gives a best estimate of equilibrium climate sensitivity of 3°C, with a narrower range compared to the Fifth Assessment Report (AR5).

4.1.1.2 Working Group II: Impacts and adaptation vulnerability

The Working Group II (WG II) contribution to the Sixth Assessment Report assesses the impacts of climate change, looking at ecosystems, biodiversity, and human communities at global and regional levels. See section 6.6 of their report for more details.

WG II also reviews vulnerabilities and the capacities and limits of the natural world and human societies to adapt to climate change (https://www.ipcc.ch/report/sixth-assessment-report-working-group-ii/). The main conclusions of the WG II report can be accessed through (https://www.ipcc.ch/report/ar6/wg2/resources/spm-headline-statements/), and could be summarised as follows –

In terms of current adaptation and its benefits, progress in adaptation planning and implementation has been observed across all sectors and regions, generating multiple benefits. However, adaptation progress is unevenly distributed with observed adaptation gaps. Many initiatives prioritize immediate and near- term climate risk reduction which reduces the opportunity for transformational adaptation.

There are feasible and effective adaptation options which can reduce risks to people and nature. The feasibility of implementing adaptation options in the near-term differs across sectors and regions. The effectiveness of adaptation to reduce climate risk is different for specific contexts, sectors and regions but will decrease with increasing warming. Integrated, multi-sectoral solutions that address social inequities, differentiate responses based on climate risk and cut across systems, increase the feasibility and effectiveness of adaptation in multiple sectors.

Soft limits to some human adaptations have been reached but can be overcome by addressing a range of constraints, primarily financial, governance, institutional and policy constraints. Hard limits to adaptation have been reached in some ecosystems. With increasing global warming, losses and damages will increase and additional human and natural systems will reach adaptation limits.

There is increased evidence of maladaptation across many sectors and regions since the AR5. Maladaptive responses to climate change can create lock-ins of vulnerability, exposure and risks that are difficult and expensive to change and exacerbate existing inequalities. Maladaptation can be avoided by flexible, multi-sectoral, inclusive and long-term planning and implementation of adaptation actions with benefits to many sectors and systems.

Enabling conditions are key for implementing, accelerating and sustaining adaptation in human systems and ecosystems. These include political commitment and follow-through, institutional frameworks, policies and instruments with clear goals and priorities, enhanced knowledge on impacts and solutions, mobilization of and access to adequate financial resources, monitoring and evaluation, and inclusive governance processes.

4.1.1.3 Working Group III: Mitigation of climate change

Working Group III (WG III) focuses on climate change mitigation, assessing methods for reducing greenhouse gas emissions, and removing greenhouse gases from the atmosphere. The Working Group III contribution in the Sixth Assessment Report provides an updated global assessment of climate change mitigation progress and pledges and examines the sources of global emissions. It explains developments in emission reduction and mitigation efforts, assessing the impact of national climate pledges in relation to long-term emissions goals (https://www.ipcc.ch/report/ar6/wg3/). The main conclusions of the WG III report can be accessed through (https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf), and could be summarised as follows –

Recent developments and current trends

- Total net anthropogenic greenhouse gas emissions have continued to rise during the period 2010–2019, as have cumulative net CO_2 emissions since 1850. Average annual greenhouse gas emissions during 2010–2019 were higher than in any previous decade, but the rate of growth between 2010 and 2019 was lower than that between 2000 and 2009.
- Net anthropogenic greenhouse gas emissions have increased since 2010 across all major sectors globally. An increasing share of emissions can be attributed to urban areas. Emissions reductions in CO_2 from fossil

fuels and industrial processes (CO_2-FFI), due to improvements in energy intensity of GDP and carbon intensity of energy, have been less than emissions increase from rising global activity levels in industry, energy supply, transport, agriculture and buildings.

- Regional contributions to global GHG emissions continue to differ widely. Variations in regional and national per capita emissions partly reflect different development stages, but they also vary widely at similar income levels. The 10 percent of households with the highest per capita emissions contribute a disproportionately large share of global household greenhouse gas emissions. At least 18 countries have sustained greenhouse gas emission reductions for longer than 10 years.
- The unit costs of several low-emission technologies have fallen continuously since 2010. Innovation policy packages have enabled these cost reductions and supported global adoption. Both tailored policies and comprehensive policies addressing innovation systems have helped overcome the distributional, environmental and social impacts potentially associated with global diffusion of low-emission technologies. Innovation has lagged in developing countries due to weaker enabling conditions. Digitalisation can enable emission reductions but can have adverse side effects unless appropriately governed.
- There has been a consistent expansion of policies and laws addressing mitigation since the Fifth Assessment Report. This has led to the avoidance of emissions that would otherwise have occurred and increased investment in low- greenhouse gas technologies and infrastructure. Policy coverage of emissions is uneven across sectors. Progress on the alignment of financial flows towards the goals of the Paris Agreement remains slow and tracked climate finance flows are distributed unevenly across regions and sectors.
- Global greenhouse gas emissions in 2030 associated with the implementation of Nationally Determined Contributions (NDCs) announced prior to COP26 would make it likely that warming will exceed 1.5°C during the 21st century. Limiting warming to below 2°C would then rely on a rapid acceleration of mitigation efforts after 2030. Policies implemented by the end of 2020 are projected to result in higher global greenhouse gas emissions than those implied by NDCs.
- Projected cumulative future CO_2 emissions over the lifetime of existing and currently planned fossil fuel infrastructure without additional abatement exceed the total cumulative net CO_2 emissions in pathways that limit warming to 1.5°C (>50%) with no or limited overshoot. They are approximately equal to total cumulative net CO_2 emissions in pathways that limit warming to 2°C (>67%).

System transformations to limit global warming

- Global greenhouse gas emissions are projected to peak between 2020 and at the latest before 2025 in global modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot and in those that limit warming to 2°C (>67%) and assume immediate action. In both types of modelled pathways, rapid and deep GHG emissions reductions follow throughout 2030, 2040 and 2050. Without a strengthening of policies beyond those that are implemented by the end of 2020, greenhouse gas emissions are projected to rise beyond 2025, leading to a median global warming of 3.2 (2.2 to 3.5) °C by 2100.
- Global net zero CO_2 emissions are reached in the early 2050s in modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot, and around the early 2070s in modelled pathways that limit warming to 2°C (>67%). Many of these pathways continue to net negative CO_2 emissions after the point of net zero. These pathways also include deep reductions in other GHG emissions. The level of peak warming depends on cumulative CO_2 emissions until the time of net zero CO_2 and the change in non-CO_2 climate forcers by the time of peaking. Deep greenhouse gas emissions reductions by 2030 and 2040, particularly reductions of methane emissions, lower peak warming, reduce the likelihood of overshooting warming limits and lead to less reliance on net negative CO_2 emissions that reverse warming in the latter half of the century. Reaching and sustaining global net zero greenhouse gas emissions results in a gradual decline in warming.

- All global modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot, and those that limit warming to 2°C (>67%), involve rapid and deep and in most cases immediate greenhouse gas emission reductions in all sectors. Modelled mitigation strategies to achieve these reductions include transitioning from fossil fuels without carbon capture and storage (CCS) to very low- or zero-carbon energy sources, such as renewables or fossil fuels with CCS, demand side measures and improving efficiency, reducing non-CO_2 emissions, and deploying carbon dioxide removal (CDR) methods to counterbalance residual greenhouse gas emissions. Illustrative Mitigation Pathways (IMPs) show different combinations of sectoral mitigation strategies consistent with a given warming level.
- Reducing greenhouse gas emissions across the full energy sector requires major transitions, including a substantial reduction in overall fossil fuel use, the deployment of low-emission energy sources, switching to alternative energy carriers, and energy efficiency and conservation. The continued installation of unabated fossil fuel infrastructure will 'lock-in' greenhouse gas emissions.
- Net zero CO_2 emissions from the industrial sector are challenging but possible. Reducing industry emissions will entail coordinated action throughout value chains to promote all mitigation options, including demand management, energy and materials efficiency, circular material flows, as well as abatement technologies and transformational changes in production processes. Progressing towards net zero greenhouse gas emissions from industry will be enabled by the adoption of new production processes using low- and zero-greenhouse gas electricity, hydrogen, fuels, and carbon management.
- Urban areas can create opportunities to increase resource efficiency and significantly reduce greenhouse gas emissions through the systemic transition of infrastructure and urban form through low-emission development pathways towards net-zero emissions. Ambitious mitigation efforts for established, rapidly growing and emerging cities will encompass (i) reducing or changing energy and material consumption, (ii) electrification, and (iii) enhancing carbon uptake and storage in the urban environment. Cities can achieve net-zero emissions, but only if emissions are reduced within and outside of their administrative boundaries through supply chains, which will have beneficial cascading effects across other sectors.
- In modelled global scenarios, existing buildings, if retrofitted, and buildings yet to be built, are projected to approach net zero greenhouse gas emissions in 2050 if policy packages, which combine ambitious sufficiency, efficiency, and renewable energy measures, are effectively implemented and barriers to decarbonisation are removed. Low ambition policies increase the risk of locking-in buildings' carbon for decades, while well-designed and effectively implemented mitigation interventions (in both new buildings and existing ones if retrofitted), have significant potential to contribute to achieving Sustainable Development Goals in all regions while adapting buildings to future climate.
- Demand-side options and low- greenhouse gas emissions technologies can reduce transport sector emissions in developed countries and limit emissions growth in developing countries. Demand-focused interventions can reduce demand for all transport services and support the shift to more energy efficient transport modes. Electric vehicles powered by low-emissions electricity offer the largest decarbonisation potential for land-based transport, on a life cycle basis. Sustainable biofuels can offer additional mitigation benefits in land-based transport in the short and medium term. Sustainable biofuels, low-emissions hydrogen, and derivatives (including synthetic fuels) can support mitigation of CO_2 emissions from shipping, aviation, and heavy-duty land transport but require production process improvements and cost reductions. Many mitigation strategies in the transport sector would have various co-benefits, including air quality improvements, health benefits, equitable access to transportation services, reduced congestion, and reduced material demand.
- Agriculture, Forestry and Other Land Use (AFOLU) mitigation options, when sustainably implemented, can deliver large-scale greenhouse gas emission reductions and enhanced removals, but cannot fully compensate for delayed action in other sectors. In addition, sustainably sourced agricultural and forest

products can be used instead of more greenhouse gas-intensive products in other sectors. Barriers to implementation and trade-offs may result from the impacts of climate change, competing demands on land, conflicts with food security and livelihoods, the complexity of land ownership and management systems, and cultural aspects. There are many country-specific opportunities to provide co-benefits (such as biodiversity conservation, ecosystem services, and livelihoods) and avoid risks (for example, through adaptation to climate change).

- Demand-side mitigation encompasses changes in infrastructure use, end-use technology adoption, and socio-cultural and behavioural change. Demand-side measures and new ways of end-use service provision can reduce global GHG emissions in end-use sectors by 40–70% by 2050 compared to baseline scenarios, while some regions and socioeconomic groups require additional energy and resources. Demand-side mitigation response options are consistent with improving basic well-being for all.
- The deployment of Carbon Dioxide Removal (CDR) to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO_2 or greenhouse gas emissions are to be achieved. The scale and timing of deployment will depend on the trajectories of gross emission reductions in different sectors. Upscaling the deployment of CDR depends on developing effective approaches to address feasibility and sustainability constraints especially at large scales.
- Mitigation options costing USD100 tCO_2-eq– or less could reduce global greenhouse gas emissions by at least half the 2019 level by 2030. Global GDP continues to grow in modelled pathways but, without accounting for the economic benefits of mitigation action from avoided damages from climate change nor from reduced adaptation costs, it is a few percent lower in 2050 compared to pathways without mitigation beyond current policies. The global economic benefit of limiting warming to 2°C is reported to exceed the cost of mitigation in most of the assessed literature.

Linkages between Mitigation, Adaptation, and Sustainable Development

Accelerated and equitable climate action in mitigating, and adapting to, climate change impacts is critical to sustainable development. Climate change actions can also result in some trade-offs. The trade-offs of individual options could be managed through policy design. The Sustainable Development Goals adopted under the UN 2030 Agenda for Sustainable Development can be used as a basis for evaluating climate action in the context of sustainable development.

There is a strong link between sustainable development, vulnerability and climate risks. Limited economic, social and institutional resources often result in high vulnerability and low adaptive capacity, especially in developing countries. Several response options deliver both mitigation and adaptation outcomes, especially in human settlements, land management, and in relation to ecosystems. However, land and aquatic ecosystems can be adversely affected by some mitigation actions, depending on their implementation. Coordinated cross-sectoral policies and planning can maximise synergies and avoid or reduce trade-offs between mitigation and adaptation.

Enhanced mitigation and broader action to shift development pathways towards sustainability will have distributional consequences within and between countries. Attention to equity and broad and meaningful participation of all relevant actors in decision-making at all scales can build social trust and deepen and widen support for transformative changes.

4.1.2 South Africa's greenhouse gas emissions

The following section is an edited extract of South Africa's 8th National Greenhouse Gas Inventory Report for the years 2000 to 2020, and the 2023 Annual Report for Mitigation Action Quantification, and readers are encouraged to read the reports for more in-depth, fully referenced, information on South Africa's greenhouse gas emissions.

The United Nations Framework Convention on Climate Change (UNFCCC) was signed by South Africa in 1993 and ratified in 1997. All countries that ratified the Convention (the Parties) are required to address climate change, including monitoring trends in anthropogenic greenhouse gas (GHG) emissions. One of the principal commitments made by the ratifying Parties under the Convention was to develop, publish and regularly update national emission inventories of greenhouse gases. Parties are also obligated to protect and enhance carbon sinks and reservoirs, for example forests, and implement measures that assist in national and/or regional climate change adaptation and mitigation.

South Africa compiled its first national GHG inventory in 1998 using activity data for the year 1990. The second national GHG inventory for the year 1994 was compiled and published in 2004. Both the 1990 and 1994 inventories were compiled on the 1996 IPCC Guidelines.

The third national GHG inventory was compiled in 2009 using activity data from 2000. For that inventory, the IPCC 2006 Guidelines were introduced, although not fully implemented for the Agriculture, Forestry and Other Land Use (AFOLU) sector. In 2014 South Africa prepared its fourth national inventory, which included annual emission estimates for 2000 to 2010. This was the first inventory to show annual estimates and trends across the time series. The inventory was then updated in 2016 for the years 2000 to 2012; in 2018 for the years 2000 to 2015; and in 2021 for the period 2000 to 2017.

The 2020 national inventory report for South Africa provides estimates of South Africa's net GHG emissions for the period 2000 to 2020, and is South Africa's 8th inventory report. The report has been compiled in accordance with the 2006 IPCC Guidelines, the *2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol* (IPCC, 2014a) and the 2019 Refinement. The report covers sources of GHG emissions, and removals by sinks, resulting from human (anthropogenic) activities for the major greenhouse gases: CO_2, CH_4, N_2O, PFCs, and HFCs. The indirect greenhouse gases, CO, NOX and NMVOCs are also included for biomass burning. The gases are reported under four sectors: *Energy*; *Industrial Processes and Product Use* (IPPU); *Agriculture, Forestry and Other Land Use* (AFOLU); and *Waste*. Sulphur hexafluoride (SF6) emissions have not yet been included due to a lack of data, however, DFFE has set a threshold for SF6 in the new GHG reporting regulation so that companies will start reporting SF6 data going forward.

4.1.2.1 Energy sector

South Africa's GDP is the 30th highest in the world, but in primary energy consumption South Africa is ranked 17th in the world. Its energy intensity is high mainly because the economy is dominated by large-scale, energy-intensive primary minerals beneficiation industries and mining industries. Furthermore, there is a heavy reliance on fossil fuels for the generation of electricity and for a significant proportion of the liquid fuels consumed in the country. The energy sector is critical to the South African economy because it accounts for a total of 15% of the GDP.

Total emissions from the Energy sector for 2020 were estimated to be 379 505 Gg CO_2e which is 81.0% of the total emissions (excl. FOLU) for South Africa. Energy industries were the main contributor, accounting for 62.4% of emissions from the Energy sector. This was followed by Transport (12.7%) and Manufacturing industries and construction (8.8%). Energy sector emissions increased by 2.2% between 2000 and 2020. The emissions increased between 2000 and 2009, then declined to 2014 after which total emissions were stable until 2019. Emissions declined by 6.8% in 2020. The main contributor to the decline is a 19.7% reduction in emissions from other sectors and a 13.7% reduction in Transport emissions. These reductions can be attributed to the reduced travel and trading during the COVID-19 lockdown restrictions. Energy emissions declined by 5.6% since 2017. The main contributors to the decrease were the energy industries and transport which decreased by 5.1% (12 679 Gg CO_2e) and 10.4% (5 590 Gg CO_2e) respectively. The Other sectors and Non-specified sectors collectively decreased by 18%. The decrease in other sectors is due to the change in allocation of fuel, of which the most is sub-bituminous coal. The Fugitive emissions sector emissions decreased by 0.06%.

Table: Change in sector emissions since 2000 and 2020

	Emissions (Gg CO_2e)			Change 2000 to 2020		Change 2017 to 2020	
	2000	2017	2020	Gg CO_2e	%	Gg CO_2e	%
Energy	371 344.6	401 901.4	379 505.2	8 160.5	2.2	-22 396.3	-5.6
IPPU	32 955.2	32 261.0	25 486.1	-7 469.1	-22.7	-6 774.9	-21.0
AFOLU (excl. FOLU)	42 439.1	42 488.1	40 774.6	-1 664.5	-3.9	-1 713.5	-4.0
AFOLU (incl. FOLU)	23 343.8	23 905.1	14 088.0	-9 255.8	-39.7	-9 817.1	-41.1
Waste	18 241.2	21 699.3	23 045.8	4 804.6	26.3	1 346.5	6.2

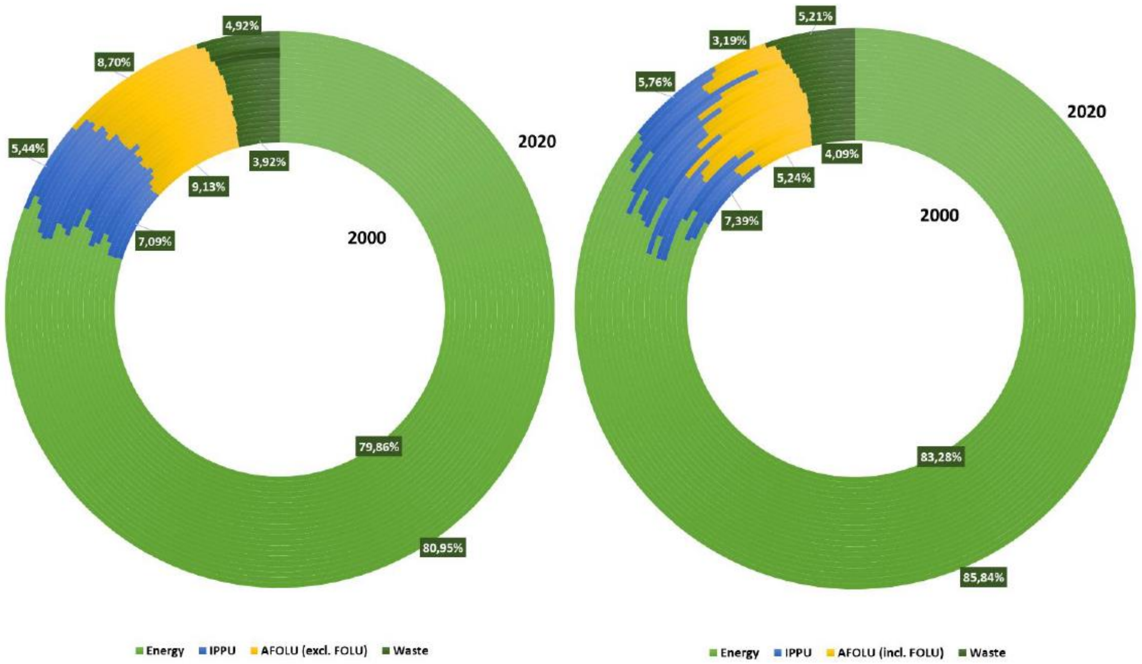


Figure: Sector contribution to total emissions excluding FOLU and including FOLU in South Africa between 2000 and 2022

4.1.2.2 Industrial Processes and Product Use (IPPU) sector

In 2020 the Industrial Processes and Product Use (IPPU) sector produced 25 486 Gg CO_2e, which is 5.4 % of South Africa's emission (excluding FOLU). The largest source category is the metal industry category, which contributes 48% to the total IPPU sector emissions. Iron and steel production and ferroalloys production are the biggest CO_2 contributors to the metal industry subsector, producing 3 853 Gg CO_2 (31.5%) and 7 069 Gg CO_2 (57.8%), respectively, to the total metal industry CO_2 emissions. The mineral industry and the product used as substitutes for ozone depleting substances subsectors contribute 18.7% and 19.4%, respectively, to the IPPU sector emissions. Carbide production, carbon black production, iron and steel production, ferroalloy production and ammonia production produce 576 Gg CO_2e of CH_4, while chemical industries are estimated to produce 836 Gg CO_2e of N_2O.

Estimated emissions from the IPPU sector are 7 469 Gg CO_2e (22.7%) lower than the emissions in 2000. There was a decline in cement production, iron and steel production and paraffin wax usage in 2020 compared to 2019. An increase in production was observed in ferroalloy production since 2019. There was an overall decrease in IPPU emissions in 2020 due to a decrease in the mineral industry of 18.4% since 2019. Emissions also decreased by 1.9% in the metal industry and 34.3% in subsector non-energy products from fuels and solvent use. IPPU emissions increased by 18.0% between 2000 and 2006, after which there was a 13.6% decline to 2009. This decrease was mainly due to the global economic recession and the electricity crisis that occurred in South Africa during this period. In 2010 emissions increased by 6.9% due to an increase in the metal industry and products used as substitutes for ozone depleting substances subsectors. The economy was beginning to recover from the global recession. Another reason for the increase in GHG emissions in 2010 was that South Africa hosted the 2010 FIFA World Cup and as a result an increase in demand for commodities was experienced.

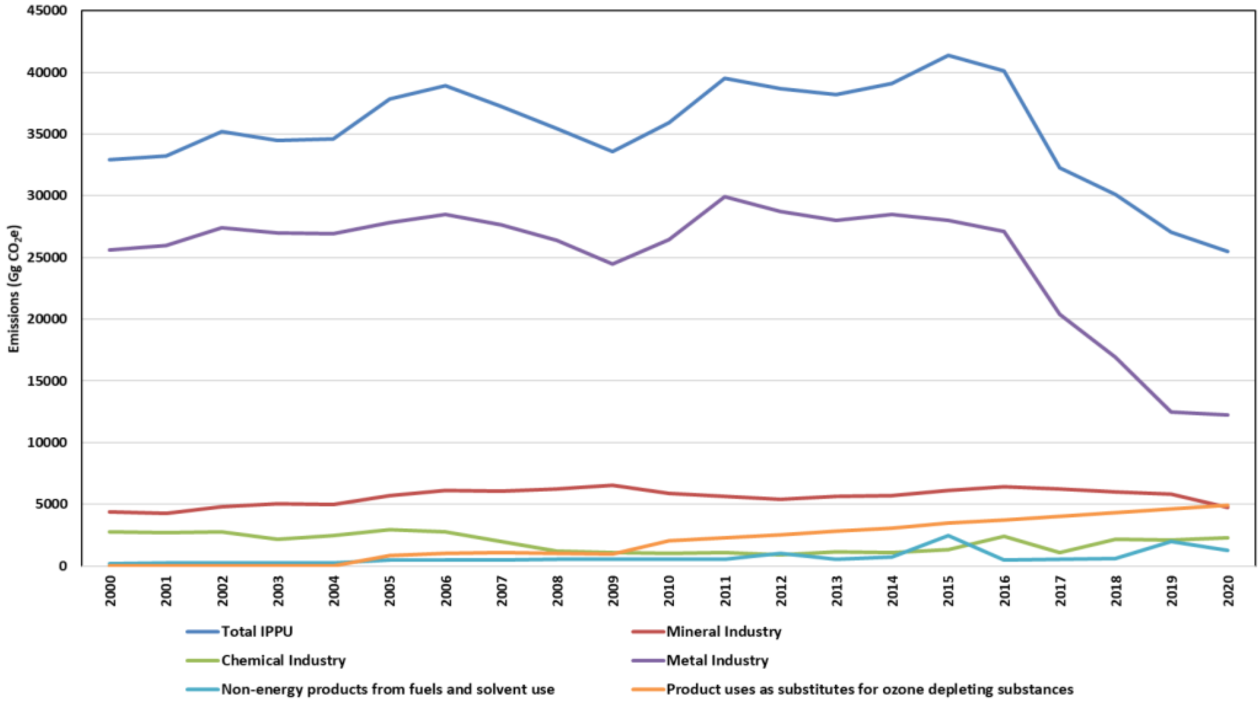


Figure: Trend in South Africa's IPPU sector emissions, 2000 – 2020

Emissions increased between 2010 and 2016 mainly due to an increase in production in the mineral and metal industries. There was an increase of 8.9% during this time within the mineral industry and an increase of 2.5% within the metal industry. The overall increase between 2010 and 2016 was 11.7%. Emissions decreased by 19.6% between 2016 and 2017 as demand in the chemical and metal industry dropped. Emissions within the sector decreased further from 2017 to 2020 by 21% due to lower production demands in the mineral, chemical and metal industry. The economy in 2020 was further strained due to the COVID-19 pandemic and stringent lockdown regulations xviii GHG Inventory for South Africa: 2000 - 2020 within South Africa. The mineral industry emissions decreased by 23.7% (1 483 Gg CO_2e) since 2017, and the metal industry showed an overall decrease of 40.0% (8 150 Gg CO_2e).

4.1.2.3 Agriculture, Forestry and Land Use (AFOLU) sector

The overall AFOLU emissions totalled 14 088 Gg CO_2e (incl. FOLU) in 2020, and 40 775 Gg CO_2e excluding FOLU. Livestock contributed 31 372 Gg CO_2e (76.9% of total excl. FOLU). Aggregated and non-CO_2 emissions on land contributed 23.1% to the AFOLU (excl. FOLU) emissions in 2020, and the largest contributor to this category is Direct N_2O from managed soils (56.1%). Nitrogen inputs from urine and dung contributed 14.9% to direct N_2O emissions, while 57.5% comes from crop residues and 19% from inorganic fertilisers. For the Land category the largest contributor to the sink is Forest land (24 575 GgCO_2e), followed by Grasslands (11 084 GgCO_2e). Other land use (6 125 GgCO_2e) is the main contributor to the source in the Land category.

There was a 3.9% decline in emissions (excl. FOLU) and a 39.7% decline in emissions including FOLU between 2000 and 2020. Enteric fermentation emissions have shown a steady decline throughout the time series following the livestock population trend. The other cattle population has declined by 12.5% since 2014 which contributes to the decline in emissions to 2020. Other cattle and sheep were the largest contributors to the Enteric fermentation emissions. Emissions from manure management increased by 11.8% between 2000 and 2020 and this is because most managed manure is on dairy, pig and poultry farms and these livestock have been increasing in numbers over this period. Emissions from aggregated and non-CO_2 emissions on land have shown a steady increase between 2000 and 2020.

The Land sector sink declined between 2000 and 2008, after which it increased to 2020. The sink was largest in 2016 due to increasing forest land and reduced losses through fuelwood collection and biomass burning. The sink declined in 2017 and 2018 but increased again thereafter. AFOLU emissions (excl. FOLU) declined by 4.0% between 2017 and 2020, due to a 4.6% and 2.2% decline in Livestock and Aggregated and non-CO_2 emissions on land. On the other hand, AFOLU emissions (incl. FOLU) declined by 41.1% over the same period due to a 51.8% increase in the land sink over this time.

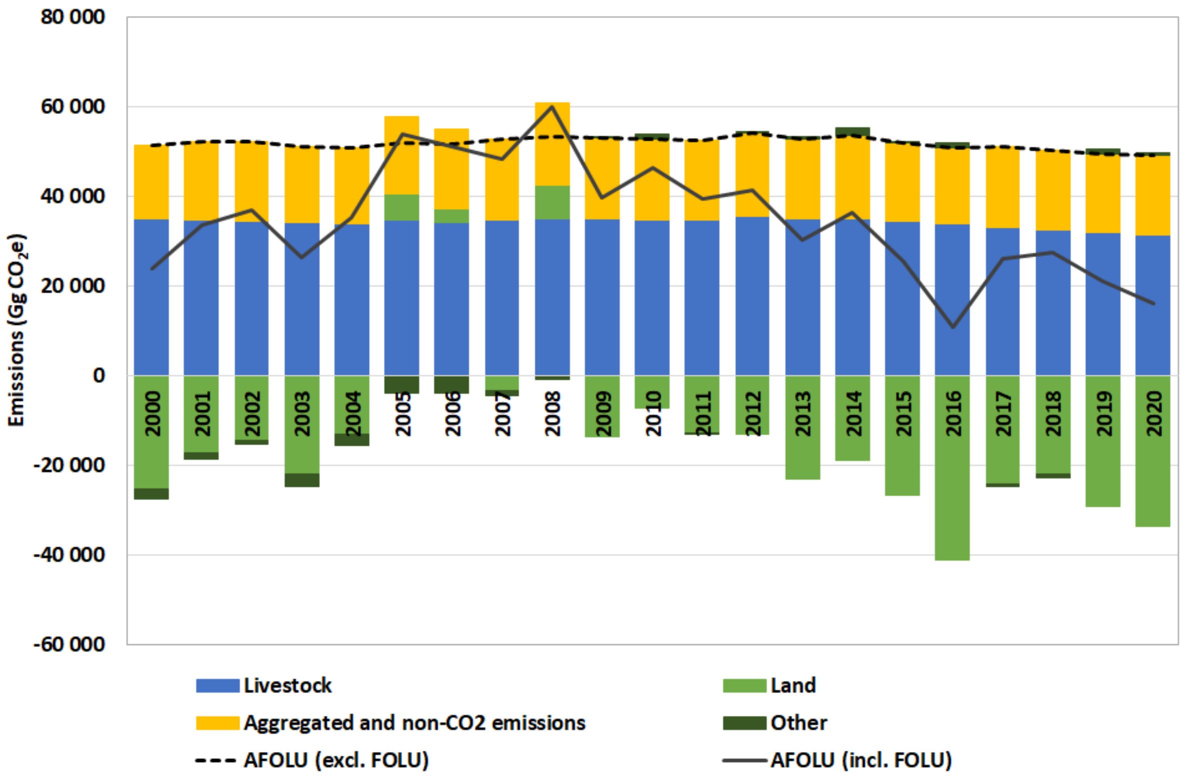


Figure: The overall AFOLU emissions for South Africa for year 2000 – 2020

4.1.2.4 Waste sector

In South Africa the total *Waste* sector emissions for 2020 were 23 046 Gg CO_2e. Most of these emissions are from solid waste disposal contributing 18 253 Gg CO_2e (79.2%) of the total Waste sector emissions. Wastewater treatment and discharge contributed a further 4 458 Gg CO_2e (19.3%) of waste emissions while open burning of waste contributed 335 Gg CO_2e (1.5%). Emissions from biological treatment of solid waste were estimated to be insignificant (0.0011) Gg CO_2e.

Solid waste disposal emissions have increased 34.1% since 2000. Incineration and open burning of waste emissions increased by 90.2% since 2000, while emissions from wastewater treatment and discharge remained stable throughout the time series. This is largely driven by increases of 42.6% in domestic wastewater treatment emissions, whilst there was a 54.2% decline in industrial wastewater treatment and discharge emissions. The sector emissions increased by 6.2% between 2017 and 2020 due to a 6.2% increase in solid waste disposal emissions, 33.6% increase in open burning of waste and a 4.5% increase in wastewater treatment and discharge emissions.

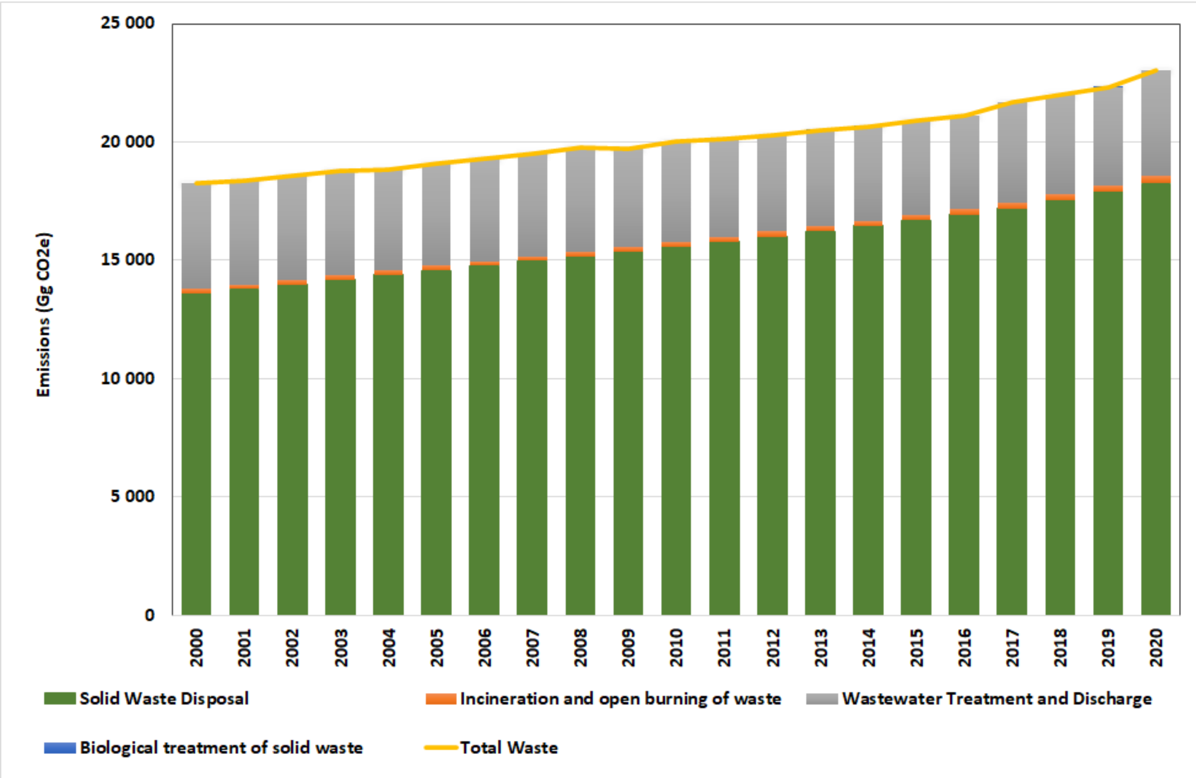


Figure: Trend in emissions from Waste sector, 2000 – 2020

4.1.2.5 Conclusions and recommendations

The 2000 to 2020 GHG emissions results revealed that emissions have increased since 2000 from the *Energy* and *Waste* sectors, with a decrease in the *IPPU* and *AFOLU* sectors. These declines are due to improved data in the *IPPU* sector, as well as a reduction in emissions in 2020 partly due to the impacts of the COVID19 pandemic on industry and transport. In the *AFOLU* sector the decline is due to an increasing Land sink. There was an annual average increase of 2.4% in the total net emissions between 2000 and 2009, and then emissions stabilised and declined with an average annual decline of 2.0% between 2010 and 2020.

The *Energy* sector in South Africa continued to be the main contributor of GHG emissions and was found to be a key category each year. It is therefore important that activity data from this sector always be available to ensure that the results are accurate. The accurate reporting of GHG emissions in this sector is also important for mitigation purposes.

The *IPPU* data was sourced from publicly available data as well as from data submitted by companies through the GHG Reporting Programme via the South African GHG Emissions Reporting System (SAGERS). Increasing the amount of company level data will enhance the accuracy of emission estimates and help reduce uncertainty associated with the estimates. The mandatory GHG Reporting Programme, which is driven by the National Greenhouse Gas Emissions Reporting Regulations, will provide enhanced data for this sector. This data has been included in the recent years of the inventory but does pose some issues in terms of time-series consistency due to the data not being available prior to 2018 in most cases. These are issues which will be improved in future as more data becomes available.

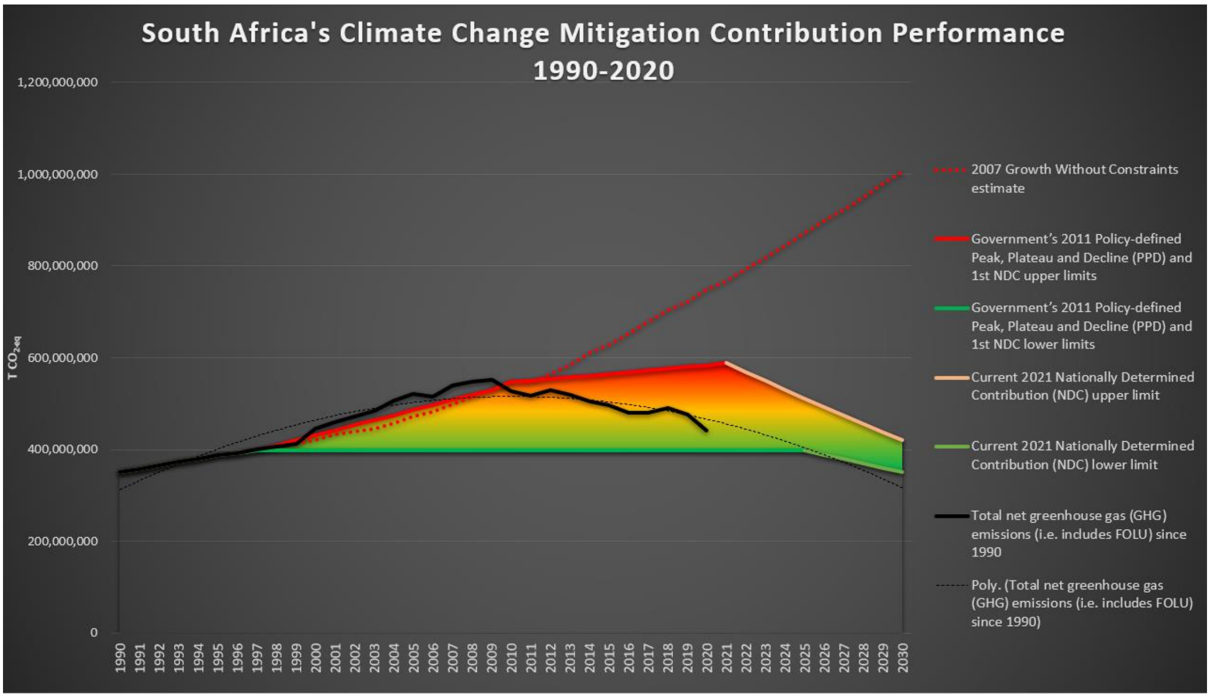


Figure: South Africa's climate change mitigation performance from 1990 to 2020 illustrating how greenhouse gas (GHG) emissions have been kept within local target limits and international commitments.

The *AFOLU* sector was highlighted as an important sector as it (excl. FOLU) has a contribution greater than the *IPPU* sector, and enteric fermentation is one of the top-10 key categories each year. The land subsector is also an important component of the *AFOLU* emissions (incl. FOLU) because of its increasing land sink. South Africa continues to require a more complete picture of this subsector. There is a need for more land change data and a system for integrating various maps irrespective of the technologies used to develop the maps. It is recommended that carbon density maps be developed for multiple years and that these maps be integrated with the land mapping system so that South Africa can move towards a Tier 3 approach. A national forest inventory would also assist in providing some of this data. This subsector also has important mitigation options for the future and understanding the sinks and sources will assist in determining its mitigation potential.

In the *Waste* sector the emission estimates from both the solid waste and wastewater sources were largely computed using default values suggested in the IPCC 2006 Guidelines, which could lead to large margins of error for South Africa. South Africa needs to improve the data capture of the quantities of waste disposed into managed and unmanaged landfills, as well as update waste composition information and the mapping of all the solid waste pathways. This sector would also benefit from the inclusion of more detailed economic data (e.g. annual growth) broken down by the different population groups. The assumption that GDP growth is evenly distributed across the different populations groups is highly misleading and exacerbates the margins of error.

4.1.3 South Africa's state of climate

4.1.3.1 Changes observed in the Southern African climate

This section is an edited extract of the Intergovernmental Panel on Climate Change's 2022 Sixth Assessment Report with a focus on information relevant to southern Africa. Readers are encouraged to read the report for more, in-depth, fully referenced information.

Southern Africa's average annual surface temperatures have increased by between 1.04°C and 1.44°C from 1961 to 2015. The annual number of hot days has increased in southern Africa over the last four decades due to human-induced climate change. The occurrence of cold extremes, including frost days, have decreased. Heat waves in the ocean have doubled and increased in intensity along the southern African coastline from 1982-2016: with 90-100 percent probability this was the result of human-induced climate change. There has been a decrease in mean precipitation over southern Africa since the 1980s, except in the North-Western parts, which show an increasing trend over this period. The number and intensity of extreme rainfall events have increased in southern Africa over the last century. Agricultural drought increased over 1961–2016, and meteorological drought frequency has increased by between 2.5 to 3 events per decade since 1961. The reduced rainfall that caused the 2015-2017 Cape Town drought was three times more likely due to human-induced climate change.

4.1.3.2 Temperature

The following three sections reflect edited extracts from the Annual State of Climate report for 2022 and the 2022 Trends in Extreme Climate Indices in South Africa report and readers are encouraged to read the reports for more, in-depth, fully referenced, information on the state of South Africa's climate.

During 2022 South Africa experienced a warm year, especially in the central interior. The annual mean temperature anomaly for 2022, based on the data of 26 climate stations, was on average about 0.4 ºC above the average of the reference period (1991-2020), making it approximately the 4th hottest year on record since 1951 (see the Figure below). A warming trend of 0.16 ºC per decade is indicated for the country, over the period 1951-2022, statistically significant at the 5% level.

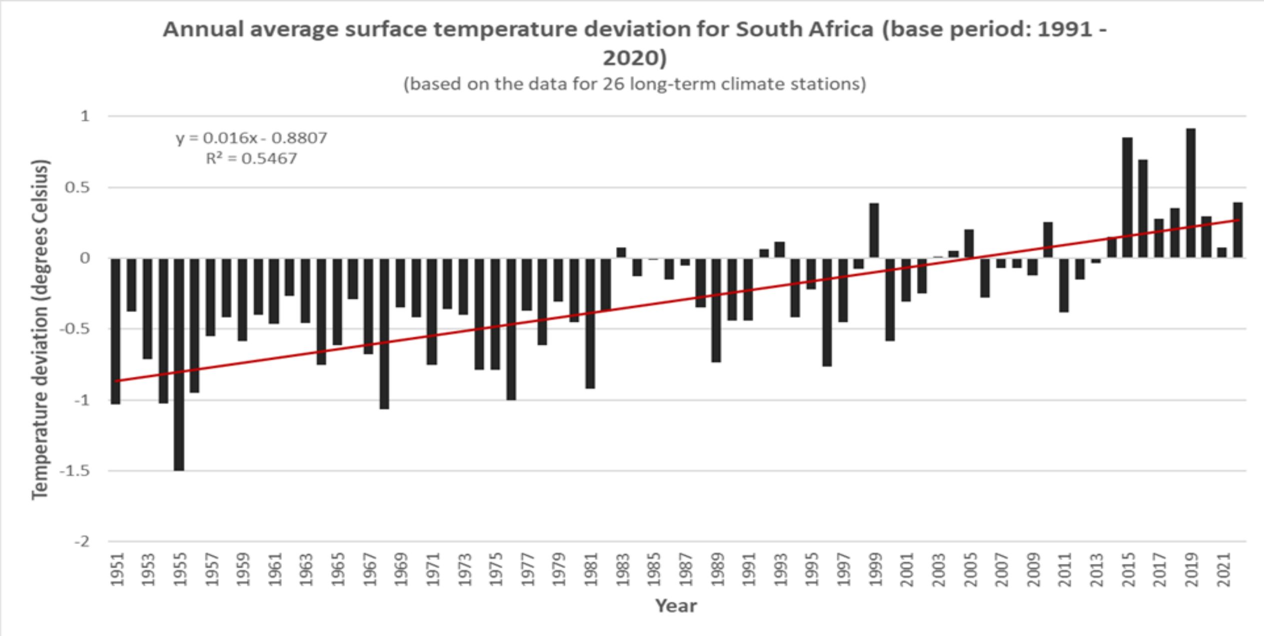


Figure: Average surface temperature over South Africa: 1951 - 2022 (base period: 1991 - 2020). The back line indicates the linear trend

4.1.3.3 Precipitation

According to the Changes in Extreme Daily Rainfall Characteristics in South Africa article South Africa's rainfall distribution is diverse and increases from below 200 mm in the west to above 1200 mm per annum in the east. This is largely due to its geographic position being situated between 22º and 34ºS, complex topography and the fact that the southern African subcontinent is surrounded by the warm Agulhas current on the eastern coast and cold Benguela current on the west. The position together with the ocean influences sets up a range of rain-producing mechanisms, ranging from mostly convectional rainfall (rainfall that occurs when heated air from the earth's surface rises upwards along with the water vapour and gets condensed when it reaches a higher altitude) over the central, northern and eastern parts of the country in summer, to mid-latitude cold fronts which move across the south-western Cape and southern coastal regions, mostly in winter. Therefore, South Africa can generally be divided into four rainfall seasonal zones, with their distinctive rain-producing mechanisms of summer, late summer, winter and all year maxima. Early research on rainfall patterns from 1880 to 1972 found no evidence of a decrease in annual rainfall over South Africa and showed no spatial clustering with regards to trends. Later research found a positive trend in extreme hourly precipitation events during summer for most of South Africa with the strongest trend over the south-east coastal region, extending inland in a north-eastward direction to include the western areas of the country.

In the global ocean, Western Boundary Current (WBC) systems are responsible for the poleward redistribution of heat and salt from the tropical regions. As such, WBCs play a crucial role in maintaining the global movement of ocean currents due to differences in temperature and salinity in different regions of water (thermohaline circulation) in the World's ocean basins. They also strongly influence the local weather patterns, including rainfall, carbon uptake and marine heatwaves, among other impacts. Off South Africa's east coast, the Agulhas Current (AC) system is the largest and strongest WBC in Southern Hemisphere, and is considered unique in comparison to other WBCs with its westernmost location being south of Cape Town (known as the Agulhas Retroflection) and its southwestward flow redirected eastward into the Indian Ocean.

The Benguela Ocean influences the temperature and rainfall of the land masses along its coast due to its properties of upwelling and the cold Benguela Current. Upwelling, which varies seasonally, is a process in which winds drag water from the depths of the ocean, bringing cooler temperatures and higher levels of nutrients and carbon-rich waters to the surface. The cold Benguela Current, which flows down from the south and along the West African coast, brings cold water from the Antarctic or Southern Ocean and prevents overheating in the area. This cold water also helps to stop the development of storms and reduce precipitation levels, thus playing an important role in weather pattern and climate variability along the east coast. This combination of cooler temperatures and drier conditions results in the arid and semi-arid climates of the areas along the Benguela Ocean's coasts.

To look at the impact of climate change, here we report a 20-year record (2000-2019) of surface dissolved inorganic carbon (C_T), pH and partial pressure of carbon dioxide (pCO_2) reconstructed by applying extended multilinear regression (eMLR) to *in situ* measurements of C_T, total alkalinity, and monthly averages of reanalysis (satellite-derived variables (such as surface temperature, salinity, chlorophyll-*a* and atmospheric CO_2) at mid-shelf stations in the Southern and Northern Benguela.

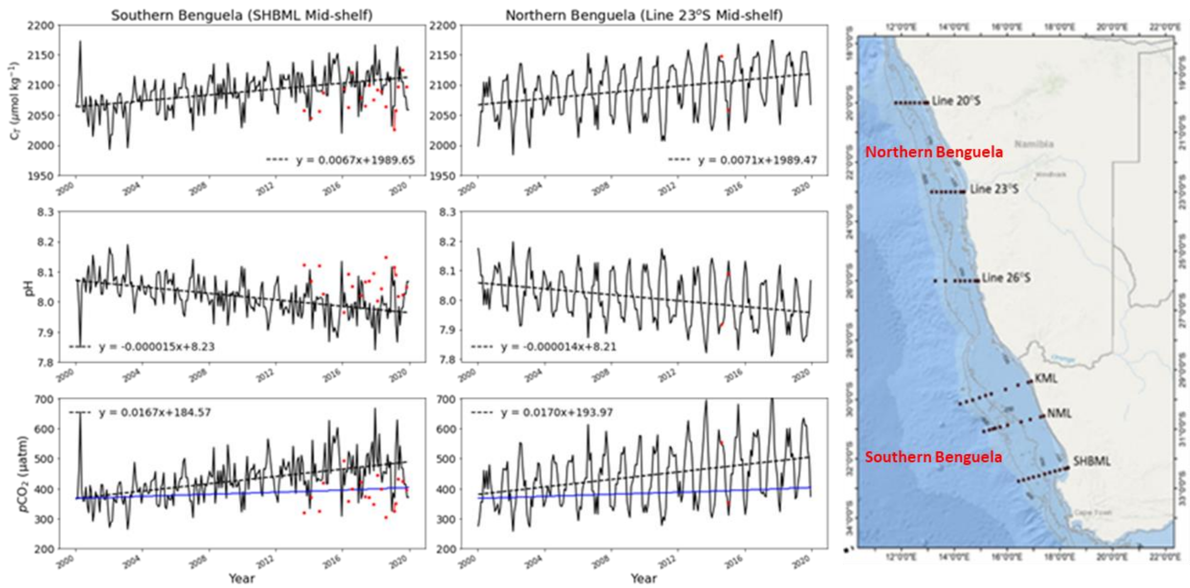


Figure: Time series of surface reconstructed monthly C_T, pH and pCO_2 (black), with *in situ* observations (red dots) from 2000 to 2019 at Station 7 of the SHBML in the Southern Benguela and Station 7 of Line 23°S in the Northern Benguela. The blue line represents the annual atmospheric CO_2

The outputs indicate that the surface pH in this region is significantly declining. However, the observed increasing trend in the rate of change C_T, which drives pCO_2 and pH, is only weakly linked to changing air-sea flux of anthropogenic CO_2. This suggest that other mechanisms, such as biological CO_2 uptake and physical processes, might be responsible for these observed changes, and needs further studies.

The most significant feature of the rainfall during 2022, presented in the Figure below from the 2022 Annual State of Climate report was the well-above normal rainfall received over extensive parts of central South Africa, but clear signals of drying in the western parts of the Northern Cape and Western Cape provinces. Dry conditions persist in parts of the Eastern Cape province.

The El Niño–Southern Oscillation (ENSO) is an irregular periodic variation in winds and sea surface temperatures over the tropical eastern Pacific Ocean, affecting the climate of much of the tropics and subtropics. The warming phase of the sea temperature is known as El Niño and the cooling phase as La Niña. During 2021/22 and 2022/23 the ENSO was in a La Niña phase, which is associated with above-normal rainfall over most of the summer rainfall regions. Overall, the parts of South Africa experiencing drought further decreased over the past year, due to particularly good rains in the early part of 2022.

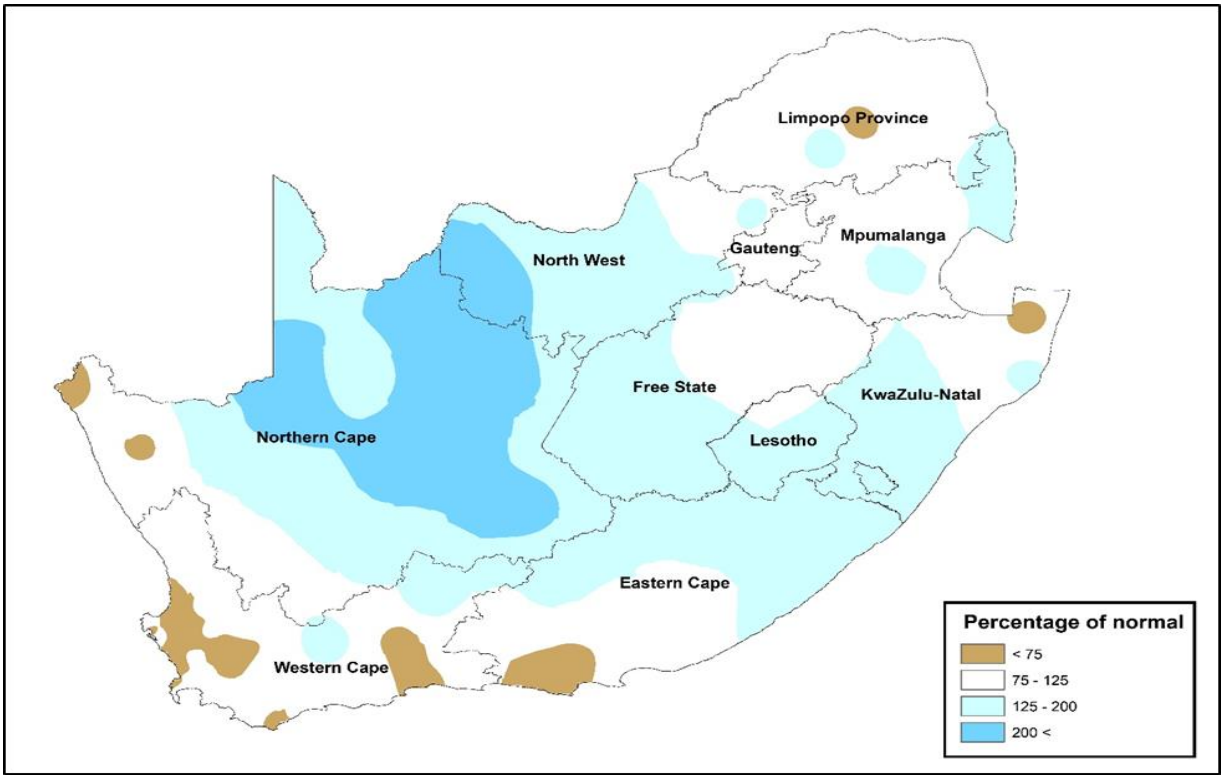


Figure: Rainfall anomalies (expressed as percentage of 1991-2020 annual average) for South Africa for 2022

4.1.3.4 Noteworthy climate and weather events

In South Africa, 2022 started off with very wet conditions in the relatively dry western interior, continuing into March. In contrast, extensive parts of the Western Cape province were hot and dry, with temperatures higher than 40°C reported in some places. In February, rainfall in the densely populated Gauteng province was often characterised by flash-flood events, displacing some communities and causing at least six casualties and extensive damage to infrastructure. By April the region of above-normal rainfall shifted towards the central interior eastwards. A large number of flooding events were reported, with the eThekwini metropole (Durban) the hardest hit. A total of 448 people died with several people unaccounted for in the week of the 8th to the 12th. Infrastructure was badly affected and more than 4000 homes were destroyed and more than 40000 people displaced from their homes. This event, caused by a cut-off low that moved from the interior eastwards over the ocean and strengthening, is considered as one of the major damaging weather events of 2022. The above-normal rainfall conditions continued in May, with more damaging floods in the eastern KwaZulu-Natal province. August saw some heavy rainfall episodes over parts of the south-western, southern and eastern coastal regions. However, some parts of the Eastern Cape province remained dry with the Nelson Mandela Bay metropole in the Eastern Cape the hardest hit by shortage of water due to drought after seven years of below-normal rainfall. However, good rains in places brought some relief in September and October. In November normal to above-normal rainfall occurred mainly over the eastern-half of the country, as well as isolated areas of the Northern and Western Cape provinces but below normal elsewhere. Some urbanised areas experienced severe flooding, for example more than 300 families at the Nancefield Hostel in Soweto, Gauteng province, were left destitute as water entered their homes due to heavy floods from the 11th to the 13th.

Standardised Precipitation Index for January 2020 to December 2021

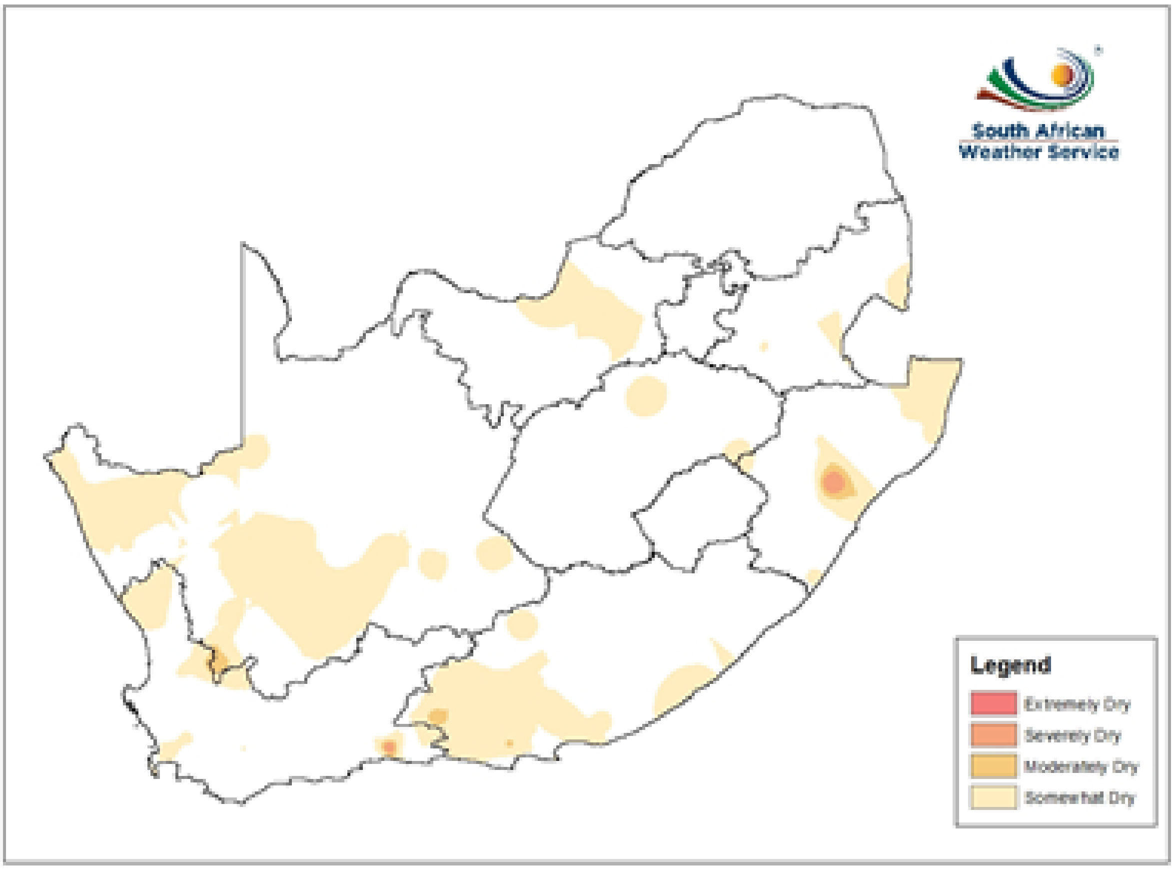


Figure: 24-month SPI map for South Africa ending December 2021

4.2 State of air

The following section is an edited extract of the presentation delivered by the National Air Quality Officer to the 16th National Air Quality Governance Lekgotla which took place from the 3rd to the 5th of October 2022.

The atmosphere is the earth's largest single shared resource, which protects and supports life through the absorption of dangerous ultraviolet solar radiation, warming the surface and regulating temperature. In South Africa, outdoor and indoor air pollution continues to be considered a serious problem, with emissions of sulphur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), nitrogen oxides (NO_X), ozone (O_3), benzene (C_6H_6) and volatile organic compounds (VOCs), and the resultant ambient air concentrations of these pollutants remaining a cause for concern. Air quality in various areas of the country is affected by pollutants emitted by numerous sources. These sources include fossil fuel-based power generation activities, industrial processes, waste disposal, fossil fuel-based transportation (private and public vehicles), biomass burning, domestic fuel burning, landfill sites, waste water treatment and agriculture.

4.2.1 Sources of air pollution

Air pollution emanates from various sources, which include natural and anthropogenic sources. Natural sources of air pollution include volcanoes, which produce sulphur, chlorine and particulates. Most forms of air pollution are as a result of human activities and include fossil fuel burning (coal, oil and natural gas in industrial processes) for electricity generation, vehicular and air transport and domestic fuel burning, and the use of household materials that contain persistent organic pollutants, biomass burning and waste incineration.

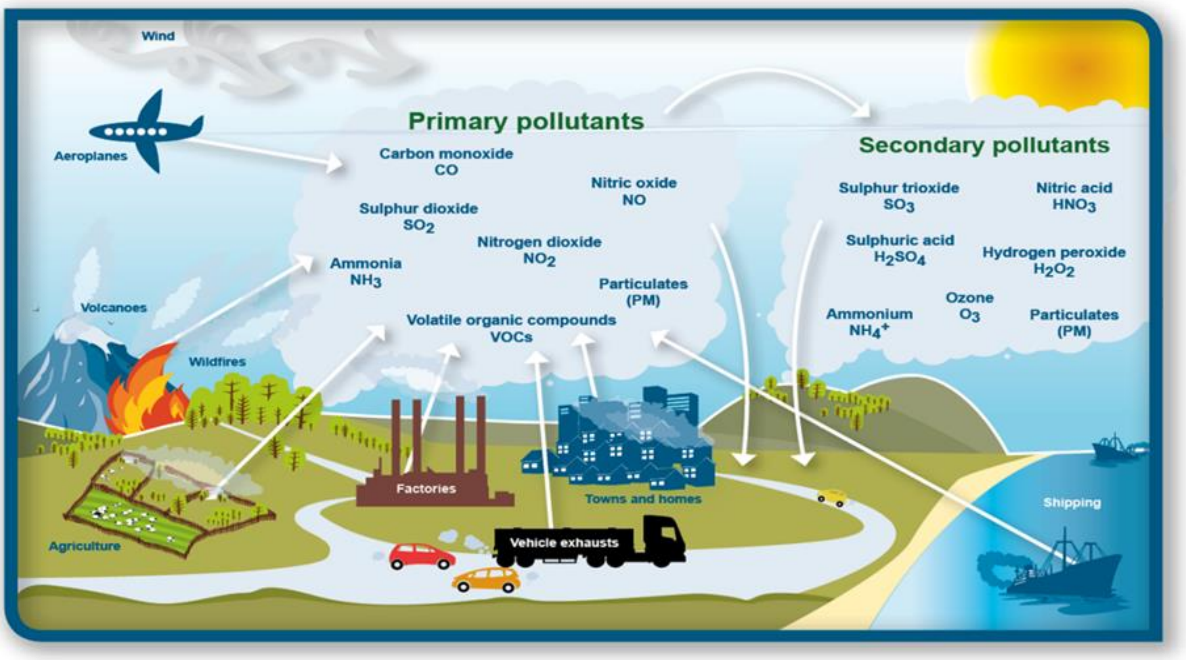


Figure: Various sources of air pollution. Also shown are different air pollutants directly emitted into the atmosphere, as well as those formed in the atmosphere (https://mhsibess.weebly.com)

4.2.2 The National Ambient Air Quality Monitoring Network

The National Ambient Air Quality Monitoring Network currently (2022) consists of over 130 government owned stations across the country and over 50 stations that are privately owned by industry or associations. Of these, over 100 of the government stations and nearly 30 of the privately owned stations are reporting live to the South African Air Quality Information System (SAAQIS) and this near real-time information on the state of air is available to the public on the SAAQIS website and mobile phone APP (see Figure).

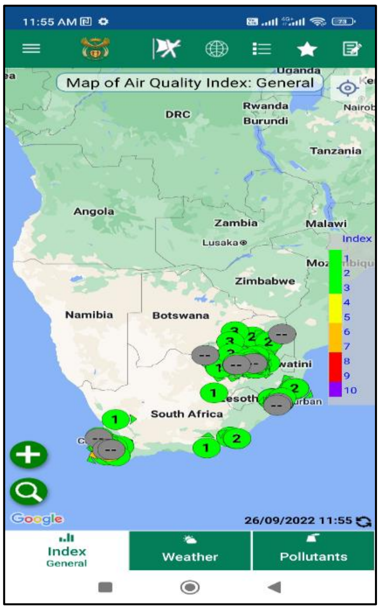


Figure: Screen shot of the SAAQIS APP

4.2.3 Monitored pollutant concentrations

4.2.3.1 sulphur dioxide (SO_2)

During the 2022 Annual Air Quality Governance Lekgotla the National Air Quality Officer indicated that the national average levels of SO_2 have significantly decreased since 1997 and continues to decrease (see figure below).

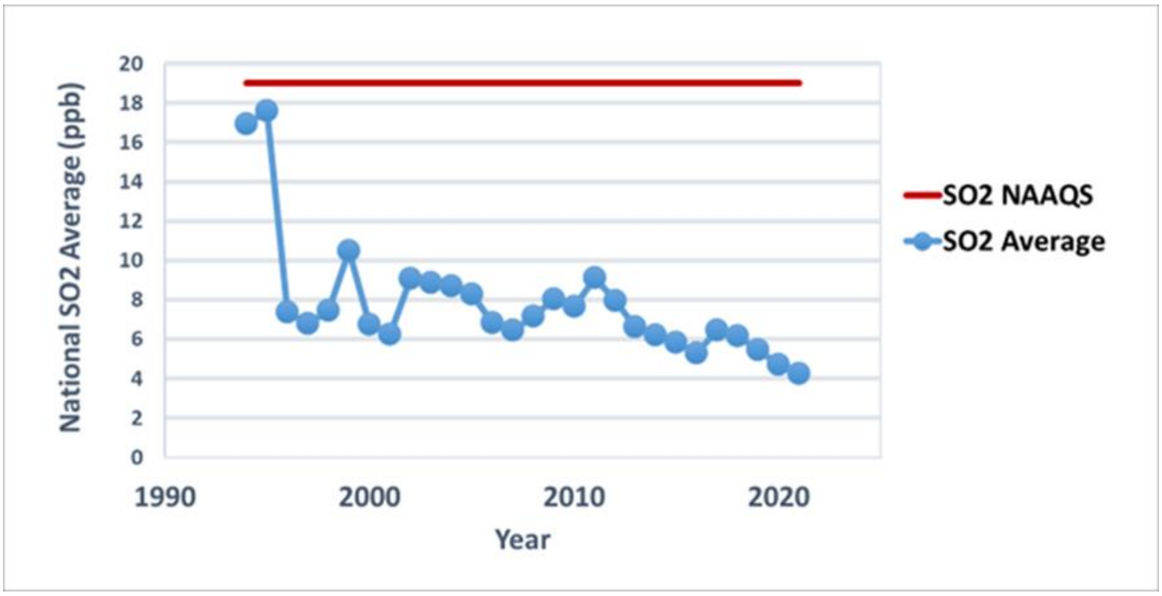


Figure: National annual average concentrations of SO_2 from 1994 to 2021 (NAAQS stands for the National Ambient Air Quality Standard)

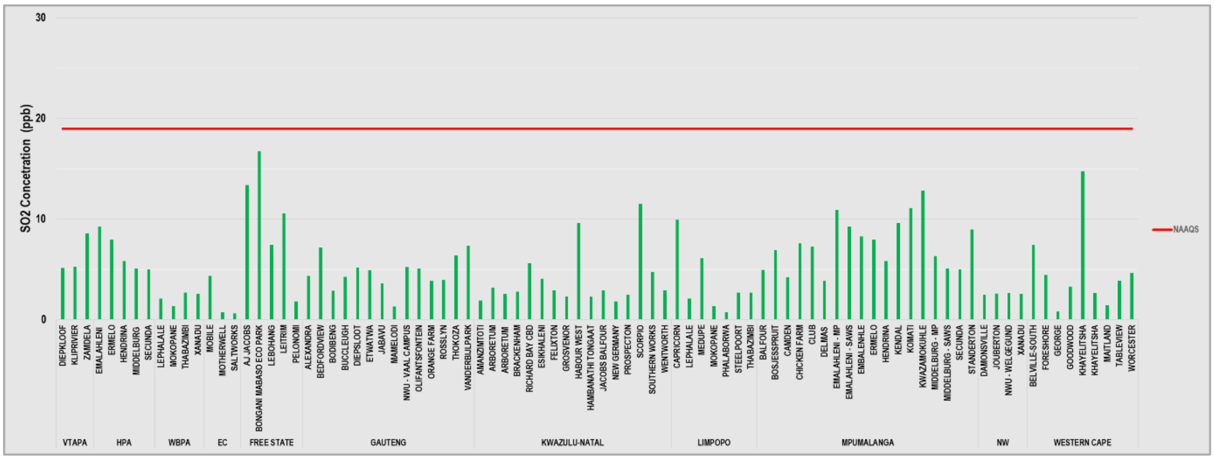


Figure: Annual averages for SO_2 at stations across South Africa for 2021

Based on the above graphs, the following conclusions can be drawn –

- The battle against SO_2 pollution appears to be being won, albeit very slowly; and
- The recent apparent up-tick in SO_2 concentrations, although not yet a cause for alarm, is a cause for concern.

4.2.3.2 Particulate matter (PM)

While national ambient average SO_2 concentrations have continued to decrease, PM_{10} is of major concern. There is a relatively rapid air quality deterioration trend from 2003 to 2010 (see the national averages below). This is largely (but not entirely) due to the fact that data from new stations in identified pollution “hotspots” were added over this latter period. For example, four stations including the South Durban Basin pollution hotspot were added from 2004; five stations in the densely populated City of Johannesburg were added from 2005; six stations within the highly polluted Vaal Triangle Airshed Priority Area (VTAPA) were added in 2007; and five stations within the highly polluted Highveld Priority Area (HPA) were added in 2008.

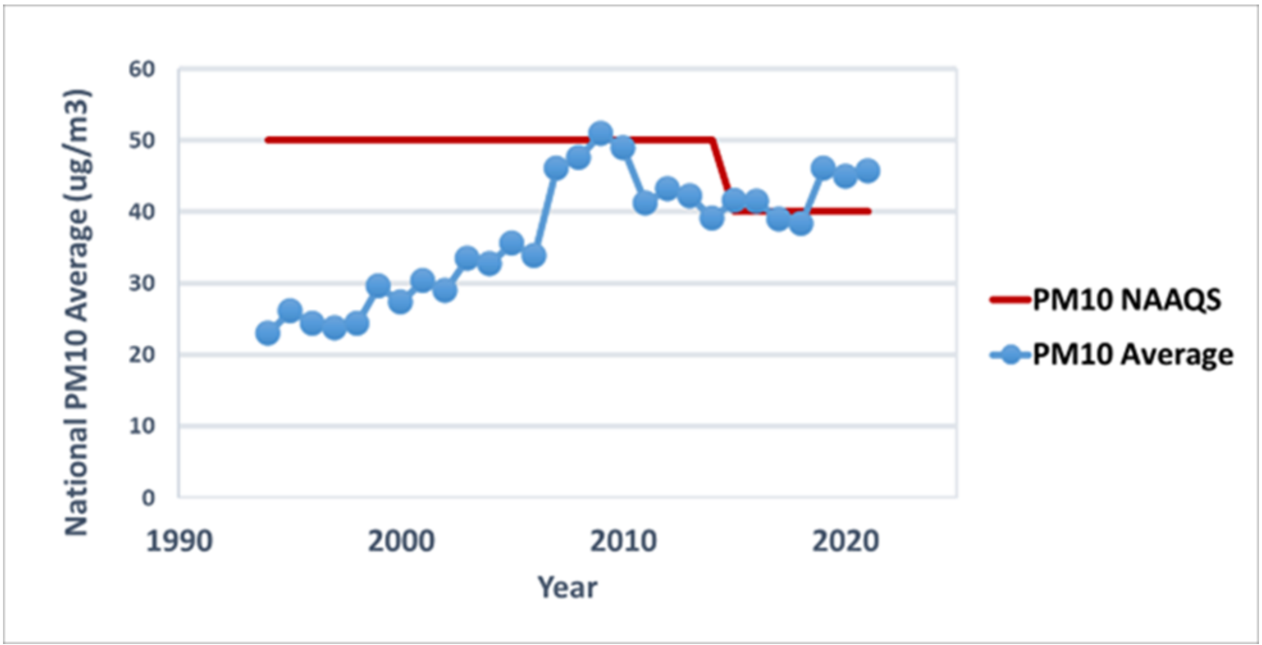


Figure: National average concentration of PM_{10} from 1994 to 2021 (NAAQS stands for the National Ambient Air Quality Standard)

Although it appears that air quality was consistently within ambient air quality standards prior to 1999, this is largely due to the fact that the data sources were not necessarily placed in pollution hotspots, i.e., some of the ambient air quality monitoring stations were in areas of relatively good air quality.

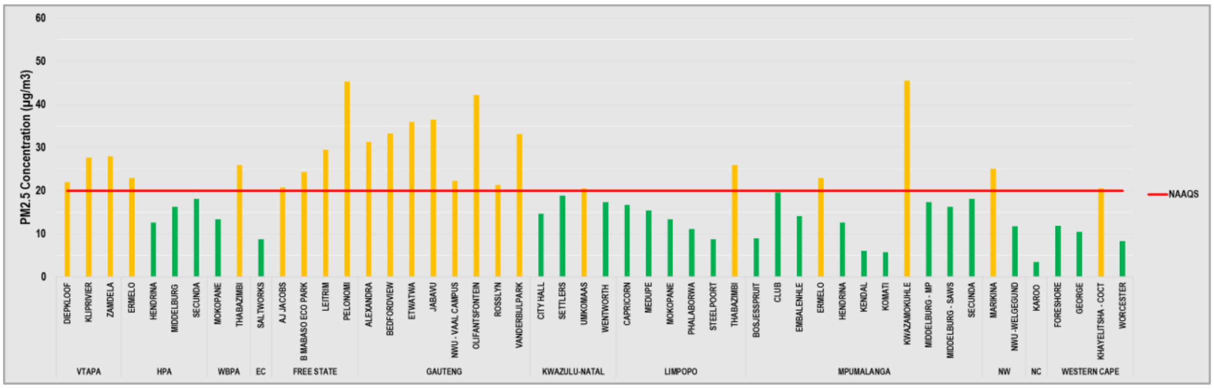


Figure: Annual averages for $PM_{2.5}$ at stations across South Africa for 2021

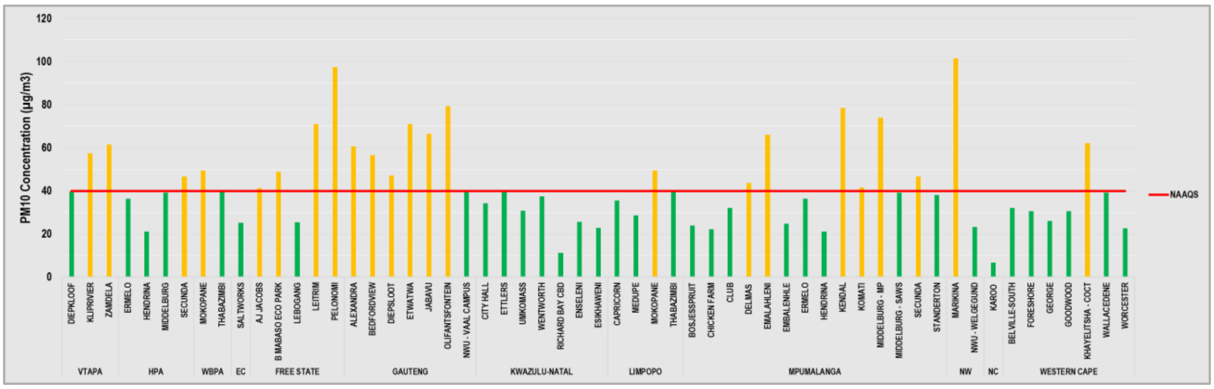


Figure: Annual averages for PM_{10} at stations across South Africa for 2021

Based on the above graphs, the following conclusions can be drawn –

- Particulate matter is still the greatest national cause for concern in terms of air quality;
- The fact that a national average of annual averages is very close to the National Ambient Air Quality Standard (NAAQS), let alone above the standard, is a real cause for concern;
- It is clear that continued and increased national provincial and local action is required in order to bring particulate concentrations down to acceptable levels; and
- It is clear that many South Africans may be breathing air that is harmful to their health and well-being.

4.2.4 NAQI derivation from annual averages of PM_{10} and SO_2

To derive the National Air Quality Indictor (NAQI), the annual averages of PM_{10} and SO_2 in the 2 graphs above (see the monitored pollutant concentration section above) are first normalised by the annual average National Ambient Air Quality Standards (NAAQS). Based on the normalised ratios of the average concentrations, the NAQI is defined as the maximum between the normalised ratios of the national annual averages of PM_{10} and SO_2, that is, for each year the NAQI is the maximum of the graph below. The NAQI is calculated as:

$$NAQI = max \begin{bmatrix} \frac{Annual\ average\ SO2\ (in\ ppb)}{NAAQS} = \frac{Annual\ average\ SO2\ (in\ ppb)}{19} \\ \\ \frac{Annual\ Average\ PM10\ (in\ \mu g/m3)}{NAAQS} = \frac{Annual\ average\ PM10\ (in\ \mu g/m3\ )}{40} \end{bmatrix}$$

Where:

- Annual average concentrations are the average of stations annual averages for each pollutant; and
- Nineteen (19) and 40 represent the annual NAAQS for SO_2 (ppb) and PM_{10} ($\mu g/m^3$).

For 2021, the national annual average SO_2 and PM_{10} were 4.68 ppb and 44.93 $\mu g/m^3$, respectively. The indicator for 2021 is then defined as the maximum of the following ratios.

$$NAQI = max \begin{bmatrix} \frac{4.23}{19} = 0.22 \\ \\ \frac{5.70}{40} = 1.1 \end{bmatrix}$$

The NAQI is defined by normalised ratio of PM_{10} against the annual NAAQS of PM_{10}, as the weighting of PM_{10} was maximum. Hence for 2021, the NAQI is 1.14.

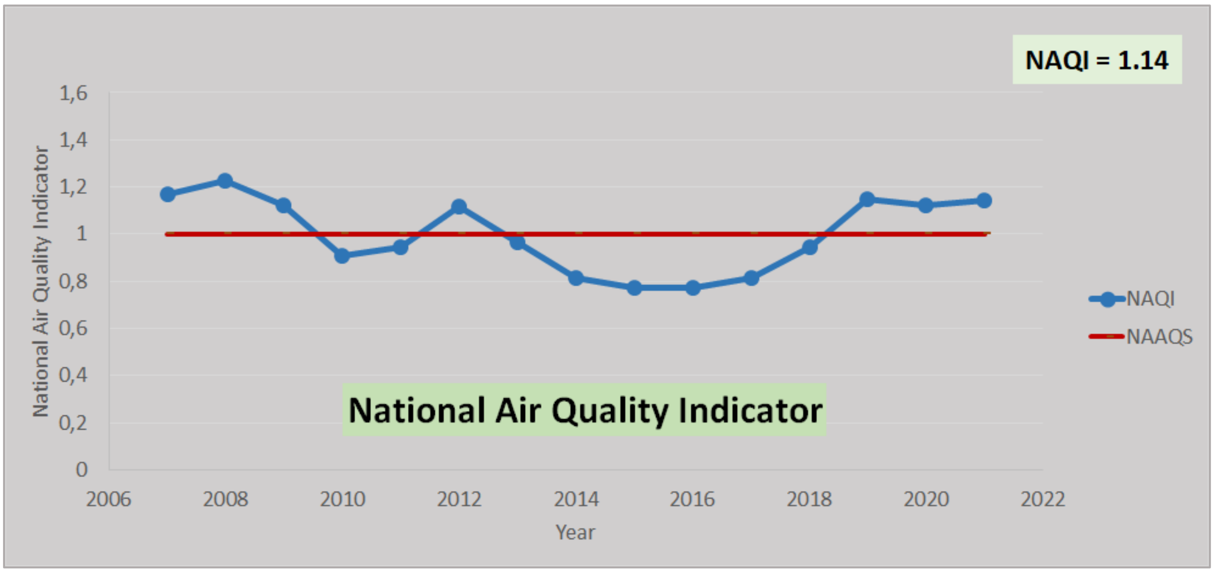


Figure: The National Air Quality Indicator of South Africa from 2007 to 2021

The following can be deduced from the NAQI trends in the above graph:

- As the NAQI is based on the annual average NAAQS, a NAQI less than 1 shows compliance with the NAAQS of either SO_2 or PM_{10}; hence air quality that is regarded as not being harmful to human health and well-being;
- A NAQI above 1 indicates noncompliance with the NAAQS of either SO_2 or PM_{10}; hence air quality that is regarded as being harmful to human health and well-being;
- Between 1994 and 1999, SO_2 was the pollutant that defined the national indicator;
- Since 2000, PM_{10} has defined the NAQI;
- Although it appears that there has been a continuously deteriorating air quality trend since 2000, this is largely, but not entirely, due to the fact that data from new stations purposefully located in identified pollution "hotspots" such as VTAPA and HPA were added over this latter period;
- Between 2011 and 2018, the NAQI has remained relatively unchanged over the period, with slight inter-annual variability; and the 2019 NAQI is significantly high and shows an increase of nearly 30 percent from 2018. However, the NAQI has remained relatively unchanged since then.

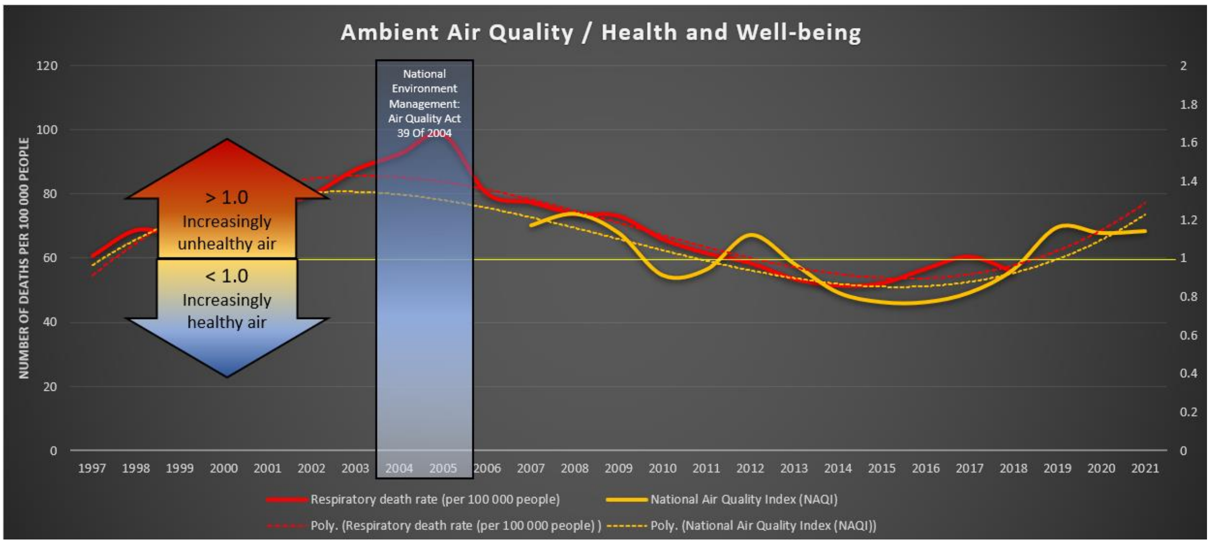


Figure: How the National Air Quality Indicator attempts to serve as a proxy measure of the realisation of the Right to ambient air that is not harmful to health and well-being

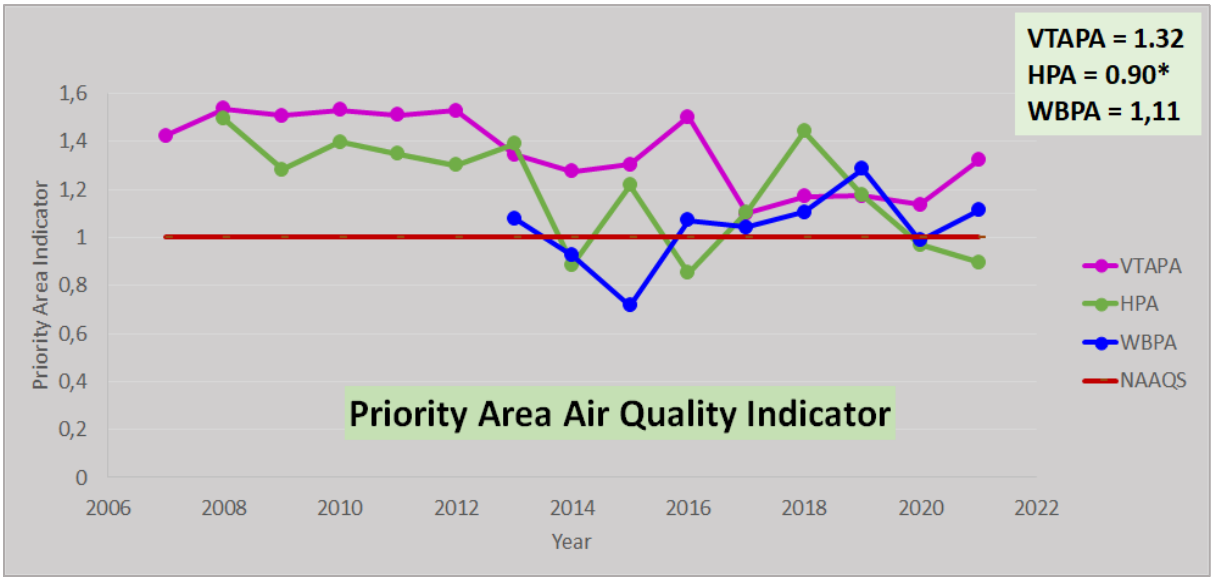


Figure: Air quality in the national air quality priority areas

4.2.5 The Highveld Priority Area (HPA) Judgement

In March 2022, in its ruling on *The Trustees for the time being of Groundwork Trust v The Minister of Environmental Affairs* case, the High Court ruled that the poor air quality in the Highveld Priority Area (HPA), the area identified by Government as an air pollution hot spot in 2007, is in breach of residents' section 24(a) Constitutional Right to an environment that is not harmful to their health and wellbeing.

The following graphs provide an indication of the changes in the quality of air in the HPA from 2009 to 2021.

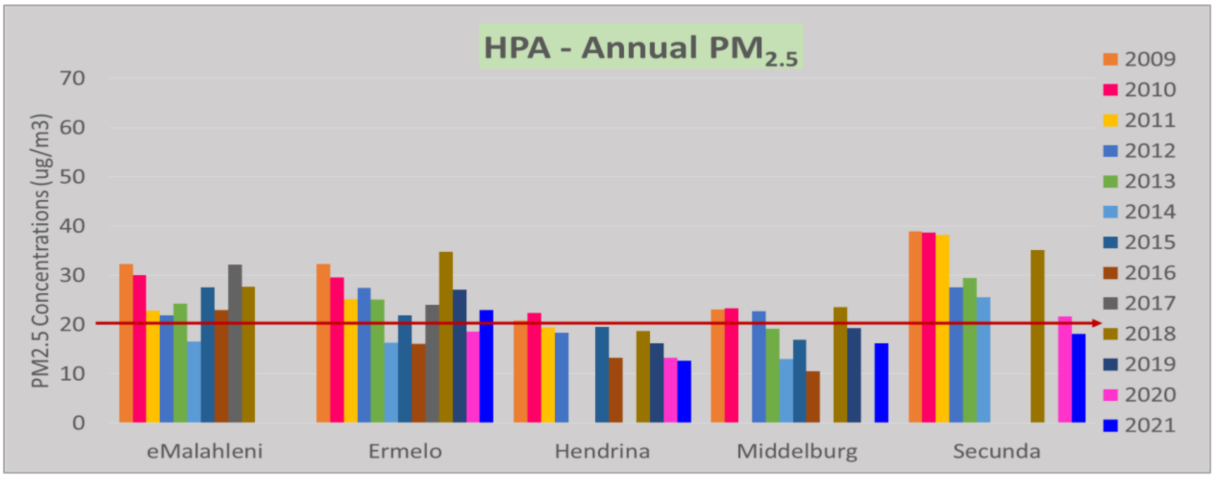


Figure: Annual average $PM_{2.5}$ trends in the Highveld Priority Area from 2009 to 2021

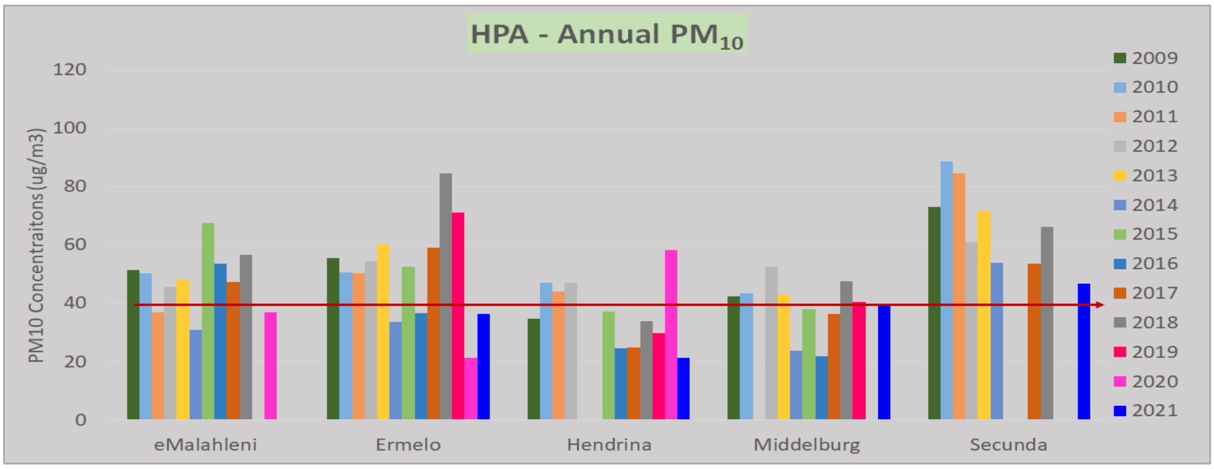


Figure: Annual average PM_{10} trends in the Highveld Priority Area from 2009 to 2021

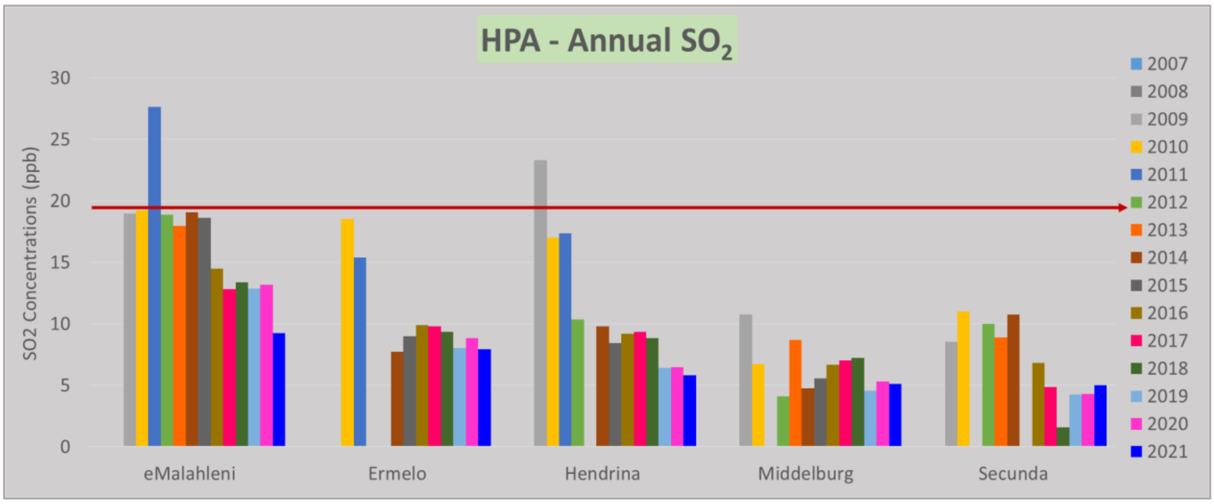


Figure: Annual average SO_2 trends in the Highveld Priority Area from 2009 to 2021

4.2.6 Case study: Estimating the burden of disease attributable to ambient air pollution

The study aimed to estimate the burden of disease attributable to ambient air pollution in South Africa (SA) for the years 2000, 2006, and 2012. Using a comparative risk assessment method, the researchers focused on particulate matter ($PM_{2.5}$) and ambient ozone as pollutants of interest. They employed climate chemistry models and air pollution observations to generate concentrations of $PM_{2.5}$ and ozone for each SA Census Small Area Level in 2012. For 2000 and 2006, population-weighted estimates were derived based on the 2012 results.

At a national scale, the number of deaths attributable to $PM_{2.5}$ increased from 15 619 in the year 2000 to 19 507 in 2012, representing a 19.9% increase. The number of deaths attributable to ozone increased by 23.5% from 2000 to 2012 (from 1 326 in the year 2000 to 1 734 in 2012). While comparing the 2000 and 2012 national scale outcomes, the $PM_{2.5}$ age-standardised death rate increased by 2.7% and the disability adjusted life years (DALY) rate increased by 5.4%. Similarly, the national scale analysis for ozone showed that the ozone age-standardised death rate increased by 6.0% and the DALY rate increased by 25.8%. In the case of both pollutants, the age-standardised death and DALY rates were higher in males than females.

Cardiovascular disease contributed to a large proportion of the mortality and morbidity burden attributable to $PM_{2.5}$ in 2000 and 2012. In terms of ozone exposure disease outcome, the study only considered the contribution of ozone to chronic obstructive pulmonary disease (COPD), hence it is not displayed in a pie chart below.

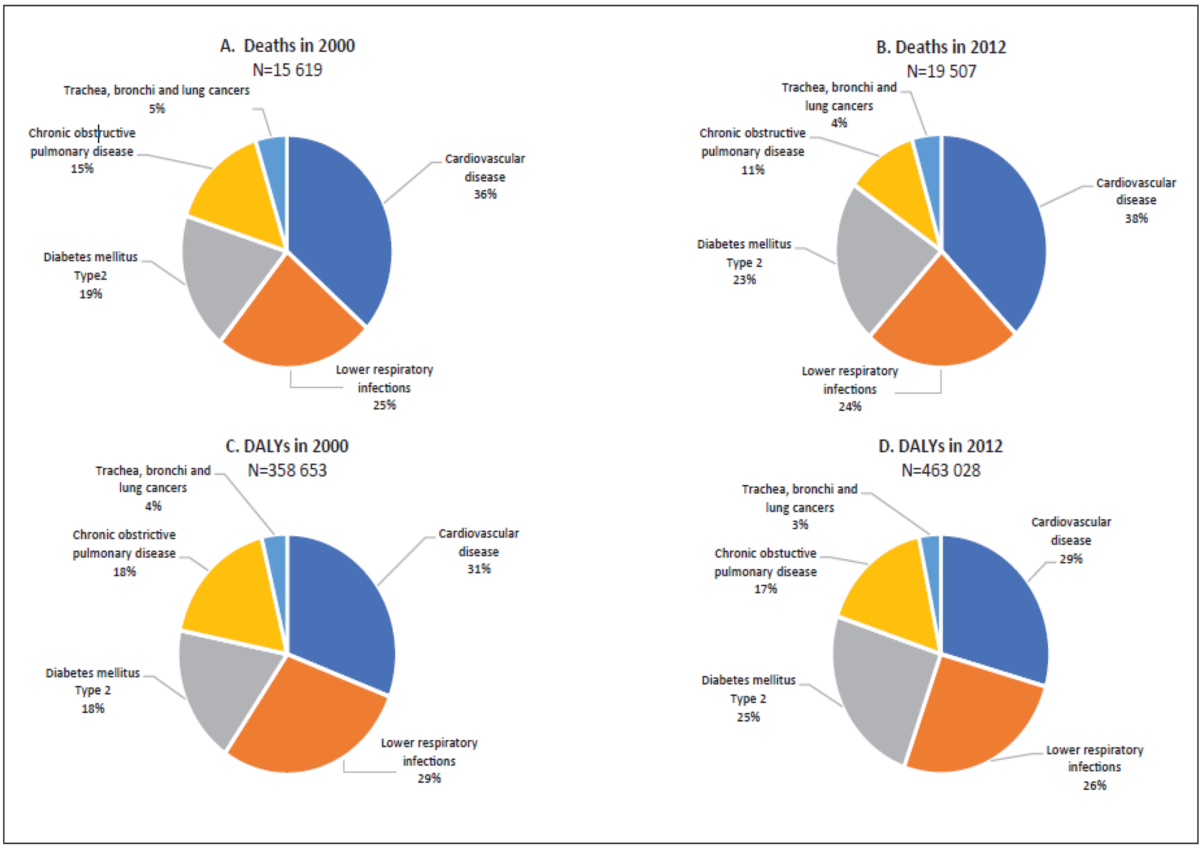


Figure: Deaths attributable to PM 2.5 by disease condition in A) 2000 and B) 2012. Disability adjusted life years (DALYs) attributable to PM 2.5 by disease condition in C) 2000 and D) 2012. (Cardiovascular disease includes ischaemic heart disease and stroke. Lower respiratory infections were a disease outcome for all ages)

The national scale analysis for age- and gender-categorised distribution of deaths attributable to $PM_{2.5}$ and ozone (for the years 2000, 2006 and 2012) are provided in section 2.2 of the appendix (https://www.samedical.org/file/1810). In terms of age-categorised impact, the deaths attributable to $PM_{2.5}$ exposure are higher within the age band of ≥70 years (for females) and 60 - 69 years (for males). In terms of the deaths attributable to ozone exposure, the age-categorised analysis shows that the female and male populations within the age band of ≥80 years experience the highest impact.

The burden of disease due to ambient air pollution, particularly due to $PM_{2.5}$, is large, especially when compared with other environmental risk factors such as household air pollution (HAP) due to cooking with solid fuels. Research on the health risks associated with ambient air pollution continues to mount, showing that even low levels of exposure can have adverse health outcomes.

The study concluded that ambient air pollution exposure poses a significant health risk in South Africa, necessitating immediate short- and long-term interventions. Short-term measures should involve enforcing the SA Ambient Air Quality Standards and industrial minimum emissions standards. Long-term strategies should focus on transitioning away from fossil fuels as a source of energy for power generation, transportation, and domestic uses, and adopting clean renewable energy sources. Additionally, regional cooperation should be established to address air pollution stemming from biomass burning and other regional sources.

4.2.7 Concluding remarks

- PM is still the greatest national cause for concern in terms of air quality. However, addressing this concern is extremely complex and challenging as climatic conditions are a major factor in PM emissions and concentrations, and the numerous sources of PM include both natural and anthropogenic sources; industrial and residential sources; numerous small and isolated large sources; and emissions vented from high and low stacks.
- Increased public concern around air quality during the COVID-19 pandemic has elevated air pollution concerns at a global scale. The challenge will be whether we as a country are able to learn lessons from this global tragedy in order to re-evaluate our approach to air quality management.
- Despite the recent up-tick in the NAQI, there is a belief that South Africa is on the right path to pollution reduction, although major policy shifts in all areas, but particular in the energy, mining and transport sectors, are critical to achieve clean air goals.
- Many South Africans may be breathing air that is harmful to their health and well-being especially in the identified air pollution hot-spots – the national air quality priority areas.
- Continued and increased national, provincial and local action is required in order to bring particulate (PM) concentrations down to acceptable levels.
- Provincial and municipal interventions must be undertaken to deal with exceedances of the national ambient air quality standards.
- The air quality co-benefits of the transition to a low-carbon economy will be significant.

4.3 State of biodiversity

The National Biodiversity Assessment (NBA) is the primary tool for monitoring and reporting on the state of biodiversity in South Africa. It is prepared as part of the South African National Biodiversity Institute's (SANBI) mandate to monitor and report regularly on the status of South Africa's biodiversity. SANBI, an entity of the national Department of Forestry Fisheries and the Environment, relies on a large network of partners to produce the NBA on a 7 year cycle (note: this will change to a 4 year cycle to better align with the reporting requirements of the Convention on Biological Diversity).

The NBA focusses primarily on assessing biodiversity at the ecosystem and species level, and covers all of South Africa's land and seas, including in the Southern ocean around the Prince Edward Islands. Threat status and protection level are the two headline indicators of the NBA and they are applied to both species and ecosystems. Efforts to include genetic diversity indicators started in 2018. The products of the NBA include technical reports, a synthesis report and a wide array of datasets. The next NBA will be released in 2025, and support South Africa's National Report to the Convention on Biological Diversity due in 2026. For more information on the 2018 version (released in 2019) visit http://nba.sanbi.org.za

4.3.1 NBA 2018 key messages

4.3.1.1 Biodiversity provides jobs

South Africa's biodiversity provides substantial employment in a range of sectors. Continued investment in managing and conserving biodiversity is essential so that jobs that depend on biodiversity can continue to increase.

4.3.1.2 Healthy ecosystems are essential for water security

Rivers, wetlands and their catchment areas are crucial ecological infrastructure for water security, often complementing built infrastructure, but the benefits from some of these ecosystems are currently compromised by their poor ecological condition. Water security can be improved through integrated management of natural resources in Strategic Water Source Areas as well as other key catchments, including protection and restoration in some cases.

4.3.1.3 Water flowing into the sea provides multiple benefits to people

Freshwater flowing from rivers through estuaries into the sea is not wasted but is essential for coastal and marine food production, livelihoods, tourism and future climate change resilience. Through appropriate management, South Africa can maintain the vital freshwater flows that reach the coast.

4.3.1.4 Small high-value ecosystem types take up just 5 percent of South Africa's territory but provide multiple benefits to people

Certain small ecosystem types function as crucial ecological infrastructure and, despite their small footprint, provide multiple benefits to society. Managing, protecting and restoring these small high-value ecosystems gives a large return on investment.

Indigenous forests, inland wetlands, lakes, estuaries, mangroves, dunes, beaches, rocky shores, kelp forests, reefs, seamounts, pinnacles and islands together take up less than 5 percent of South Africa's territory, but are responsible for a disproportionally large number of benefits such as water purification, nutrient cycling, carbon storage, storm protection, recreation and harvesting of food directly from nature.

4.3.1.5 Benefits from fishing are at risk, including food and job security

Estuarine and marine ecosystems provide South Africans with food and livelihoods by providing a basis for fishing – whether commercial, subsistence or recreational. Yet many fish stocks are overexploited and many fish species are threatened. While a range of plans are in place to ensure that fisheries are sustainable, better practices to rebuild stocks of priority species are needed, as well as reliable data and sufficient capacity for undertaking regular stock assessments.

4.3.1.6 Climate change is impacting on people and ecosystems; in spite of this, healthy ecosystems can help us adapt to climate change

The impacts of climate change are evident across all realms and within most species groups. Biodiversity provides resilience against the worst effects of climate change. Restoring ecosystems and maintaining them in a good ecological condition means they are better able to support natural adaptation and mitigation processes, offering increased protection to human communities and reducing the economic burden of future climate disasters.

4.3.1.7 Estuaries and wetlands are the most threatened and least protected ecosystems in South Africa

Estuarine and inland wetland ecosystems face numerous pressures and are highly threatened. Funding the restoration and protection of estuaries and inland wetlands will secure essential benefits and deliver large return on investment.

4.3.1.8 Coastal biodiversity assets, including beaches, are at risk

Sixty percent of coastal ecosystem types are threatened – a result of the many pressures concentrated on the coast. Judicious coastal development that avoids sensitive area can minimise further damage, maintain ecological infrastructure and reduce climate risks.

4.3.1.9 Protected areas: investment success in the ocean and on land

Protected areas have expanded in the ocean and on land, and are a source of pride for South Africans. Continued expansion will help to ensure biodiversity conservation, ecological sustainability and even more social and economic benefits from biodiversity.

In 2018, 20 new Marine Protected Areas were accepted for declaration, covering 5 percent of the country's mainland marine territory and advancing the marine realm above other realms in terms of the percentage of ecosystem types having at least some protection (87 percent). Substantial advances were also made around the Prince Edward Islands in 2013, with a large MPA that covers 36 percent of South Africa's marine territory in the sub-Antarctic. The protected area estate of South Africa's terrestrial mainland increased by 11 percent between 2010 and 2018 and now covers nearly 9 percent (>108 000 km2) of the country's land area. The land-based protected area network is increasingly representative of the full range of ecosystem types, with three quarters of terrestrial ecosystem types now having some form of representation.

4.3.1.10 Protected areas: providing effective protection for many species

South Africa's protected areas are generally providing good protection for species, as shown by a new protection level indicator for species. The results provide important feedback for protected area expansion strategies and for protected area management.

South Africa's birds and reptiles are the best protected of the seven species groups assessed in this NBA, with over85 percent of these species considered Well Protected. Continued investment in protected areas is paying off for species, as the proportion of threatened species represented in protected areas has increased for most groups over the past 30 years.

4.3.1.11 Freshwater fishes are the most threatened species group in South Africa

Freshwater fishes are the most threatened of all species groups that have been fully assessed in South Africa, and half of South Africa's freshwater fish species are found nowhere else in the world. Effective management and conservation strategies to halt the decline and promote recovery of threatened fish species are needed, focused on the rivers and catchments where these fish occur.

SA has 118 freshwater fish species, of which half are endemic. One third of South Africa's native freshwater fish species are threatened. Two thirds of the endemic taxa are threatened, and most of these are concentrated in the mountainous Cape Fold ecoregion.

4.3.1.12 Trends in threat status show rapid declines in some of South Africa's species, especially freshwater species and butterflies

Changes in species threat status over time were tracked for eight taxonomic groups using the IUCN Red List Index (RLI). Increased extinction risk is evident for most groups but freshwater species and butterflies, in particular, show a steep decline. For the RLI to be more comprehensive repeat assessments are required for species in the marine and estuarine realms, and invertebrates in general.

4.3.1.13 Areas where pressures are concentrated should be priorities for spatial planning

The spatial distribution of pressures on biodiversity across the landscape and seascape are uneven. Pressure hotspots, where many different pressures converge, require strategic spatial planning and focused management.

Human activities are often concentrated in areas rich in natural resources, of high productivity and high accessibility. Pressures are particularly marked in and around estuaries, inland wetlands, river valleys and riparian areas, lowland areas such as coastal plains, the sea shore, and the inner shelf and shelf edge in the ocean. In addition to these natural features, pressures are also focussed on regions with high agricultural potential, around human settlements and in regions with high mining potential. Ecosystems and species in these pressure hotspots are therefore particularly at risk of extinction or collapse due to the accumulation of pressures.

4.3.1.14 Biological invasions threaten biodiversity and human well-being

Over 100 exotic species are having a severe impact on South Africa's biodiversity and, in some cases, on human well-being. Although some successes in the management of biological invasions have been achieved, the adoption of a national strategy for managing biological invasions, improved project-level planning for prevention and management, and enhanced spatially explicit data will greatly increase effectiveness of current efforts.

Over 2 000 exotic species have become established in South Africa in South Africa, and at least a third of these have become invasive. Of these, 107 species (mostly plants) are having a severe impact on both biodiversity and human well-being. Biological invasions are major pressures on biodiversity assets and ecological infrastructure in all realms, impacting on water security and food security. Invasive trees and shrubs reduce surface water resources by between 3 and 5 percent, and threaten up to 30 percent of the water supply of cities like Cape Town and Port Elizabeth, and invasive exotic plants reduce the capacity of natural rangelands to support livestock production thereby threatening rural livelihoods and food production.

4.3.1.15 Cooperative governance is essential for healthy landscapes and seascapes

Biodiversity patterns and ecological processes are connected in complex ways that cross realms as well as human-constructed boundaries. At the same time, human activities in a range of different sectors that have separate policies and legislation and are separately managed can impact on the same biodiversity or ecological infrastructure. To deal with this interconnectedness, cooperative governance and cross-sectoral planning and decision making are essential.

4.3.1.16 Investment in strategic and collaborative biodiversity monitoring programmes is crucial to inform management and decision-making and for biodiversity assessments

Investment in existing and future strategic and co-operative biodiversity monitoring programmes is essential to strengthen our ability to detect and report on trends, plan accordingly and manage effectively.

While South Africa has some robust biodiversity monitoring programmes, many involving citizen scientists (e.g. South African Bird Atlas Project), the NBA 2018 has highlighted gaps that should be filled and priorities for building on existing monitoring efforts. It is important that gaps in monitoring of species populations, ecological condition and community composition are filled (e.g. implementation of the new National Wetland Monitoring Programme). Existing monitoring programmes (e.g. National Aquatic Ecosystem Health Monitoring Programme, which is focussed on rivers) need to be maintained and supported.

4.3.2 NBA 2018 summary findings

The following table provides a summary of the key findings contained in the NBA 2018.

NBA 2018 summary findings	
Realm	**Key facts**
Terrestrial realm	• Ecosystem threat status: 22% of 458 ecosystem types are threatened. • Ecosystem protection level: 26% of 458 ecosystem types are Well Protected, 25% are Not Protected. • Species threat status: 13% of 22 667 taxa assessed are threatened. • Species protection level: 69% of 3050 taxa assessed are Well Protected and 9% are Not Protected. • Key pressures: Habitat loss (5); overutilisation of rangelands (2); altered fire regimes (2); biological invasions (2); climate change (2)
Inland aquatic realm	• Ecosystem threat status: 64% of 222 river ecosystem types are threatened & 79% of 135 inland wetland ecosystem types are threatened.

NBA 2018 summary findings	
Realm	**Key facts**
	• Ecosystem protection level: 13% of 222 river ecosystem types are Well Protected while 42% are Not Protected; 6% of 135 inland wetland ecosystem types are Well Protected while 61% are Not Protected. • Species threat status: 17% of the 658 [taxa assessed are threatened. • Species protection level: 68% of 501 [taxa assessed are Well Protected with the exception of freshwater fishes where only 18% are Well Protected. • Key pressures: Changes to the hydrological regime (5); pollution (4); habitat loss (4); biological invasions (4); climate change (3)
Estuarine realm	• Ecosystem threat status: 86% of 22 ecosystem types are threatened. • Ecosystem protection level: 18% of 22 ecosystem types are Well Protected while 27% are Not Protected. • Species threat status: 27% of 66 taxa assessed are threatened. • Protection level not assessed • Key pressures: Freshwater flow modification (5); overfishing and bait collection (5); pollution (4); habitat loss (3); and climate change (3)
Marine realm	• Ecosystem threat status: 50% of 150 ecosystem types are threatened. • Ecosystem protection level: 31% of 150 ecosystem types are Well Protected while 13% are Not Protected. • Species threat status: 18% of 376 taxa assessed are threatened. • Key pressures: Fishing (5); ports and harbours (3); freshwater flow modification (3); habitat loss (2), mining (2); pollution (2); climate change (2); biological invasions (2);
Coastal	• Ecosystem threat status: 60% of 186 ecosystem types are threatened. • Ecosystem protection level: 36% of 186 ecosystem types are Well Protected while 22% are Not Protected. • Key pressures: Fishing (5), habitat loss (4), freshwater flow modification (4), pollution (3), Mining (3), biological invasions (3), climate change (3)
Sub-Antarctic	• Ecosystem threat status: 21% of 29 marine ecosystem types are threatened, five terrestrial ecosystem types are still to be assessed. • Ecosystem protection level: 34% of 29 marine ecosystem types are Well Protected, 14% are Not Protected. All 5 (100%) terrestrial ecosystem types are Well Protected. • Key pressures: Invasive house mouse (4); Patagonian Toothfish fishery (3); climate change (3).

4.3.2.1 The terrestrial realm

South Africa's terrestrial realm is recognised globally for its biodiversity and high levels of endemism. The unique and diverse fauna and flora, together with the wide range of ecosystems, underpins South Africa's vibrant and growing tourism and wildlife industries, culturally and economically important traditional medicine practices, extensive livestock farming industry, and the functioning of water catchment areas. Together these industries and functions provide hundreds of thousands of jobs and contribute to food and water security.

Terrestrial ecosystems and species face pressures from a range of human activities, including loss and degradation of natural habitat, biological invasions, pollution and waste, unsustainable natural resource use and climate change. These pressures interact in complex ways that undermine biodiversity and ecological infrastructure, which are important foundations of the country's social and economic systems. The key drivers of habitat loss are land clearing for croplands, human settlements, plantation forestry, mining and infrastructure development. These activities have led to the loss of 21 percent of South Africa's natural terrestrial ecosystem extent. Other key pressures include invasive species (plants in particular), overutilisation of rangelands, disrupted fire regimes and climate change. These have not yet been mapped and quantified at an adequate scale to gauge and track their impacts on biodiversity nationally, and this situation needs to be addressed urgently.

A quarter of South Africa's terrestrial ecosystem types are threatened. This is a clear indicator of mounting pressures on biodiversity and ecosystems. These pressures should be closely monitored and the data required to do this (principally ecological condition data) should be acquired as a matter of priority. The Indian Ocean Coastal Belt, Fynbos and Grassland biomes have the highest proportion of threatened ecosystem types including 27 Critically Endangered and 29 Endangered types between them. Since most land that has not been cleared is considered natural/near natural, the assessment generally underestimates ecosystem modification and some ecosystem types may be in significantly worse condition (and at higher risk of collapse) than the available data suggest. Improved invasive exotic plant and land degradation mapping is required to address this shortcoming. The innovative steps taken to incorporate threatened ecosystem types into systematic biodiversity plans and land-use decision making processes should be continued.

Of the 22 667 terrestrial taxa assessed, 3 024 (13 percent) are threatened. Mammals have 17 percent of taxa threatened with extinction; plants have 14percent, amphibians 13 percent, butterflies 10 percent, birds 9 percent and reptiles 5 percent. South Africa has very high levels of endemism (64 percent) and one in five of these endemics are threatened with extinction. The trend in species status over time has been measured for the first time using the Red List Index (RLI). Groups for which sufficient time series data existed included all terrestrial vertebrates, a sample of 900 plants and one invertebrate group, butterflies. Similar levels of decline were observed for all taxa. The decline observed for butterflies highlights the need to assess and monitor additional invertebrate groups. Despite there being an overall increase in risk of extinction for all six taxonomic groups assessed, 10 mammal taxa have genuinely improved in threat status since 2004.

The terrestrial protected area estate of South Africa increased by 11 percent between 2010 and 2018 – now covering almost 9 percent of the mainland. The placement of these new protected areas has resulted in overall improvement in ecosystem protection levels for all biomes. A quarter of the terrestrial ecosystem types are Well Protected and a quarter are Not Protected. Biodiversity stewardship programmes underpinned the majority of this increase and continue to be the most cost effective mechanism for protected area expansion. Efforts should be made to support and expand biodiversity stewardship programmes and address those ecosystems types that are Not Protected.

Protection levels for species were assessed for the first time – using an indicator developed specifically for the NBA – and show that birds and reptiles are relatively well protected by South Africa's protected areas network, while butterflies, mammals, plants and amphibians are under-protected (i.e., Not Protected, Poorly Protected or Moderately Protected). Over 85 percent of bird and reptile taxa qualify as Well Protected, while only 72 percent of amphibians, 63 percent of plants, 57 percent of butterflies and 56 percent of mammals are Well Protected. Plants have the highest proportion of under-protected taxa with 17 percent in the category Not Protected. Even for relatively Well Protected groups, like reptiles, the most threatened species often remain unrepresented in protected areas. Threatened or endemic taxa should therefore also be considered, along with under-represented taxa, to be targeted in protected area expansion efforts.

4.3.2.2 Inland aquatic realm

The high temporal and spatial variability of rainfall in South Africa results in variable runoff and flow regimes for rivers, as well as a diverse range of flood regimes for wetlands. The combination of a broad range of climatic settings, high topographic variability, and variable hydrological regimes make for high ecosystem-level diversity. Limited geographic ranges for a number of taxa contribute to high species endemism. Two layers represent these ecosystem types in the South African Inventory of Inland Aquatic Ecosystems (SAIIAE): (i) the 222 river ecosystem types with 164 018 km of mainstem and tributaries; (ii) the 135 inland wetland ecosystem types mapped in the National Wetland Map version 5 (NWM5). Inland wetlands mapped in NWM5 cover 2.2 percent of South Africa. Detailed catchment level studies have, however, indicated that wetland coverage is higher in certain regions of South Africa, suggesting that the extent of inland wetland ecosystem types is currently underestimated. Continued efforts are required to improve the representation of inland aquatic ecosystem types in the national inventory.

Water security is essential for human well-being and livelihoods. Aquatic ecosystems supply the quantity and quality of water required for survival. Freshwater is often a limiting resource for socio-economic development. Over-abstraction of water and water pollution place aquatic ecological infrastructure assets at risk. Strategic Water Source Areas (SWSAs) are landscapes where a relatively large volume of runoff produces water for the majority of South Africa. The National Freshwater Ecosystem Priority Areas (NFEPA) study initially identified high water yield areas and high groundwater recharge areas. Recently, these were refined to 22 areas for surface water (SWSA-sw), covering 10 percent of the extent of South Africa and supplying 50 percent of the country's mean annual runoff. In addition, 37 areas for groundwater (SWSA-gw) were identified, accounting for 9 percent of the land surface of South Africa and up to 42 percent of the baseflow in the respective areas, sustaining flows in the dry season.

Currently, only 12 percent of the SWSAs' extent fall within protected areas. Catchment-level planning and management is thus critical for ensuring that the ecosystem diversity, functionality and connectivity are maintained. **Inland wetlands are highly threatened and under-protected**. Nearly 80 percent of inland wetland ecosystem types are threatened (107 of 135; 61 percent Critically Endangered, 9 percent Endangered and 9 percent Vulnerable), constituting more than 2.3 million ha of >2.6 million hectares of inland wetlands mapped in NWM5.

Approximately 75 percent of inland wetland ecosystem types are both threatened and under-protected. Only 6 percent of inland wetland ecosystem types are considered Well Protected, while 61 percent are Not Protected. Compared to the NBA 2011, where wetlands were found to be poorly mapped, highly threatened and poorly protected, the trends in ecological condition and protection level appear to be declining further. Action ought to be taken to improve maps in planning and prioritisation, involve citizens in stewardship programmes, improve awareness and accountability of all citizens, and implement the National Wetland Monitoring Programme.

River ecosystem condition declined by 11 percent between 1999 and 2011. Of the 222 river ecosystem types assessed, 64 percent were found to be threatened (43 percent Critically Endangered, 19 percent Endangered and 2 percent Vulnerable). River ecosystem types are also Poorly Protected with only 13 percent considered Well Protected and 42 percent Not Protected. The majority of rivers (67 percent of total river length) are degraded. Tributaries are generally less heavily impacted than main rivers with 38 percent of tributary length in natural condition compared to 28 percent of mainstems. The percentage of threatened river ecosystem types is higher for lowland and lower foothill rivers (67 percent) than for the upper foothills and mountain streams (25 percent), which is a reflection of multiple pressures accumulating and increasing from river source to sea. River protection levels are higher for mountain stream types (16 percent Well Protected) than for lowland types (6 percent Well Protected), reflecting the general bias of protected areas to mountainous regions. During the NFEPA project 62 free-flowing rivers were identified, but the decline in ecological condition between 2011 and 2018 resulted in 14 rivers losing this status. Of these 14 rivers, four lost more than half and the remainder lost all of their extent in a natural condition. Cooperative governance linked to integrated water resource management partnerships at catchment scale is required to address the decline in the ecological condition of rivers and to ensure effective river conservation.

The 19 free-flowing rivers identified as flagships rivers in the NFEPA project of 2011 have remained intact over the past seven years. Despite the general decline in ecological condition of river ecosystem types, the value of effective conservation planning through the NFEPA project and implementation of these priorities at various scales, ensured that the ecological condition of these rivers were maintained. It is crucial that these flagship rivers retain their free-flowing character since they provide important ecosystem service provision to the communities along their shores. The flagship rivers represent some of the few remaining examples of connected river ecosystem types that are intact from source to sea, both in South Africa and globally.

South Africa has eight unique freshwater lakes (freshwater bodies greater than 2m in depth), all of which are Critically Endangered and under-protected. South Africa's largest lake, Lake Sibayi (8 400 ha) on the Maputaland Coastal Plain in the KwaZulu-Natal Province, provides freshwater to communities in the vicinity. The remaining freshwater lakes include Baberspan (1 730 ha), Chrissiesmeer (1 300 ha), De Hoop (950 ha), Groenvlei (360 ha), Tevredenpan (330 ha), Lake Fundudzi (200 ha) and Lake Banagher (185 ha). All eight of the freshwater lakes are considered Critically Endangered since <20 percent of the spatial extent of these systems is in a natural or near natural ecological condition. The key pressures on these systems are changes to the hydrological regime, water pollution, habitat modification, invasive species and climate change. Five of the freshwater lakes are Not Protected while three are Poorly Protected.

A total of 658 indigenous freshwater taxa associated with rivers and inland wetlands, from seven taxonomic groups, were assessed for this NBA. Of these freshwater fishes are the most threatened (36 percent of all taxa and 66 percent of endemic taxa threatened. Amphibians, birds, Odonata (dragonflies and damselflies), mammals, freshwater fishes, reptiles and a sample of aquatic plants were assessed. Of these taxa, 160 taxa are endemic and 65 (41 percent) of endemic taxa are threatened with extinction. All freshwater-associated taxonomic groups exhibited a gradual decline in Red List Index threat status over the assessment period, indicating that pressures are impacting species in aquatic ecosystems. While freshwater fishes had the highest threat levels, freshwater mammals had the steepest decline. Based on a meta-analysis of species Red List assessments, the major pressures causing decline were invasive exotic species, habitat loss and degradation due to pollution, urban expansion, poor dam and water management activities and agricultural activities. Despite multiple threats to freshwater fish species, including pollution, invasive species and over-abstraction of water, no freshwater fish taxa have yet gone extinct, largely owing to active management interventions by conservation agencies. The high levels of endemism of this group (49 percent), and that harvesting of freshwater fish for food and recreation is important to many South Africans, means that urgent interventions are required. Multiple and integrated mechanisms are essential for curbing the pressures on freshwater fishes. Successful invasive fish eradication methods trialled by CapeNature during this past assessment period need to be expanded and rolled out nationally.

The first protection level assessment for species found that the majority of freshwater associated taxa, with the exception of freshwater fishes, are Well Protected: 100 percent of freshwater-associated reptiles, 83 percent of birds, 65 percent of mammals and 76 percent of amphibians. Only 18 percent of freshwater fish species are Well Protected, which can be attributed to their sole dependence on rivers and the fact that only 14 percent of South African river lengths occur within the protected area network. Moreover, only 43 percent of South Africa's rivers are in a natural/near natural condition. Pressures not mitigated through the protected area network have resulted in 20 freshwater fish taxa (21 percent) and 8 amphibian taxa (8 percent) dropping down a category of protection. Twenty-three taxa of conservation concern were assessed as Not Protected and these should be prioritised. There is an urgent need to increase the representation of inland aquatic systems within the protected area network, prioritising rivers and inland wetlands inhabited by under-protected species. Furthermore, there is a need to bolster management interventions that mitigate threats to freshwater taxa of conservation concern within protected areas.

4.3.2.3 Estuarine realm

South Africa has 290 estuaries and 42 micro-estuaries that have been classified into 22 estuarine ecosystem types and 3 micro-estuary types. This represents a high diversity of estuary types stemming from diverse climatic, oceanographic and geophysical drivers. Some ecosystem types and estuarine species only occur in South Africa, with some species confined to a few estuaries.

More than 60 percent of South African estuaries are relatively healthy, but this amounts to only 22 percent of total estuarine extent, comprised mostly of small estuaries. More than 63 percent of estuarine area is heavily or critically modified with important ecological processes under severe pressure, which reduces productivity, food security, fisheries livelihoods, property values and recreational enjoyment. Multiple interventions are required to avoid further decline in health. These include protection of freshwater inflow, restoration of water quality, reduction in fishing effort and avoidance of mining, infrastructure development and crops in the Estuarine Functional Zone (EFZ).

The estuarine realm is the most threatened of all realms in South Africa, both for the number of ecosystem types (86 percent threatened) and for area (99 percent threatened). Of estuary types 10 percent are Critically Endangered, 45 percent are Endangered and 32 percent are Vulnerable. By area 77 percent are either Critically Endangered or Endangered. This emphasises the need for strategic interventions across multiple sectors to restore estuarine health and protect benefits to people. To avoid further compromising of the benefits of these ecosystems Strategic Estuarine Management Plans – including freshwater allocation, fish resource use, water quality management and land-use planning – should be developed and implemented in a coordinated, cross-sectoral manner.

South Africa's 12 estuarine lakes are in crisis with all four ecosystem types threatened. This includes St Lucia, Kosi, uMgobezeleni, iNhlabane, uMhlathuze/Richards Bay, Touws/Wilderness, Swartvlei, Klein, Bot/Kleinmond, Heuningnes, Seekoeivlei and Verlorenvlei. This group of estuaries has seen extensive infrastructure development in the EFZ, substantial flow reduction, nutrient pollution, over fishing (especially gillnetting) and are subjected to artificial breaching or mouth manipulation. In addition, the lakes are highly vulnerable to climate change. These impacts have reduced their ability to provide key services such as flood regulation, nutrient cycling, nursery habitat, and have compromised recreational and tourism values. To ensure future climate change resilience, a strategic programme is needed to restore habitat, improve water quantity and quality, reduce pressure on resources and increase protection levels.

Estuaries are under-protected in South Africa with only 18 percent of ecosystem types and 1 percent of estuarine area Well Protected. Since 2011 the situation has worsened with a loss of protection caused by removal of no-take restrictions and developing commercial fisheries in Marine Protected Areas (MPAs). This said, several under-protected ecosystem types can advance to Well Protected solely with improved management of fishing and water quality. For example, 10 percent of estuarine area could be categorised as Well Protected if fishing effort in just three estuaries were better controlled – Langebaan, Knysna and Kosi.

Salt marsh, seagrass and mangrove habitats require greater protection. Mangroves no longer occur in 10 out of 26 Subtropical estuaries and nearly 30 percent of salt marsh habitat has been lost as a result of poor land-use practices, flow reduction and related mouth closure, direct harvesting and overgrazing. Priority systems for protection are the Groot Berg, Knysna, Mngazana, uMlalazi, St Lucia and Kosi estuaries. The Berg Estuary, with its expansive floodplain marshes, is especially unique and should be prioritised for rehabilitation and protection; while greater protection of the Endangered seagrass Zostera capensis (also known as Cape Eelgrass) and large intertidal salt marshes areas of Knysna Estuary is also needed.

Several estuarine-dependent fish species are threatened by overfishing (especially gill-netting), declining water quality, and reduced flows with their concomitant influence on recruitment and marine connectivity. For example, Dusky Kob (Argyrosomus japonicus) is Critically Endangered at <1 percent of pristine reproductive adult biomass, White Steenbras (Lithognathus lithognathus) is Endangered at <6 percent, and Leervis (Lichia amia) is Vulnerable at <14 percent. Many more estuarine invertebrate and fish species may be threatened and are as yet undetected due to lack of monitoring and assessments. Stock or population recovery should be facilitated by reducing fishing pressure (e.g. prohibition on fishing at night in estuaries), increased enforcement of fishing regulations, ensuring adequate freshwater inflow, decreasing nutrient pollution, managing noise pollution and boating activity.

There has been a loss of at least 265 000 waterbirds from South African estuaries, most of which are waders from larger estuaries, especially in the Cool Temperate bioregion. Overall, non-passerine waterbirds have declined by 68 percent in 40 years. Some of these declines are externally driven (e.g. global habitat loss), but are also significantly related to estuary health, and not mitigated by level of protection alone. Bird numbers are still decreasing, emphasising the need to manage the overall decline in estuary condition, habitat loss, impact of gillnetting on birds, solid waste (plastics), hunting and human disturbances in key foraging and roosting areas.

Estuaries are under pressure and there is a lack of long-term monitoring data to inform conflict resolution and support high confidence decision making. This results in poor decision making and hinders maximising the benefits that flow from estuaries. Country-wide estuary abiotic and biotic surveys are urgently needed to ensure optimum resource allocation, use and protection.

4.3.2.4 Marine realm

South Africa's marine environment includes the Atlantic, Indian and Southern Oceans with the contrasting cold Benguela upwelling region and the warm, fast flowing Agulhas current interacting with the diverse geological setting and topography to drive exceptional marine biodiversity. The broad range of climatic, oceanographic and geological settings result in a wide array of ecoregions and 150 different marine ecosystem types. Globally, South Africa is reported to have the third highest marine endemism with an estimated 33 percent of its marine fauna found only in South Africa. There is high marine endemism in the warm temperate Agulhas ecoregion on the south coast, which is geographically very isolated from other warm temperate regions.

The NBA 2018 substantially advanced South Africa's map of marine ecosystem types, drawing from major efforts to collate and increase bathymetric, oceanographic, sediment and biodiversity data. Key advances in the map of marine ecosystem types included very fine-scale shore mapping with alignment and integration in the coast; the inclusion of kelp forests, bays and fluvial fans as distinct types; and the introduction of finer depth strata across shelves and on the slope. Finer scale pressure mapping was conducted and additional pressures were mapped to support the analyses of ecosystem degradation and threat assessment. Of the 31 pressures included, six are new; including abalone fishing (South African Abalone, Haliotis midae), ammunition and disposal of dredge material, beach seine net fishing, gillnet fishing and oyster harvesting.

The main pressures impacting marine ecosystems and species include fishing, freshwater flow reduction, coastal development (including ports and harbours), pollution and climate change. South African ocean activities are expanding and diversifying as South Africa develops its ocean economy. Emerging pressures include increasing pollution concerns, desalination and ocean noise. A total of 95 introduced marine species, of which 56 are invasive, have been reported. Climate change causes changes in currents, upwelling, water temperatures and turbidity, while elevated atmospheric carbon dioxide results in increasing ocean acidification. Climate change and invasive species exacerbate other pressures and further research is needed to understand the complex interactions between pressures. Long-term data series are crucial to enable ecosystem assessment.

Approximately half of marine ecosystem types are threatened; by area this equates to only 5 percent of the ocean space around South Africa with more inshore and shelf ecosystem types threatened than those in the slope and abyss. Only two ecosystem types are Critically Endangered, with 22 Endangered (15 percent) and 51 Vulnerable (34 percent). The most threatened functional ecosystem groups include bays, islands, muddy ecosystem types and rocky ecosystems on the shelf and shelf edge. The cold temperate Southern Benguela ecoregion is more threatened than the warm temperate Agulhas ecoregion, with the subtropical Natal-Delagoa ecoregion being less threatened. Data to improve this assessment should be acquired as a matter of priority and further work is needed to determine the appropriate scale for ecosystem red listing.

Twenty new MPAs were approved for declaration in 2018, so that MPAs now cover 5 percent of the ocean around South Africa. The placement of these new protected areas has resulted in a marked improvement in ecosystem protection levels for many ecosystem types and has contributed to better protection in all ecoregions. The new MPA network is helping to protect marine ecosystems, rebuild fish stocks, support climate [resilience and sustain South Africa's emerging ocean economy. Of the 150 marine ecosystem types in the ocean around South Africa, 87 percent have some representation in the MPA network, but only 31 percent of ecosystem types are Well Protected. Of the 70 ecosystem types that were Not Protected in 2018, 51 (73 percent of these 70 types) received their first protection in 2019.

South Africa's oceans provide a high diversity of marine resources with more than 770 marine species harvested for food. Fisheries stock status is not assessed for 90 percent of these species. Of the assessed resources, more than a third are overexploited or collapsed. South African Abalone (Haliotis midae) and West Coast Rock Lobster (Jasus lalandii) resources are in crisis with escalating poaching preventing resource recovery. Given the importance of fisheries to food and job security in South Africa, it is essential that fisheries stocks are well managed. We need to gather reliable data for stock assessments, maintain fisheries science expertise and develop stronger interventions to rebuild stocks in line with scientific recommendations.

The number of species assessments conducted using the IUCN Red List criteria is increasing with 376 South African marine species assessed to date through a combination of national, regional and global assessments. Of these, approximately 18 percent of taxa are threatened. However, this may not be representative of the actual proportion of taxa threatened as there has been a focus on assessing economically important species and few marine taxonomic groups have been comprehensively assessed. Seabirds, seabreams and turtles are particularly threatened. Marine species have the highest levels of data deficiency across all realms signalling the need to address knowledge gaps and increase capacity for marine species red listing. A lack of knowledge and techniques limits our ability to assess the risks to the genetic component of marine biodiversity.

Climate change is impacting marine species and ecosystems, decreasing resilience and threatening coastal communities and livelihoods. The complexity and variability of South Africa's marine systems, in concert with multiple anthropogenic stressors, make future impacts difficult to predict, nevertheless there is high certainty that impacts on biodiversity, ecosystem function, food security and valuable economic industries will continue to escalate. Additional climate change vulnerability assessments and focussed monitoring of species and ecosystems are required to enhance the detection and attribution of climate change impacts on marine ecosystems, species and genes.

4.3.2.5 Coast

For the first time, there has been substantial effort to align the ecosystem level assessments of the four realms at the land-sea interface, recognising the cross-realm linkages and dependencies. A seamless, cross-realm map of ecosystem types was created, from which an ecologically determined coast was defined, spanning the terrestrial, estuarine and marine realms. Rivers and inland wetlands were not considered as part of this coastal assessment but collaborative efforts ensured that inland wetland ecosystem types and river reaches were spatially aligned with estuarine features in particular. The integrated coastal map of ecosystem types represents a powerful new tool for coastal planning and assessments.

The South African coast comprises dunes, cliffs, beaches, rocky and mixed shores, estuaries, mangroves, kelp and reefs. The country's coastal biodiversity is thus exceptional with high levels of endemism, especially among dune plants and beach fauna. The coast provides South Africans with food, jobs and protection from extreme weather and waves, and it is a place to play and enhance human health and well-being. However, the coast has been overlooked as an ecological entity in its own right, with piecemeal management of the different realms. Some management actions in the past have been inappropriate due to an incomplete understanding of coastal processes, with current managers facing many erosion and sand-inundation issues as a result of this legacy. This holds true both internationally and in South Africa.

Given the geographic position of the coast, it is exposed to pressures from both land and sea. Key drivers and pressures in the coast include: fishing and other biological resource use; inappropriate land use and development, especially on the foredunes and in EFZs; decreased water and sediment flowing through estuaries to the sea; pollution; ports and harbours; and mining. Many of these are cross-realm pressures and/or are more concentrated on the coast compared to that in the rest of the country. For example, the land area within 10km of the shore has seven times more mining, four times more development and plantations, and twice the rate of natural habitat loss compared to that of the hinterland. Furthermore, these pressures are exacerbated by climate change, particularly stressors such as sea-level rise, extreme storms, droughts and floods. As a result, the ecological condition of the coast is generally worse than that further inland and offshore, which in turn has consequences for coastal ecosystem threat status.

There are more threatened ecosystem types in the coast (60 percent) compared to that for the rest of the land and sea (16 percent). Within the coast, there are more Critically Endangered coastal ecosystem types on land (18) compared to the other two realms (3). However, a much larger proportion of estuarine and marine ecosystem types are threatened overall (19/22 and 57/85 respectively) compared to that for the terrestrial realm (34/79). These trends are probably driven by the fact that terrestrial pressures largely result in more localised areas of habitat loss related to a direct pressure (e.g., mining, urban development), whereas estuarine and marine ecosystem types are more impacted by multiple diffuse pressures that cause chronic degradation of ecosystem functioning (e.g. flow modification, pollution, trophic cascades from overfishing).

Approximately 87 percent of coastal ecosystem types have some level of protection and, overall, coastal ecosystem types have slightly higher protection levels than non-coastal ecosystem types. Marine coastal ecosystem types generally have higher levels of protection than their terrestrial and estuarine counterparts; with 54 percent and 22 percent in the Well Protected category respectively. It is expected that implementation of the new marine systematic biodiversity plan (that explicitly considered coastal integration) and ongoing negotiations towards even further expansion of the coastal and marine protected area network will see this indicator moving from strength to strength in the near future.

4.3.2.6 Sub-Antarctic territory

For the first time, South Africa's southernmost territory, the Prince Edward Islands (PEIs) and the surrounding territorial sea and exclusive economic zone have been included in the NBA. These sub-Antarctic islands are situated approximately 1 700 km southeast of the mainland and are comprised of Marion Island and the smaller Prince Edward Island. The sub-Antarctic region has unique terrestrial and marine ecosystem types not found on the South African mainland or in its surrounding oceans. The PEIs support abundant marine and terrestrial biodiversity and are a crucial breeding and feeding ground for globally threatened seabirds and for seals. Decades of research conducted at the PEIs by a network of institutions have placed South Africa at the forefront of sub-Antarctic and Antarctic science, and highlight the role of the PEIs as a natural laboratory for global change studies. Including the PEIs in the NBA provides a valuable addition for regular reporting of past and current research on the islands, which could ultimately make an important contribution to the management and conservation of their unique biota by identifying and directing future research and monitoring priorities. The terrestrial and marine biodiversity has been assessed using the IUCN Red List of Ecosystems guidelines, and this first attempt at national assessment will highlight knowledge gaps and research priorities for the PEI research community to focus on moving forward.

The Prince Edward Islands are a Special Nature Reserve and a Ramsar Wetland of International Importance, and 36 percent of the surrounding ocean is proclaimed as a MPA, however there are pressures on biodiversity – particularly from invasive species, fishing and climate change. Activities in this area are restricted to research, conservation management and commercial fishing. However, the ecological integrity of the PEIs has been affected by invasive species and climate change, which have brought about changes in both terrestrial and marine ecosystems. Of particular concern on Marion Island is the invasive House Mouse (Mus musculus), which has profoundly impacted indigenous invertebrates, plants and seabirds. As the impacts of invasive species are exacerbated by climate change, the two threats to the ecosystems are interactive and compounding. Marine invasive species are an emerging concern in the sub-Antarctic region, but their presence and potential impact around the PEIs is poorly understood due to limited research in the ecosystem types beyond the shelf. The commercial longline fishery for Patagonian Toothfish (Dissostichus eleginoides) has been a key pressure in the marine ecosystems of the shelf and slope. The potential impacts of this fishery, including impacts on Toothfish predators and prey, require further research. Elsewhere in the Southern Ocean, demersal longline fishing has impacted seabed ecosystems, particularly in fragile areas constituting Vulnerable Marine Ecosystems (VMEs). An improved understanding of the ecosystem impacts of this fishery is a research priority.

The first map of marine ecosystems for the Prince Edward Islands has been developed for this assessment, including 29 marine ecosystem types. As for the mainland, these marine and coastal ecosystem types merge seamlessly with the existing terrestrial ecosystem types mapped in 2006. The new marine ecosystem types include shore types, shelf types, as well as ecosystem types of the slope, plateau, ridges, seamounts, rift valleys and abyss. On the islands, five terrestrial ecosystem types have been previously described in the two biomes: Sub-Antarctic Tundra and Polar Desert. However, challenges remain in mapping these types at an appropriate scale. The majority of the marine and terrestrial ecosystem types described are likely to occur on and around other sub-Antarctic islands, indicating the need for regional work in ecosystem classification and mapping.

The preliminary national assessment of the PEI marine ecosystem types found that 21 percent of types are threatened by historical or current fishing, including one Endangered ecosystem type and five

Vulnerable ecosystem types. Terrestrial ecosystem types are currently categorised as Data Deficient. While the terrestrial ecosystems of the PEIs are free from the typical direct pressures of the mainland (e.g. croplands), they are subject to biological invasions and climate change. Both of these pressures are the subject of ongoing research and a preliminary regional assessment will be possible in the near future. Marine ecosystem threat status is driven largely by historical and current pressure from the longline fishery for Patagonian Toothfish. This includes substantial illegal, unreported and unregulated (IUU) fishing, particularly between 1994 and 2004. These assessments may be updated as new information on ecological condition becomes available (linked to the impacts of climate change, invasive species and Toothfish fishing) and global or regional assessments may be undertaken when the full extent of ecosystem types are considered. Regional assessment will require additional ecosystem mapping efforts on nearby islands and surrounding seas. There are also 28 threatened or Near Threatened bird species breeding on the islands. Birds were assessed as part of the marine assessment for the mainland since those species occurring on the islands also frequent South Africa's mainland waters. While understanding of the PEIs' species and ecosystems has developed substantially over the last few decades, there is considerable room for improving knowledge of ecological condition and species population trends, especially under accelerated climate change.

A first assessment of ecosystem protection levels was completed for both terrestrial and marine ecosystems. This national assessment found that 10 of 29 marine ecosystem types are Well Protected, 14 are Moderately Protected, one is Poorly Protected and four are Not Protected. All five of the terrestrial ecosystem types were categorised as Well Protected. Regional assessments are needed to better understand protection levels for those ecosystem types that also occur outside of South Africa's territory in the sub-Antarctic.

4.3.3 South Africa's protected areas accounts

The following section is an edited extract of South Africa's Protected Area Accounts, 1900 - 2020 report. Readers are encouraged to read these reports for more, in-depth, fully referenced, information.

4.3.3.1 Accounts for Protected Areas

The Accounts for Protected Areas, 1900 to 2020, were published on 4 October 2021 by Statistics South Africa (Stats SA), in collaboration with the South African National Biodiversity Institute (SANBI) and the Department of Forestry, Fisheries and the Environment (DFFE), as the second publication in Stats SA's Natural Capital series.

The Accounts for Protected Areas were produced as part of the Natural Capital Accounting and Valuation of Ecosystem Services (NCAVES) project, which was implemented from 2017 to 2021, led globally by the United Nations Statistics Division (UNSD) and United Nations Environment Programme (UNEP) with funding from the European Union (EU). In South Africa, the NCAVES project was led jointly by Statistics South Africa (Stats SA) and the South African National Biodiversity Institute (SANBI).

4.3.3.2 Tracking change in the protected area estate

At the end of 2020, just over 11,2 million ha or 9,2 percent of the mainland surface area of South Africa was protected. Protected areas are national assets that serve as nodes in South Africa's ecological infrastructure network, protecting ecosystems that deliver important services to people, such as the production of clean water, flood moderation, prevention of erosion, carbon storage, and the aesthetic value of the landscape.

They provide a home for some of the country's most iconic species, as well as providing recreational spaces for South Africans and global visitors. Protected areas can also play an important role in the development of rural economies. If protected land in South Africa was its own province, it would be larger than North West, KwaZulu-Natal, Mpumalanga or Gauteng.

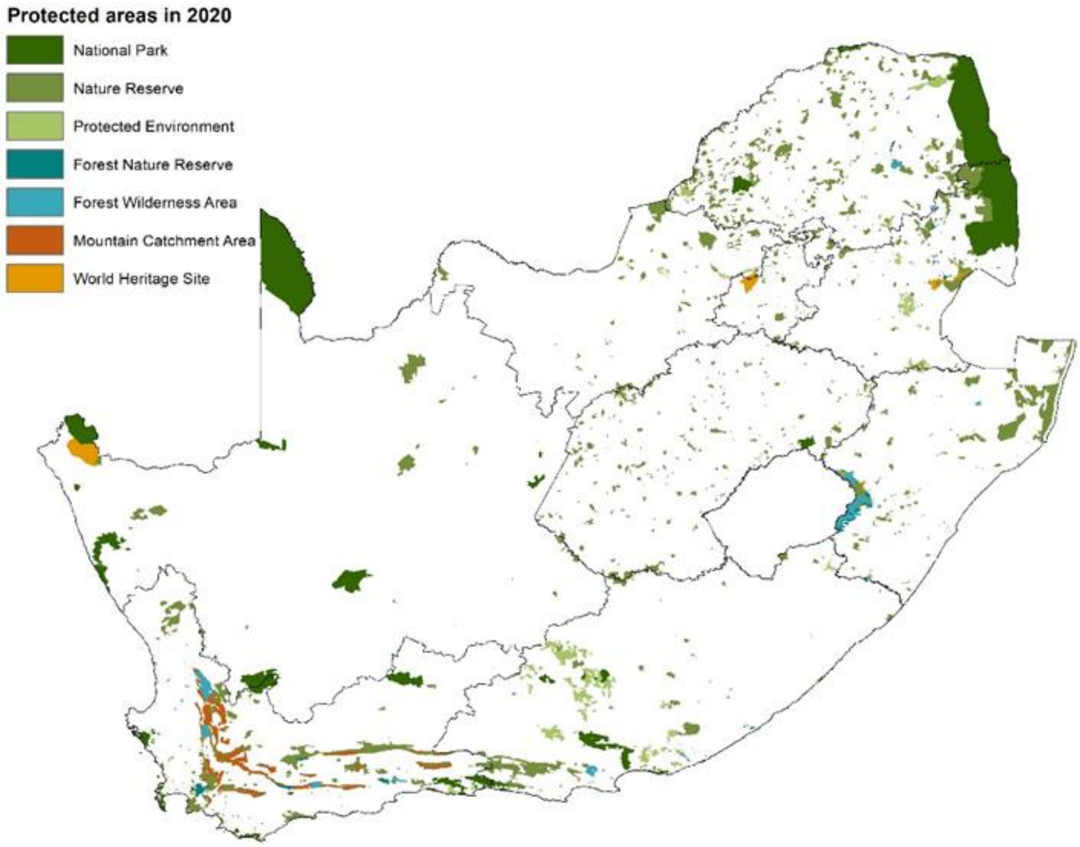


Figure: Land-based protected areas in 2020, based on declaration dates in the South African Protected Areas Database (SAPAD). Note that World Heritage Sites show only the portion not in other protected area types.

Looking back to 1900, the South Africa's first Accounts for Protected Areas, 1900 to 2020, presents a range of facts and figures about the country's land-based protected areas over 120 years. The document takes a dive into the South African Protected Area Database (SAPAD), breaking down the data by province, biome, and type of protected area and tracking the expansion of the protected area estate at regular time steps over the period 1900 to 2020. Land-based protected areas are ecologically important as they may provide protection for both terrestrial and freshwater ecosystems. The analysis doesn't yet include marine protected areas, which are also an important part of the protected area estate.

Proclaimed by law and managed for biodiversity conservation, land-based protected areas include National Parks, Nature Reserves, Protected Environments, Forest Nature Reserves, Forest Wilderness Areas, Mountain Catchment Areas and World Heritage Sites. National Parks and Nature Reserves make up the majority of the protected area estate. Over the most 15 years however, Protected Environments have made a growing contribution to the protected area estate, now making up, for example, 38 percent of the Eastern Cape's protected area estate.

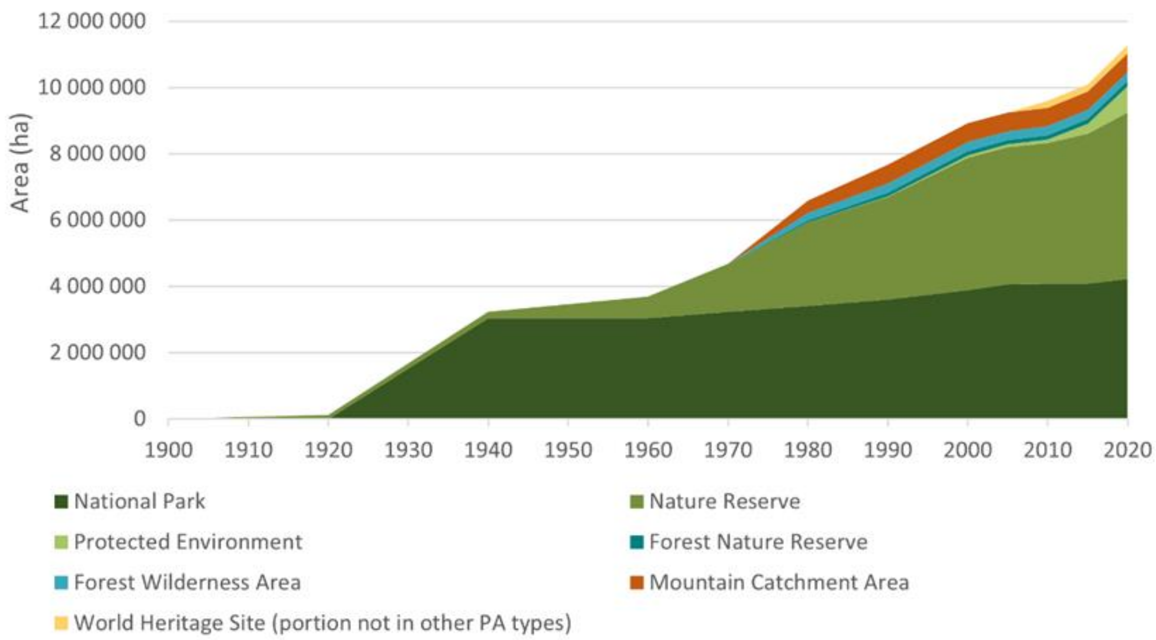


Figure: Cumulative extent of the land-based protected area estate by type of protected area, reflecting the 11 accounting periods from 1900 to 2020, and based on declaration dates in the South African Protected Area Database, in hectares

The accounts track the expansion of the protected area estate at regular time intervals over the period 1900 to 2020, at national, provincial and biome level, disaggregated by types of protected areas. Accounts for protected areas form part of Natural Capital Accounting (NCA), which provides a systematic framework for measuring and reporting on stocks and flows of natural capital, analogous to accounts for other forms of capital. They provide a tool to monitor and report on changes in the protected area estate, in support of policy and decision-making.

4.3.3.3 Tracking change in the land-based protected area estate over 100 years

The size of the land-based protected area estate has increased since early declarations over 100 years ago. The protected area estate has expanded in all provinces and in all biomes across South Africa, but not evenly. To make information about the growing nature of protected areas, the accounts provide account tables, graphs and maps showing key indicators such as size of the protected area estate, proportion of the country, province or biome protected, percentage change in the size of the protected area estate for a given accounting period and the composition of protected area estate based on type.

At the end of 2020, the most extensively protected province in terms of the proportion of the province protected was Mpumalanga, with just under 1,7 million ha or 22 percent of the province protected. In terms of absolute area protected though, this is less than the area protected in Limpopo (just over 2,4 million ha) and the Northern Cape (just over 2 million ha). Limpopo and the Northern Cape are much larger provinces, so protected areas made up 19,3 percent and 5,5 percent of those provinces respectively. Over the period between 2000 and 2020, the largest increase in the proportion of province protected was seen in Gauteng and Eastern Cape. The types of protected areas that protect the mainland surface vary across provinces. More than half of Mpumalanga is protected by National Parks, specifically Kruger National Park. North West Province is mainly protected with Nature Reserves.

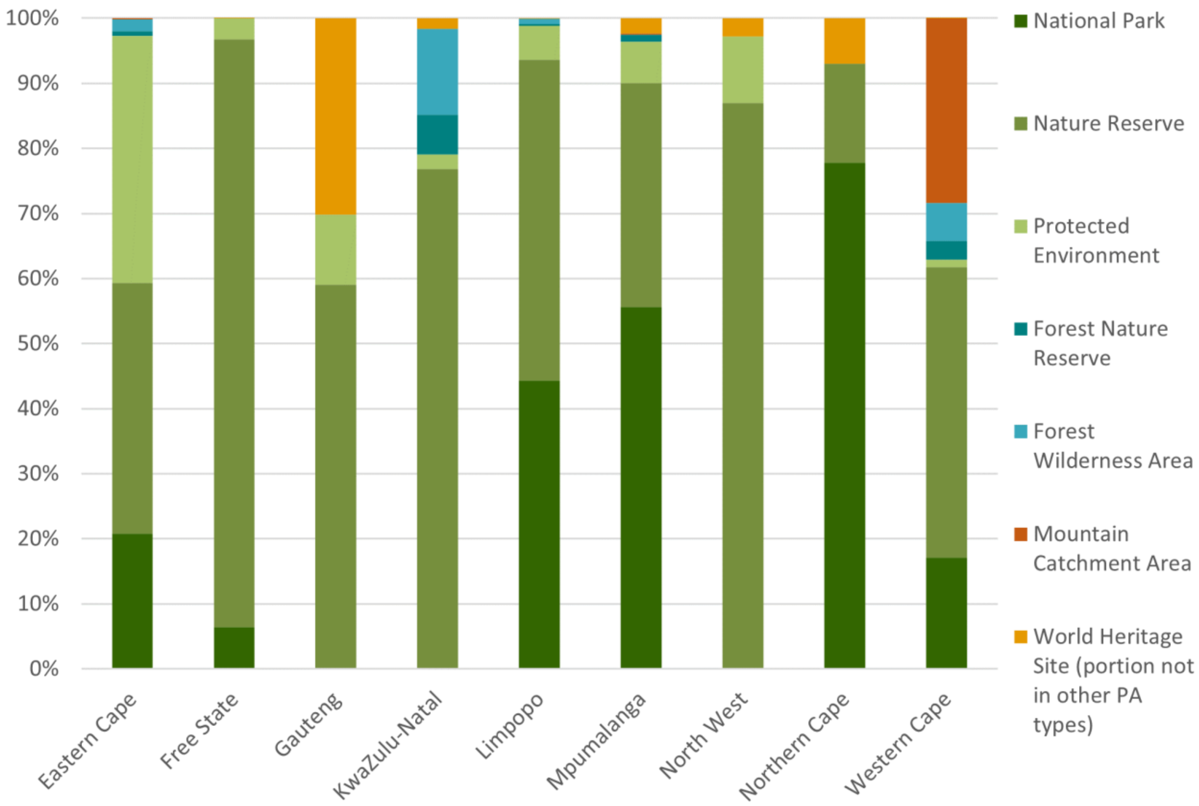


Figure: Composition of the protected area estate by protected area type, for each province in 2020, based on the South African Protected Areas Database

The accounts allow one to look at individual biomes over time, which also tells interesting stories. The Savanna Biome is the largest biome in South Africa and has been well represented in the protected area estate for a long time with well-known protected areas such as the Kruger National Park and Pilanesberg Game Reserve. The Desert Biome is the second smallest biome in South Africa and was not protected until the end of the 2000 accounting period. By the end of 2020, 22,4 percent of the Desert Biome was protected. The Forest Biome had the largest proportion of the biome protected at the end of 2020 with 40.1 percent of the biome protected. The biomes with the largest increase in the area protected over the five-year period from 2015 to 2020 were the Nama-Karoo (105,5 percent increase) and Albany Thicket (42,5 percent increase).

It is interesting to view these findings together with the assessment of Ecosystem Protection Level from the National Biodiversity Assessment (NBA) 2018. For example, notwithstanding the large recent increases, the Nama-Karoo and Albany Thicket biomes had the highest proportion of under-protected ecosystem types. Although better protected overall, the Fynbos, Savanna and Grassland biomes had by far the highest number of under-protected individual ecosystem types. In other words, many ecosystem types within these biomes are still under-protected and not adequately included in the protected area network. The NBA, together with the National Protected Area Expansion Strategy, helps to ensure that as the protected area estate grows, it includes a wider range of different ecosystem types.

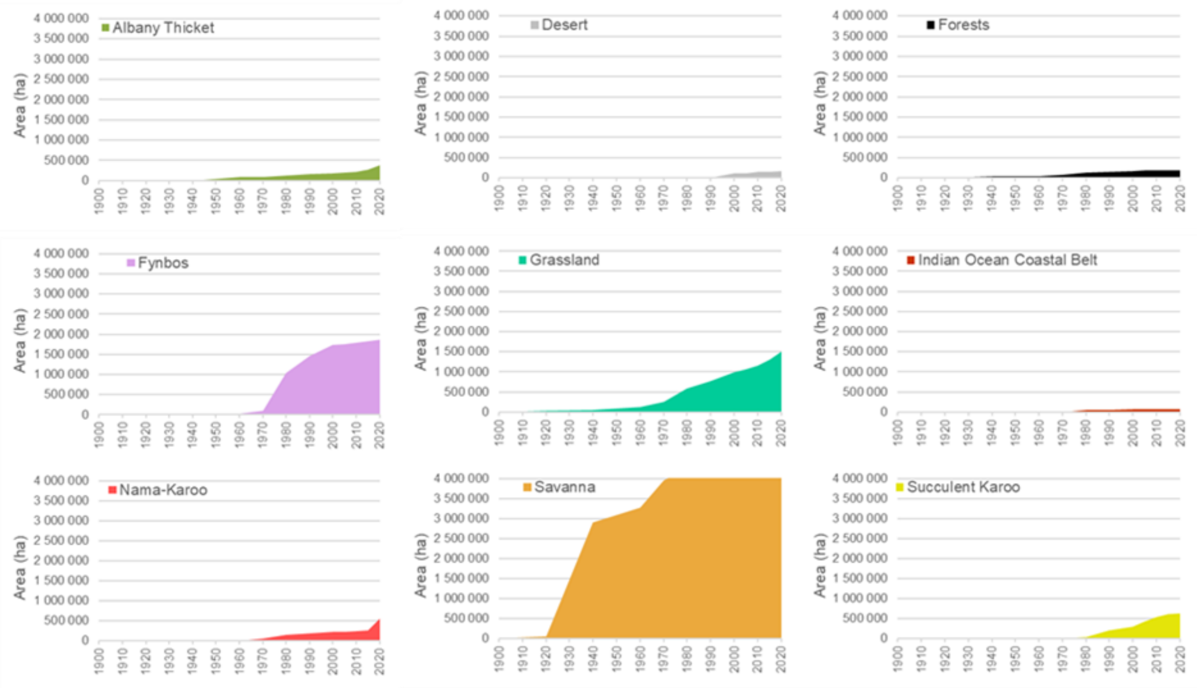


Figure: Cumulative extent of the land-based protected area estate in each biome, reflecting the 11 accounting periods from 1900 to 2020 and based on declaration dates in the South African Protected Areas Database, in hectares, all shown on the same scale

4.3.3.4 Taking an accounting approach and future directions of work

Accounts provide a standardized approach for measuring and presenting changes in protected areas across the country over time. The information from the accounts can provide evidence to inform planning, policy and decision-making related to protected areas, along with the National Biodiversity Assessment (NBA), the National Protected Areas Expansion Strategy (NPAES) and other existing strategies. Furthermore, the accounts can provide information for reporting on progress towards national and global targets for protected areas.

Future iterations of accounts for protected areas will include marine protected areas. The accounts use the South African Protected Area Database (SAPAD), which is the spatial data inventory of protected areas in South Africa developed and maintained by DFFE. The strength of this dataset is that it includes protected area names, types and declaration dates in a manner that provides a time series for accounts. Limitations of the SAPAD dataset have been made explicit in the report, including uncertainty around the declaration dates of some protected areas. More investment in improving the protected area dataset is needed, such as in terms of declaration dates, ensuring data for protected areas declared through biodiversity stewardship and withdrawals from the protected area estate. Notwithstanding these, the findings add to the richness of available information about protected areas.

4.3.4 Biological invasions

The following section is an edited extract of The Status of Biological Invasions and their Management in South Africa 2019 report and readers are encouraged to read the report for more, in-depth, fully referenced, information on the state of South Africa's biological invasions.

Biological invasions have had varied and significant impacts on all sectors of South African society. They are a major threat to socioeconomic sustainability, they have exacerbated the impacts of droughts, floods and wild-fires, and have caused significant losses in agriculture, pastoralism, and forestry. Biological invasions account for a quarter of all biodiversity loss in South Africa to date. The South African government spends well over 1 billion ZAR per year on their management. Given South Africa's rich and varied cultural and biological diversity, and the long history both of alien species introductions and of attempts to regulate, manage, and study them, South Africa is a global exemplar of the impacts of and potential responses to biological invasions. South Africa has taken a world-leading stance in controlling invasions specifically in terms of combining efforts at alien plant clearing with poverty alleviation, the use of classical biological control, and its innovative Alien and Invasive Species (A&IS) Regulations of 2014. One feature of the A&IS Regulations is the requirement for the South African National Biodiversity Institute (SANBI) to report, every three years, on the status of biological invasions and their management in South Africa.

4.3.4.1 Pathways prominence

Invasive species introduction pathway prominence considers the size of the pathways of introduction in terms of their socio-economic importance. The pathway categorisation scheme used for all pathway indicators is that adopted by the Convention on Biological Diversity. In most cases, introduction pathway prominence has not changed since the 2017 report (The status of biological invasions and their management in South Africa in 2017), but the number of fishing boats in South African waters has decreased by 40 percent and, therefore, so too has the prominence of the pathway related to stowaways on fishing equipment. There has, however, been some significant research on pathways of introduction since the release of 2017 report, facilitating more robust assessments for some pathways, and allowing introduction pathway prominence to be estimated for the first time for others. Recent research has shown that hundreds of invertebrate taxa are sold in the pet trade (195 tarantula species and 53 other invertebrates, but it is likely that many more are sold), although the role of the pet trade in new introductions versus within-country dispersal is unclear.

Figure: The hundreds of alien medicinal plant which are imported into South Africa, like this *Moringa oleifera*, pose an invasion threat

Based on these studies the prominence of the pet trade pathway is now scored as moderate (it was scored as minor in the 2017 report). This increase in introduction pathway prominence is due to better knowledge. Whether there has been an actual change in the volume of trade is not known. One introduction pathway that had previously received little research attention is the traditional medicine trade. Hundreds of alien medicinal plant and fungal species (214 species, 101 as propagules) are imported into South Africa, often from multiple sources. Some of these species, e.g. Moringa oleifera, Nigella sativa and Zingiber officinale, pose an invasion threat to the country as they are imported as viable propagules, have high propagule pressure, and a history of invasion elsewhere in the world.

Introduction rates of invasions

Introduction rates consider the number of new alien taxa introduced through the pathways of introduction, and how this number has changed over time. The introduction pathway of most taxa (54 percent) introduced to South Africa is still not known. Of the alien taxa known to have been introduced to South Africa, most (15 percent) are plants that were introduced for horticulture and/or ornamental purposes. Many of the taxa that are known to have been accidentally introduced were introduced through shipping (5 percent of all introductions). Due to better data, it is clear that new alien taxa continue to be intentionally and accidentally introduced to South Africa, and there has been an increase in the number of taxa that are thought to have been introduced over all time, through 18 of the 44 pathways. During the 2017–2019 period new taxa are likely to have been introduced accidentally through the timber trade, shipping (hull fouling or the release of ballast water), as contaminants on imported animals, and through natural dispersal from other African countries where previously introduced.

In terms of legal intentional introductions, many alien taxa (157 taxa) have been released as biological control agents against invasive organisms such as invertebrates and plants, with four new taxa introduced to control alien plants during the 2017–2019 period. Biological control is a highly regulated pathway and, as part of obtaining an import permit, these taxa are assessed and must be found unlikely to have important direct negative impacts. The introduction of biological control agents provides substantial benefits, and to date these introductions have caused no important negative impacts. Therefore, these introductions are not included in the estimate of the high-level indicator 'Rate of unregulated introduction of new species'. Besides those for biological control, no import permits were issued in the 2017–2019 period for specimens of taxa not previously recorded in the country or for which an import permit had not been previously issued.

There has been an increase in the number of new alien taxa that are thought to have entered South Africa through natural dispersal from neighbouring countries where they had been previously introduced. Therefore, while many introductions are believed to be due to intercontinental human-mediated dispersal, it appears an increasing number of alien taxa are showing intra-African dispersal.

Within-country dispersal rates

Within-country dispersal rates consider the number of taxa that have dispersed within South Africa through the pathways of dispersal, and how this number has changed over time. Data for within-country dispersal rates have not been collated for the entire country, and so the indicator could not be populated. However, as in the 2017 report, data collected from the literature indicates that alien and native taxa are being intentionally and accidentally transported around the country, and that these taxa are dispersing within the country through many pathways, with taxa dispersing through at least 22 of the 44 pathways of dispersal. Recent research on biofouling has highlighted the importance of recreational yachts, particularly those used for cruising, in the dispersal of marine alien taxa within South Africa. Furthermore, 137 alien plant species are considered as transformers in South African National Parks, and most were intentionally introduced as ornamental plants or were dispersed by rivers and animals, and many utilised multiple pathways. It is expected that this pattern is applicable for South Africa more broadly. For example, a freshwater gastropod (*Tarebia granifera*) from South-East Asia, is dispersing rapidly within the country both through natural spread (e.g. on aquatic plants and by attaching to the feathers of birds) and as a stowaway on boats and trailers. However, it is unclear how the within country dispersal pathways have changed.

Figure: The freshwater gastropod *Tarebia granifera* from South-East Asia, is dispersing rapidly within the country both through natural spread (e.g. on aquatic plants and by attaching to the feathers of birds) and as a stowaway on boats and trailers

Trends in pathways indicators

Indicator	Trend (confidence)	Current status	Outlook
Introduction pathway prominence	⇨ (Medium)	There has been little change since the 2017 report. 11 introduction pathways play a major socio-economic role.	There is no desired trend for introduction pathway prominence as it is largely a function of global trade and travel. However, there is a need to track pathways and trends in trade to ensure that interventions respond to these trends, otherwise potentially harmful alien taxa will continue to be introduced. For example, growth in intra-African trade will increase the risk of

Indicator	Trend (confidence)	Current status	Outlook
			importing invasive taxa to South Africa, and exporting them to other African countries.
Introduction rates	→ (Low)	During the 2017–2019 period, new taxa were legally introduced for biological control, and were accidentally introduced through the timber trade, shipping, as contaminants on imported animals, and through natural dispersal from other African countries where they had previously been introduced.	In many cases regulated taxa (for which the risks have been analysed and found to be acceptable) are expected to be a net benefit to the country, and in the case of biological control assist with the control of biological invasions. Therefore, no specific trend is desirable for regulated taxa, but what is desirable is that a process is in place to regulate them. The rate of introduction of unregulated taxa will increase as the volume of trade and travel increases. The rate of introduction of unregulated taxa is, however, sensitive to the intensiveness of survey activities and is likely to be relatively unresponsive to changes in actual introductions. This is because many accidental introductions can go undetected for a long time and are only discovered once a specialist survey is undertaken. Unless pathways are identified, prioritised, and managed, potentially harmful alien taxa will continue to be accidentally and illegally introduced.
Within country pathway prominence	Not assessed	Many pathways are likely playing a socio-economic role within the country, but the extent of this role and how it has changed since the 2017 report is not known.	There is no desired trend for within-country pathway prominence as it is a function of internal trade and transport. However, trends in these pathways need to be tracked to ensure interventions are in place where they are needed.
Within-country dispersal rates	Not assessed	National-scale data has yet to be collated, but information was available for alien plant taxa in South Africa's national parks. Most alien plants were intentionally introduced to national parks as ornamental plants or were dispersed by rivers and animals, and many utilised multiple pathways.	Increases in the volume of trade and travel will lead to increases in the within-country dispersal rates of taxa known to be invasive, or that are considered likely to become invasive. The spread of regulated invasive taxa is of particular concern, and while other taxa might also spread, it is not clear whether this should be a concern. Unless pathways that facilitate the within country dispersal of regulated taxa are identified, prioritised, and managed, the spread of these taxa will increase, and so there will be increases in both the rate of expansion of currently invasive taxa, and in the likelihood that alien taxa will find a suitable part of the country in which to become invasive.
High level indicator A. Rate of unregulated introduction of new species	↘ (Low)	Between 2010 and 2019 approximately 3 new taxa were introduced per year either accidentally or intentionally but illegally. This was lower than the	Despite the apparent recent decline in introductions, opportunities for the introduction of alien species are expected to increase as the volume of trade and travel increases. Whether this will result in the introduction of more invasive species will depend on the degree to which key

Indicator	Trend (confidence)	Current status	Outlook
		estimated rate during the previous decade (~ 5 per year).	pathways are identified and prioritised for management. Improvements to inspection, management, and incursion response at border would strengthen South Africa's biosecurity.

4.3.4.2 Species

Number and status of alien species

While there are various estimates of the number of alien species in South Africa, it is not always clear how such estimates are arrived at, and the evidence underpinning the reported status of particular alien species is in some cases missing, e.g. several species listed as invasive under the NEM: BA A&IS Regulations do not appear to be present in the country. The A&IS Regulations require the Minister of Environmental Affairs to develop and maintain a national list of invasive species that are known to occur in South Africa. As of December 2019, 556 taxa were listed under these regulations but there are many other alien species that might warrant regulating. However, for the majority of alien species found in South Africa, there are no studies documenting their occurrence status. The alien species list in the biological invasion report, therefore, represents not just an update to the alien species list in the 2017 report, but a step towards a national registry of alien species in the country.

The data sources capture current knowledge of the status of each alien species in a manner that allows for the information to be easily reviewed and updated. The changes since the 2017 report are summarised and documented in detail. These changes reflect both differences in how data were collated and changes in the actual status of specific alien species. The species listed in the 2019 report have been carefully checked and only species for which a reliable record of their occurrence in South Africa have been included. This has resulted in a new baseline from which change can be tracked.

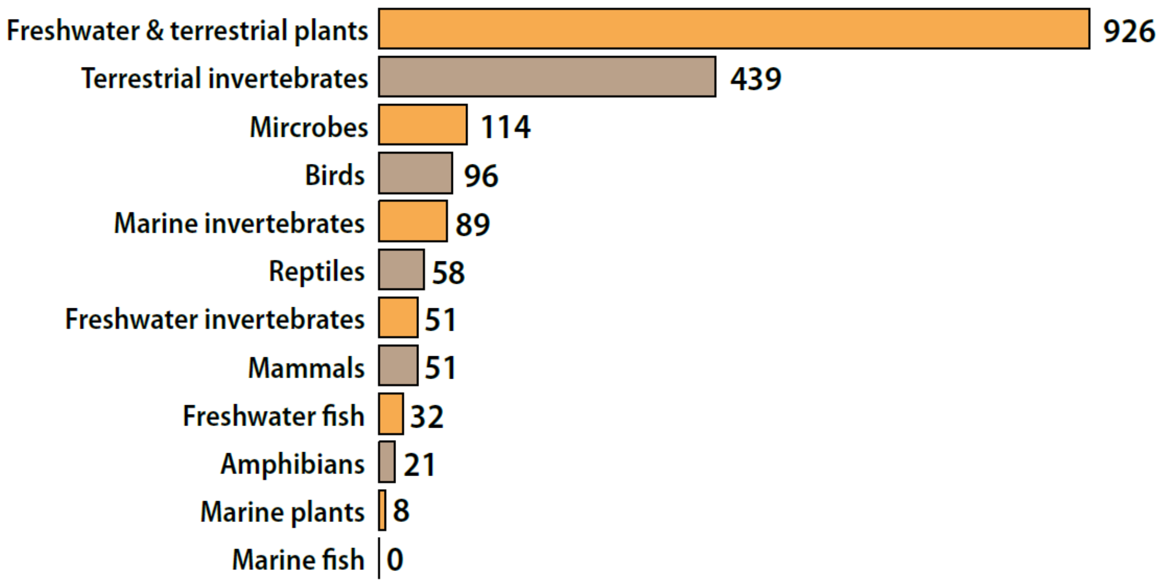


Figure: The number of alien species recorded as present in South Africa as of December 2019

Additional species have also been added to the list. These additions were either taxa that arrived in the period 2017–2019, or that arrived prior to 2017, but were only recently confirmed, for example the polyphagous shot hole borer. Whether an alien species recorded as present is naturalised or invasive is not well known at present. Currently this distinction is based on the assessment done in the 2017 report that inferred invasiveness from known distribution range, literature, and expert opinion. This needs to be re-evaluated and should be based solely on documented evidence.

In terms of the number of alien species recorded as present in South Africa as of December 2019, as per the regulatory groupings of the NEM: BA A&IS Regulations, many of these taxa are not invasive and are only known from captivity or cultivation. The list is not comprehensive (many alien taxa in captivity or cultivation are not included yet); however, the evidence for the presence of every taxon that is included is clearly specified.

Figure: The polyphagous shot hole borer, which looks set to be one of the most damaging biological invasions faced by South Africa, is an example of a new addition to the list of alien species recorded as present in South Africa as of December 2019

Extent of alien species

Occurrence data published on the Global Biodiversity Information Facility (GBIF) were only available for a few taxa. At a provincial scale, there has been minimal change in the extent of many alien species, and the majority are only found in three or fewer provinces.

The table below indicates the number of alien species that are recorded as present in a given number of provinces in South Africa as of December 2019 based on occurrence records from GBIF and the change in these values since the 2017 report. The majority of alien species are localised, although approximately 9 percent are found in all nine provinces.

Table: Number of alien species in provinces

	Number of provinces								
	1	2	3	4	5	6	7	8	9
End of 2016	290	167	128	80	80	67	65	59	85
End of 2019	281	161	140	82	80	63	70	59	87
Change	**-9**	**-6**	**12**	**2**	**0**	**-4**	**5**	**0**	**2**

At a finer scale quarter degree grid cells (qdgc) almost half (44 percent) of the alien species for which data was available showed an increase in spatial extent. Taxa that had small ranges (i.e. they are found in ≤ 10 qdgcs) have seen their broad-scale distributions double since the 2017 report, while the extent of very widespread taxa (≥ 100 qdgcs) have, on average, increased by 12 percent. The annual proportional increase is similar to that seen for invasive plants when evaluated over the period 2000–2016 and supports the general assertion that the majority of alien species have a limited distribution, but that many of these are increasing in extent. However, the spatial extent of an alien species cannot decline as it is estimated here. A consistent method of detecting and documenting reductions in species' extents is needed.

Abundance of alien species

In the 2017 report, estimates of the abundance of alien species were based on two sources of data on terrestrial plants – a 1998 report to the Water Research Commission (WRC) and the National Invasive Alien Plant Survey (NIAPS). This situation has not changed and both these estimates are made with low confidence. While some of the NIAPS survey approach was recently further described, it is still difficult to assess if the method works because no results and no estimates of distribution or abundance is estimated for the three species studied.

Impact of alien species

There have been major advances since the 2017 report in monitoring the impact of alien species. The Environmental Impact Classification for Alien taxa (EICAT) has been approved as an International Union for Conservation of Nature IUCN product, and has recently been published as a standard, and the Socio-Economic Impact Classification of Alien taxa (SEICAT) has been developed to deal with non-environmental impacts. There have been global EICAT assessments for amphibians, birds, mammals, bamboos, gastropods, and some other invertebrates. In South Africa, national-level EICAT assessments have been done for 32 species but in many cases (62 percent) there was no reliable data. Seven were recorded to cause major or massive impacts. These include, two grass species giant reed (*Arundo donax*) and reed meadow grass (*Glyceria maxima*) that competitively displace native species, and five fish species that threaten native fauna through direct predation smallmouth bass (*Micropterus dolomieu*), largemouth bass (*M. salmoides*), rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) and hybridisation Nile tilapia (*Oreochromis niloticus*). SEICAT has only been applied to a limited range of taxa so far, including gastropods and some mammals alien to South Africa, and alien amphibians and marine fishes globally. EICAT and SEICAT are based on published evidence and aim to make impact assessments comparable by providing a clearly defined protocol to identify impact mechanisms and their magnitudes, and to minimise assessor bias. Therefore, the aim of future reports is to fully incorporate EICAT and SEICAT assessments. However, and despite the methodological advances of EICAT and SEICAT, quantifying the impacts of alien species remains a major challenge, both globally and in South Africa. For most species, there is almost no documented evidence of impacts and available evidence is based on different assessment methods, which makes it difficult to compare impacts across taxa and regions. Reliable impact assessments for alien species in South Africa will require systematic data on impacts to be collected and collated.

Figure: Smallmouth bass (*Micropterus dolomieu*), is one of the five fish species that threaten native fauna through direct predation

Table: Trends in species indicators

Indicator	Trend (Confidence)	Current status	Outlook
Number and status of alien species	↗ (Low)	Over a third of 1880 alien species that are known to occur in South Africa have become invasive. A notable new invasive species is the polyphagous shot hole borer (an ambrosia beetle from Southeast Asia), which was first detected in 2017 in Pietermaritzburg, but was already well established in several urban areas around the country at the time of its detection. It looks set to be one of the most damaging biological invasions faced by South Africa. It has already killed thousands of trees and threatens many more.	South Africa faces a substantial invasion debt because most alien species are not yet invasive, and new alien species will continue to arrive. The number of alien species recorded in the country will also increase if more effort is spent on detection, even for well-studied groups like plants.
Extent of alien species	↗ (Low)	Occurrence data were only available for a few taxa. At a broad scale (e.g. provinces), there has been minimal	The majority of alien species are localised and only a few are widespread. However, the

Indicator	Trend (Confidence)	Current status	Outlook
		change in the extent of many alien species, and the majority of species remain confined to a few sites. At a finer scale (e.g. quarter degree grid cell), taxa that had small ranges have seen their distributions double since the 2017 report, while already very widespread taxa have on average increased by 12%.	potential for them to increase their distribution is large and the extent of most species will continue to increase unless effective control is put in place.
Abundance of alien species	Not assessed	No new data were available on the abundance of alien species.	Understanding trends in abundance is important if the effectiveness of management interventions are to be monitored, and the magnitude of future impacts predicted.
Impact of alien species	➡ (Medium)	215 species have been assessed using an evidence-based framework, and 7 species have been reported to cause major to massive impacts using EICAT and 1 using SEICAT. However, there was no reliable data for the majority of the assessed species. This represents a shift from expert-based assessments of impact of alien species to evidence-based assessments.	This remains a major gap where detailed research is needed. Unless the impacts of invasive species can be quantified, attempts to regulate them will remain contentious in many cases.
Number of invasive species that have major impacts	Not assessed	In the 2017 report, 107 alien species were identified by experts as particularly damaging. A process is under way to formally assess all invasive species using the IUCN's EICAT scheme. So far 215 species have been assessed, and eight found to cause major to massive impacts (five fish, two grasses, and one mammal species). However in many cases there was a lack of reliable data.	The number of alien species recorded to have major or massive negative impacts will increase as more species are formally assessed. The formal assessment of the impact of alien species provides the rationale for regulation and management, can improve compliance and implementation of intervention measures, and assist to resolve conflicts. However, impact assessments are hampered by a lack of reliable data for most species.

4.3.4.3 Sites

Alien species richness

The alien species reported from South Africa are distributed across the country, with most broad-scale administrative units and biogeographical regions being invaded by a variety of species. The recorded invasive species richness has increased by 0–4.5 percent in individual provinces, with the highest invasive species richness still in Mpumalanga, while the Northern Cape still has the lowest richness. Invasive species richness is highest in the Fynbos, Savanna, and Grassland biomes and lowest in the Desert and Forest biomes. Only 2 of the 22 water management areas have no recorded invasive animal species, but the other water management areas only have at most 4 species recorded. 56 invasive species have been recorded in South Africa's marine ecoregions, with the highest richness being recorded in the Agulhas and Southern Benguela ecoregions. To date, no invasive species have been recorded offshore or in the ocean around the Prince Edward Islands.

In terms of invasive species richness in South Africa for different broad-scale administrative units and biogeographical regions, the estimates of change are made with low confidence because most reported increases arise from the formal recording of species that have probably been present for some time. South African records are available from GBIF.

Invasive terrestrial species and invasive freshwater plant species richness per province

Province/region	End of 2016	End of 2019	Change
Eastern Cape	142	148	+6
Free State	85	88	+3
Gauteng	131	133	+2
KwaZulu-Natal	182	184	+2
Limpopo	103	106	+3
Mpumalanga	204	210	+6
Northern Cape	64	64	0
North West	81	81	0
Western Cape	178	186	+8
Prince Edward Islands	NA	35	NA

Relative invasive abundance

The distribution and cover of invasive plants have been estimated for some protected areas. Estimates of relative abundance were provided by Cape Nature and Ezemvelo KwaZulu-Natal Wildlife for all of their protected areas for the 2017 report. These estimates were not updated for the 2019 report. However, estimates of relative abundance for the 2019 report were provided by the South African National Parks. While no protected areas are currently dominated by invasive plants, several important invasions are apparent. For example, parts of the Garden Route National Park are dominated by invasive plants although overall the park is only moderately invaded. The reliability of such estimates is, however, questionable, as fine-scale systematic surveys can produce estimates that are substantially different from datasets used for planning alien plant control operations. Nonetheless carefully considered broad-scale estimates of relative abundance repeated over time would allow trends to be tracked with a moderate level of confidence in future reports. Achieving consistency in tracking relative abundance in protected areas could be facilitated by the inclusion of a standardised monitoring protocol in the criteria for the preparation of management plans developed by the DFFE in terms of the NEM:BA A&IS Regulations.

Estimates of relative invasive abundance in South Africa's protected areas

Relative invasive abundance	Number of Cape Nature's protected areas (2017 report)	Number of Ezemvelo KwaZulu-Natal Wildlife's protected areas (2017 report)	Number of SANPark's protected areas (2019 report)
Alien-free	0	1	0
Minor <2%	19	59	14
Moderate 2–10%	4	39	2
Extensive 10–50%	1	22	0

Dominant >50%	0	0	0

Impact of invasions

The results of several studies that assessed the impacts of biological invasions at a number of scales have been published since the 2017 report. These studies strengthen the evidence base for quantifying the magnitude of impacts, but overall levels of confidence in these estimates remain low. This is because several of the studies are based on models in which assumptions have had to be made that were acknowledged to be tenuous, and results still have to be extrapolated from small scales (e.g. several hectares) to larger scales (e.g. provinces, biomes or water management areas). The impacts at particular sites are, however, increasingly well understood.

Findings of research studies published in the period 2017–2019 with comparisons to indicator values from the 2017 report where relevant.

Affected sector	Value in the 2017 report	Value in the 2019 report	Difference
Biodiversity	Moderate impacts on biodiversity intactness for South Africa	Major impacts on biodiversity over 10–50 ha.	Scales differ, so not comparable.
Biodiversity	Not assessed	All major taxonomic groups have species directly threatened by invasions according to Red List assessments. Invasive species are the leading pressure on native amphibians and freshwater fishes. Invasive species were the primary driver of some species, especially plants and butterflies, being listed in higher categories of threat.	Not applicable.
Soil	Not assessed	Moderate impacts through soil nutrient enrichment following invasion over 10–50 ha.	Not applicable
Fire severity	Not assessed	Major impacts on fire severity over ~10 qdgcs.	Not applicable
Water runoff	Annual Surface water runoff reduced by 1–321 million m^3 per primary catchment.	Annual Surface water runoff reduced by 1.15–2.11, and 7.98 million m^3 for two catchments.	No change
Rangeland carrying capacity	Reduction in carrying capacity of 19 000 large livestock units in the grassland biome.	Reduction in carrying capacity of 75% (from 5 to 1.25 large livestock units on 10 ha).	Scales differ, so not comparable
Monetary value of impacts on sites	Annual losses of ZAR 5 864 million and ZAR 337 million for water resources and livestock production respectively for South Africa.	Losses have net present value (NPV) of ZAR 34 and 1.9 billion for water resources and livestock production respectively for South Africa.	Annual losses reported in the 2017 report would have to be converted to NPV (6% discount rate over 25 years) to be able to compare estimates.

4.4 State of water

The following section is an edited extract of the National State of Water Report, 2022. Readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African state of water.

The Department of Water and Sanitation, the custodian of the nation's water resources and a public trustee, is obliged by the National Water Act (Act No. 36 of 1998) to establish monitoring networks and information systems and report on the status of water resources in the country. The National State of Water report, which is published annually, is set out to (i) communicate the available water resources information to the public and aims to assist water users in decision-making; (ii) evaluate the implementation of legislation; (iii) highlight identified problem areas; and (iv) outline measures taken by the department to eradicate highlighted issues and balance the water demand and supply.

4.4.1 Water sector institutional reform

The South African Water Sector Institutional Reform has not been completed, and the outlook as of October 2022 is illustrated in figure below. The national Department of Water and Sanitation (DWS) is the custodian of water resources with an obligation to perform water resource management functions. The national Department, acting through the Minister, is responsible for water sector policy, support, and regulation. The water resource management functions are to be delegated to the Catchment Management Agencies (CMAs), although there is some level of uncertainty currently. This supports the principles of good governance, where water is managed locally. In water management areas where a CMA has not been established, the responsible authority (DWS national and provincial offices) continues to act as a CMA to perform all water resource management functions at a catchment level.

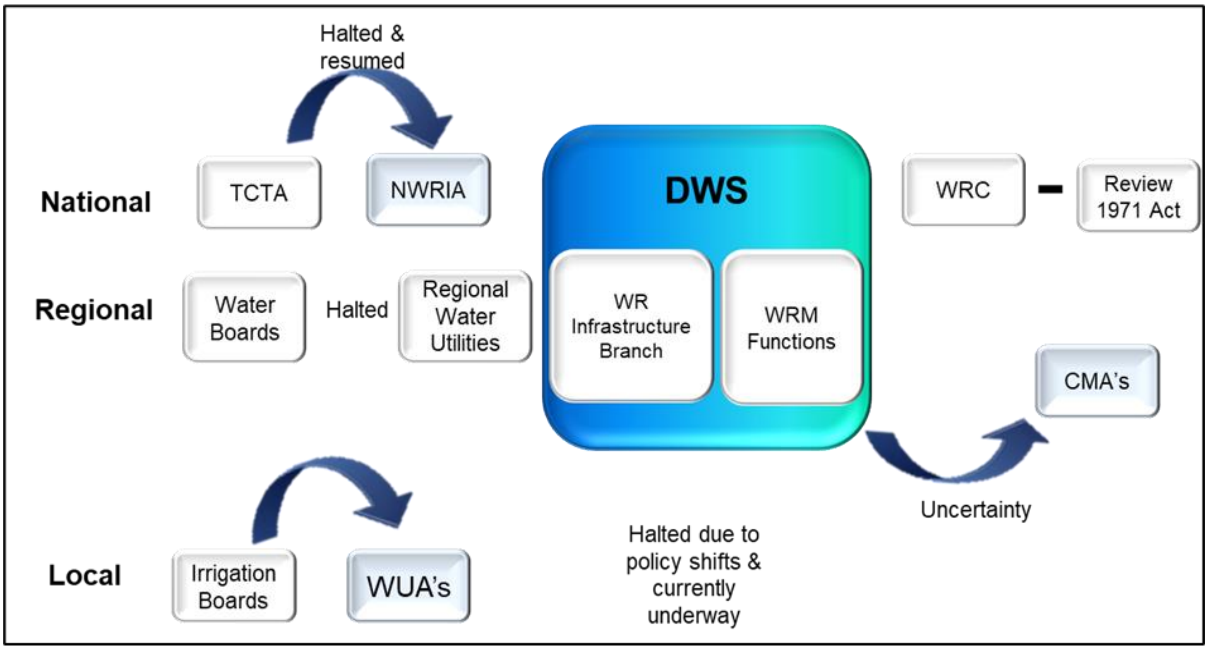


Figure: Water Sector Institutional Landscape in 2022

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

Furthermore, although not shown in the illustration above, there are water services institutions at the local level, and these are Water Services Authorities (WSAs); municipalities that provide water services or outsource water services provisions to the private Water Services Providers (WSPs). These WSAs and WSPs that provide water and sanitation services are regulated by the Department of Cooperative Governance and Traditional Affairs. A water services authority means any municipality, including a district or rural council as defined in the Local Government Transition Act, 1993, responsible for ensuring access to water services. Water services providers are any persons who provide water services to consumers or another institution. Notably, some WSAs are WSPs; in other cases, the WSA has WSPs that provide water services on their behalf.

4.4.2 Water management areas

Based on the outcome of the Department of Water and Sanitation Institutional Reform and Realignment (IRR) study, the National Water Resource Strategy (NWRS) 2nd edition established the nine WMAs in South Africa in July 2012. These replaced the 19 Water Management Areas (WMAs) identified before this date. It was recognised that these WMA boundaries needed to be reviewed periodically to accommodate new realisations and issues. WMAs are based mainly on catchment boundaries, except for those catchments that cross international borders. Within these WMAs, catchments are further subdivided into tertiary, secondary, and quaternary catchments. The status and trends of water resources provided in the National State of Water 2022 report have been analysed and presented based on the nine WMAs or, in some instances, provinces, as shown in the figure below.

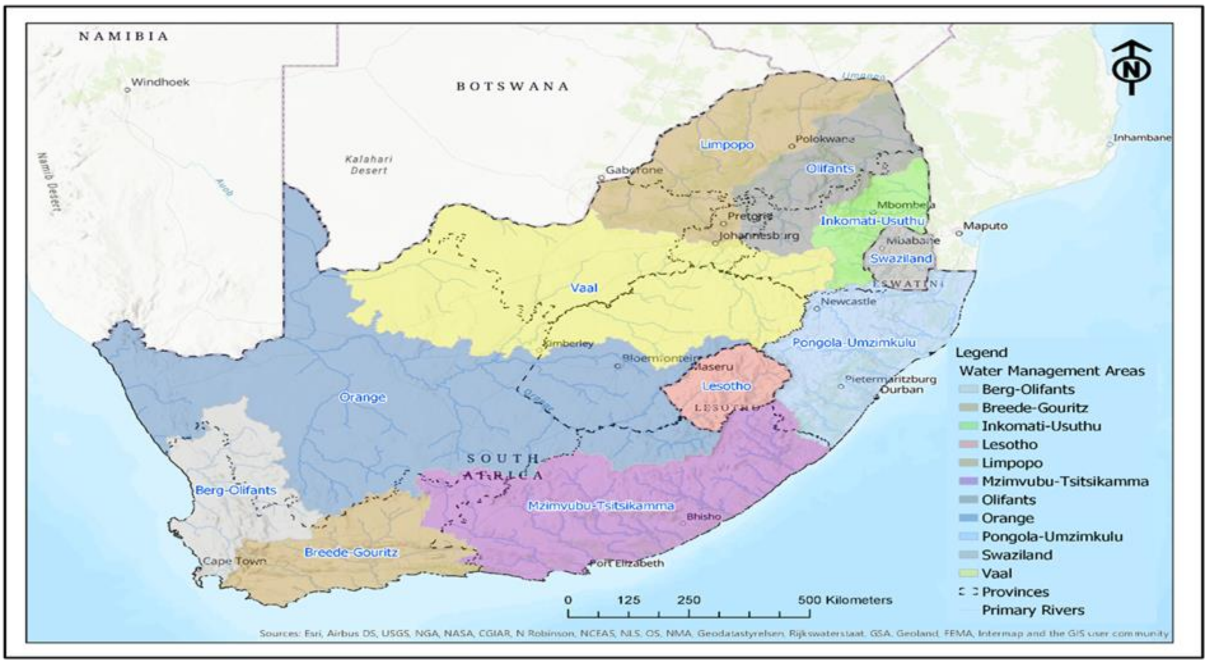


Figure: South African nine Water Management Areas as of 2012

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

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

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

Figure: Proposed new WMAs and CMAs configuration

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

4.4.3 Climatic environment

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

4.4.3.1 Temperature

As presented in the figure below, during the summer season months, the maximum temperature deviations were above-normal (positive) by up to 40°C in some areas mostly in the Western Cape province and southern parts of the Eastern Cape province from January to March 2022. The country's eastern half also experienced higher-than-normal maximum temperatures during November 2021 and February 2022. During the winter months, an observation is again made that the Western Cape province has, for the months of May to September 2022, experienced maximum temperatures above normal. Generally, the whole country experienced below-normal maximum temperatures during December 2021 and April 2022. These correlate with months when the eastern half of the country received high amounts of rainfall.

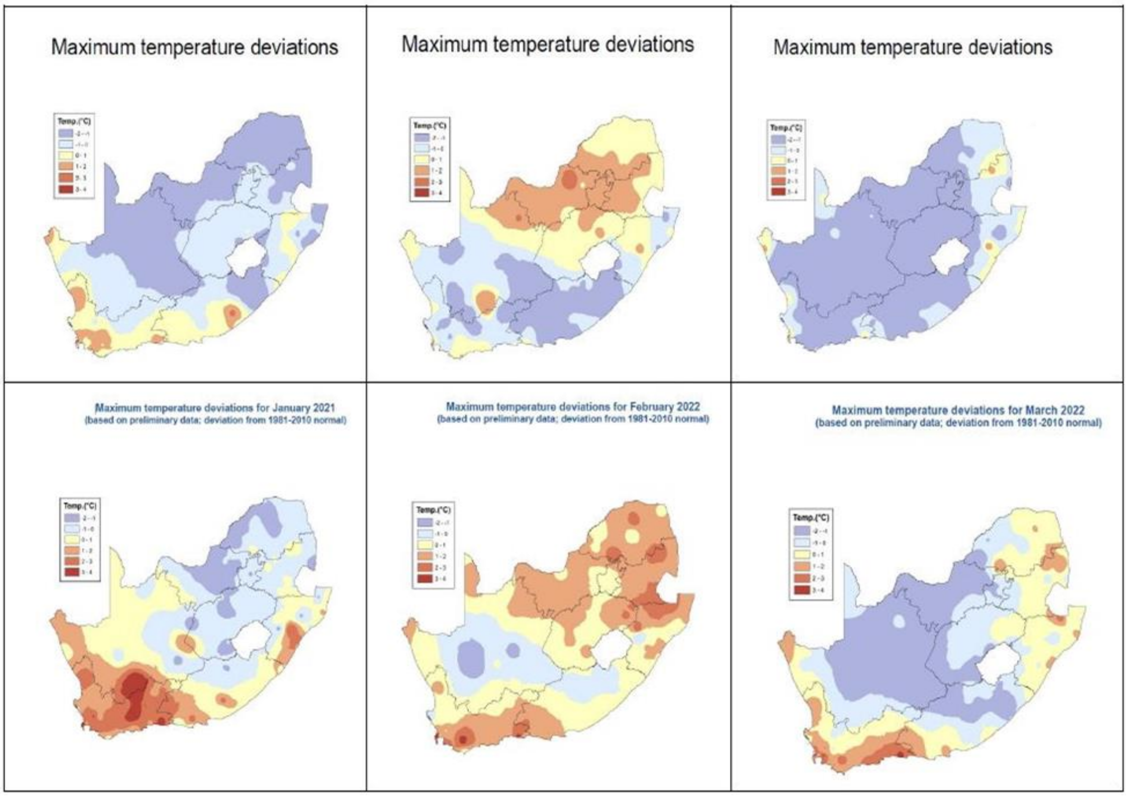


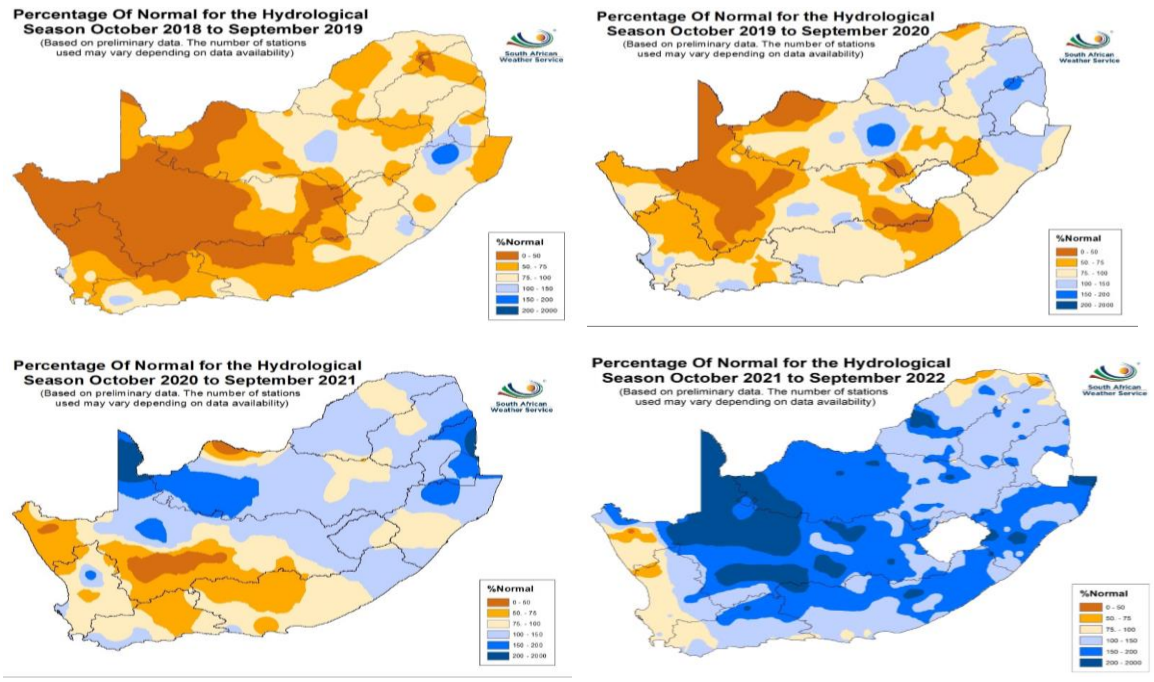
Figure: Maximum temperature deviations for the summer season months (October 2021 to March 2022)

4.4.3.2 Hydrological year rainfall

A significant feature of the rainfall received during the hydrological year 2021/22, presented in the figure below is above-normal rainfall received for almost all parts of South Africa, apart from a strip on the southwestern coastline of the Western Cape province. The eastern half of the country, characterised by summer rainfalls, has received significantly above-normal rainfall in the past two hydrological years, i.e. 2020/21 & 2021/22. These have resulted in areas in the country experiencing drought conditions decreasing over the past four hydrological years.

During the summer, significant rainfalls mostly covering the eastern half of the country were received during December and January 2022. During the winter season, again, the eastern half of the country received significant rainfalls in April 2022, with a strip along the coastal line of KwaZulu-Natal receiving significant amounts, between 200 mm to 500 mm of rain just in April 2022.

The long-term rainfall trend analysis per water management area is presented in the below figure, rainfall (% of Normal) for October 1981 - September 2022. The normal period used is October 1981 to September 2010.



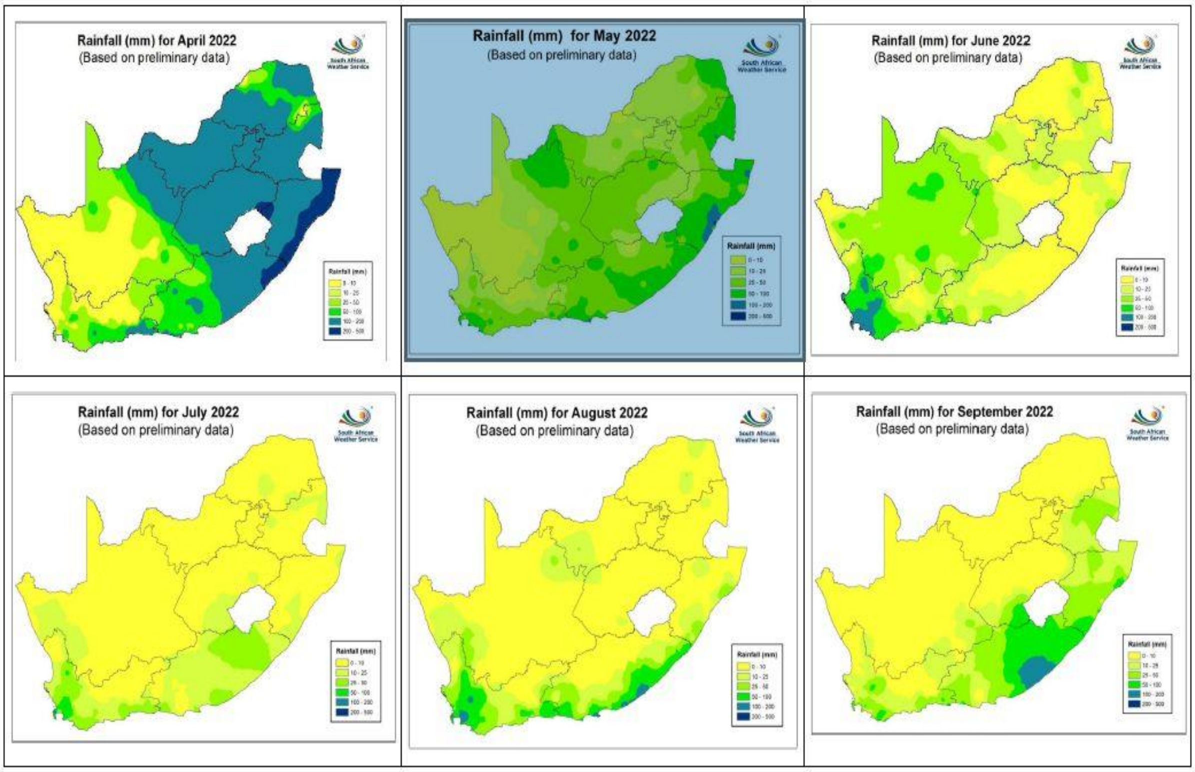


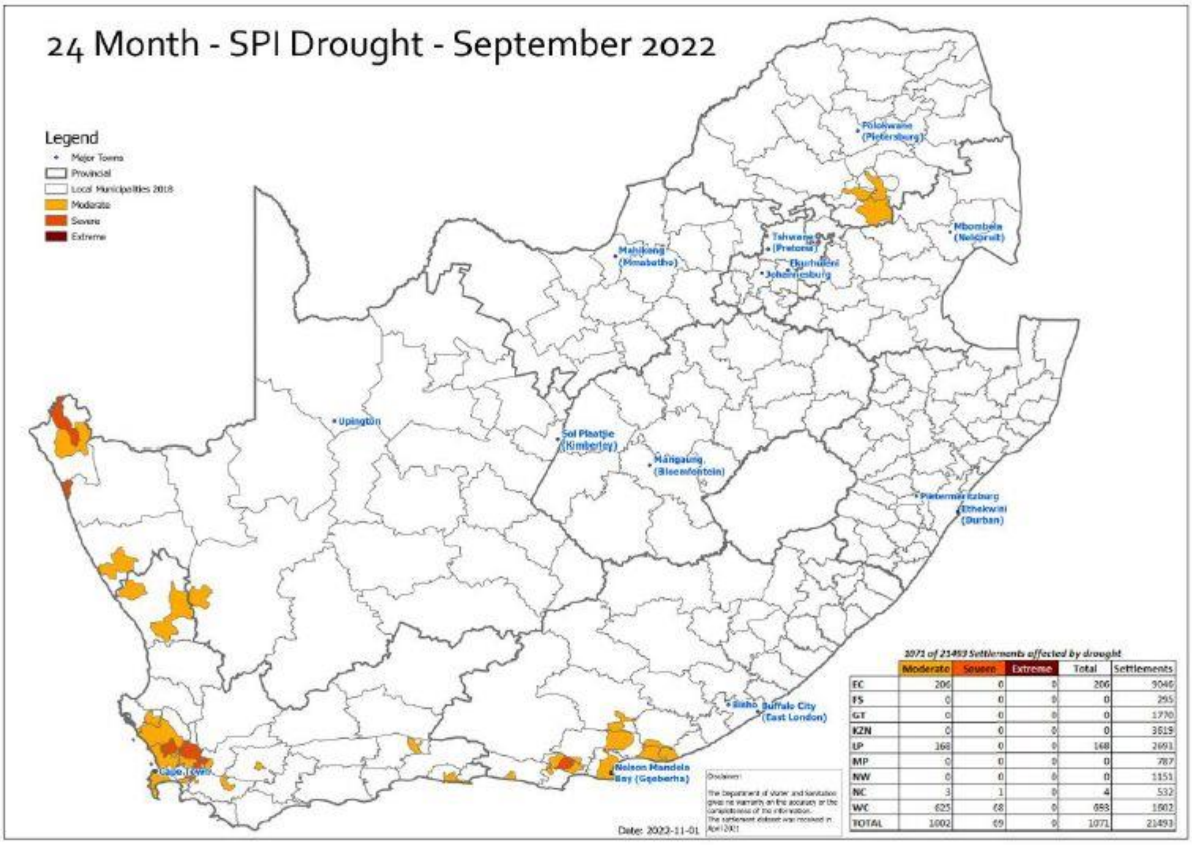
Figure: Summer season monthly rainfall distribution

The 2021/22 hydrological year, most Water Management Areas (WMAs) were classified as having experienced an above-average year. These are the Mzimvubu-Tsitsikamma WMA, Pongola-Umzimkulu WMA, Vaal and Orange WMA. Surface storage dam levels are expected to have been the highest in these water management areas during the reporting period.

4.4.3.3 Indicators of drought

The following section is an edited extract of the National State of Water Report, 2022, and readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African state of water.

The Standardised Precipitation Index (SPI) is an index based on the probability of rainfall for any time scale and can assist in assessing the severity of any drought. The 24-months (long-term) Standardised Precipitation Index (SPI) presented in the figure below shows that 5 provinces have been affected by drought in the last 24 months.



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

Figure: 24-months Spatial Precipitation Index – September 2022

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

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

The Northern Cape experienced arid conditions. The dry conditions eased in Free State, Gauteng, Limpopo, and KwaZulu-Natal in December 2019 but persisted in Mpumalanga, Northern Cape, Western Cape, and Eastern Cape until November 2020. Since December 2020, conditions have been near-normal in most provinces, with the Western Cape, Eastern Cape, and Mpumalanga crossing the near-normal line only in March, June, and November

2021, respectively. The summer rainfall region was usually wet from October 2021 to April 2022, with some areas experiencing rain well into June. Over that time, the SPI for provinces has increased, confirming the wet conditions. There are parts of the summer rainfall region where SPIs have exceeded 1.0 and reached levels last touched five years ago.

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

4.4.3.4 Extreme weather events

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

Between the 20 and 22 of May 2022 a surface trough was situated over the eastern parts of the country. Heavy rainfalls which resulted in more damage to infrastructures and loss of lives were measured over the KwaZulu-Natal coastal areas and in places over Mpumalanga.

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

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

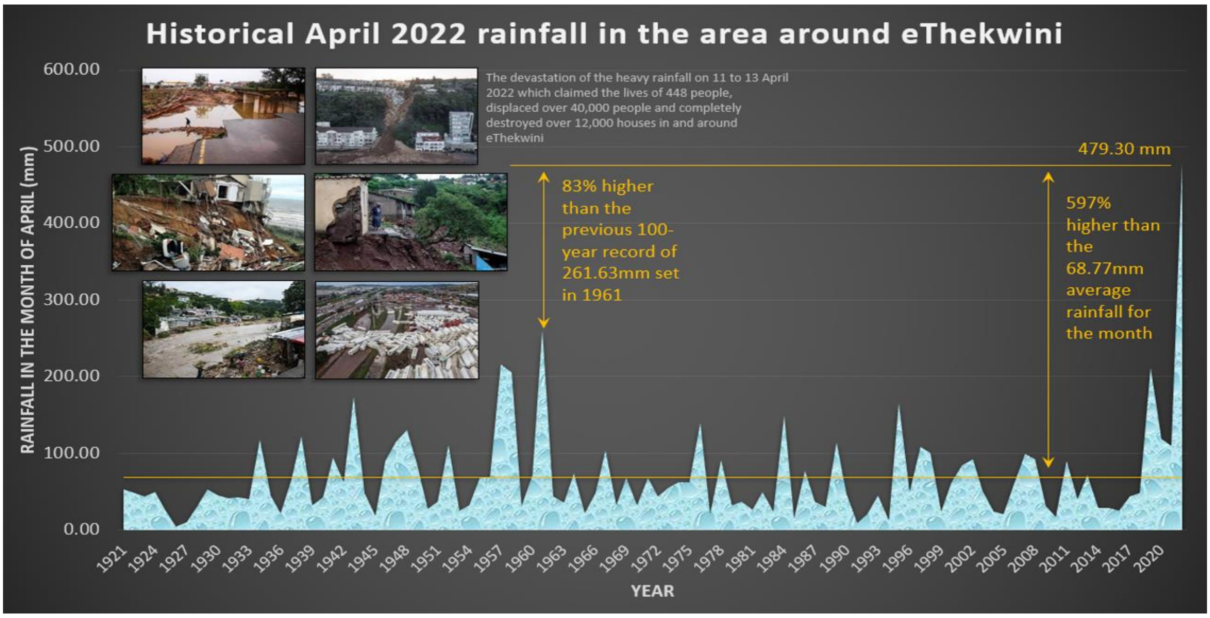


Figure: The rains that precipitated the tragic flooding in eThekwini and surrounding areas from 11 to 13 April 2022 were exceptional. Apart from being the highest rainfall recorded for the area for the month of April for the past 100 years, they were just under 600% higher than the 100-year average and almost double the previous record set in 1961.

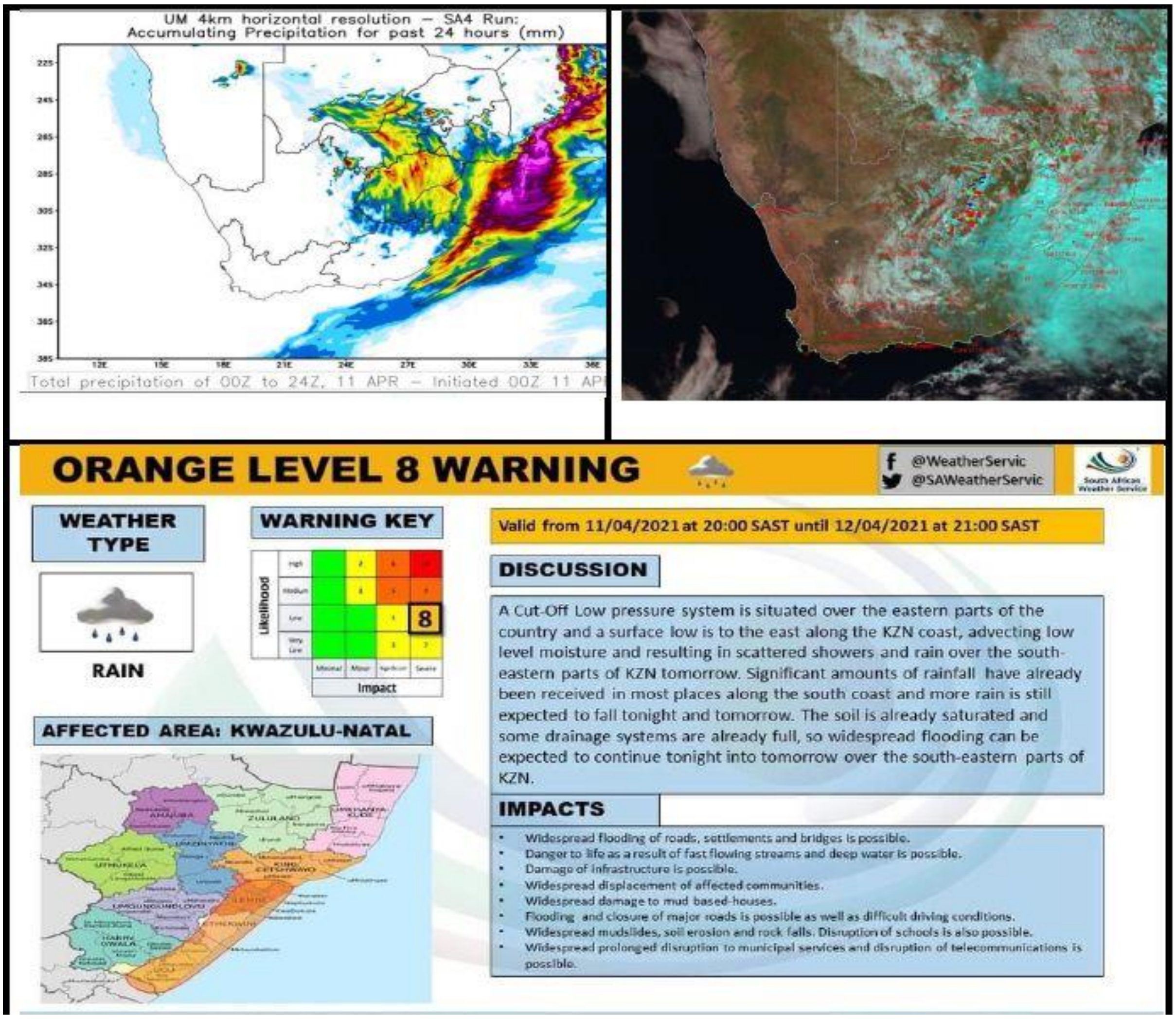


Figure: Cut off low-pressure system experienced by KZN province April 2022

4.4.4 Status of rivers

4.4.4.1 Stream flow

Approximately 60% of the streamflow in South African rivers is shared through transboundary water systems. Therefore, South Africa must implement Integrated Water Resource Management (IWRM) in a manner that conforms to international water protocols and treaties while being compliant with the legislation governing water resource management in South Africa. The international agreements have guidelines and limits on the quantities of water that South Africa may use out of the rivers and the amount of water the country must release to the neighbouring countries.

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

4.4.4.2 Streamflow anomaly at strategic points

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

The map shows that of the 21 strategic stations displayed, four stations experienced below normal streamflow's, while eight stations were just above normal during the reporting period. One station in the Pongola-Mtavuma WMA V5H002 (Tugela River at 58 Mandeni) was flagged out as it was much below normal. The historical observed streamflow data revealed that this station was also moderately low in November 2021, and it tends to peak in January to March of each year, with the highest 5-year peak flow of 457 m3/s observed in January 2017.

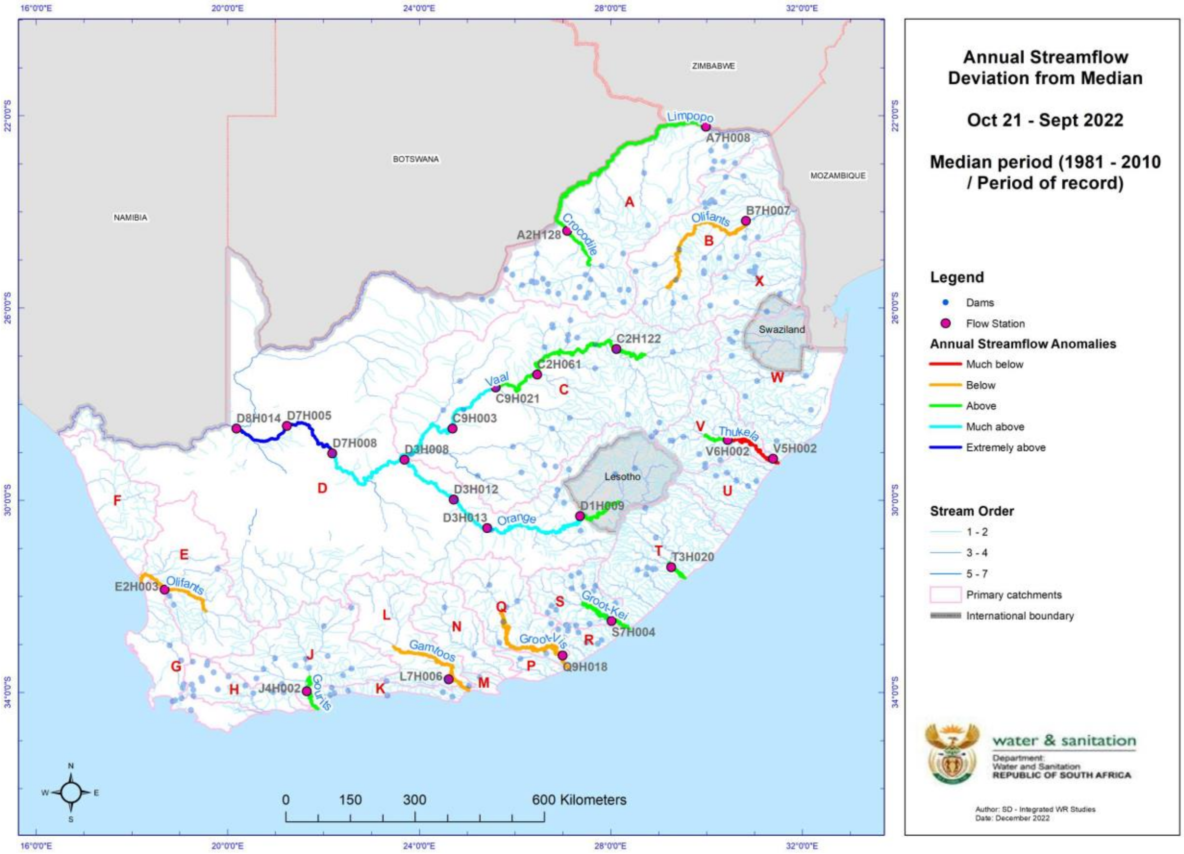


Figure: Annual streamflow anomaly for Strategic River Flow Monitoring Stations as of November 2022.

4.4.4.3 Eutrophication

Eutrophication is the process of excessive nutrient enrichment of water that typically results in problems associated with excessive macrophyte, algal, or cyanobacterial growth. The trophic status of the water body provides a measure and description of the degree of eutrophication (nutrient enrichment) and the extent of plant growth that can be sustained. The list of trophic status classes and criterion used to assign the trophic status are given in tables below.

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

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

The trophic status and eutrophication potential were calculated for 65 of the 119 sites monitored. The sites with four or more data sets were considered for trophic status and potential eutrophication calculation, The trophic status calculation demonstrated that fourteen sites were hypertrophic, one eutrophic, nine mesotrophic, and 32 oligotrophic. The other nine sites did not have chlorophyll-*a* data and could not be assigned a trophic status. Eutrophication potential was also calculated (based on total phosphorous (TP) concentration) as serious (26 sites), significant (13 sites), moderate (10 sites), and negligible (14 sites). Two sites did not have TP data.

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

In the Eutrophication Management Strategy for South Africa, the challenges of eutrophication are identified as being exacerbated by: (i) insufficient wastewater treatment infrastructure maintenance and investment; (ii) deteriorating ecological infrastructure; (iii) recurrent droughts driven by climatic variation, and an inescapable need for water resource development; (iv) inequities in access to safe sanitation, against the backdrop of a growing population; (v) water use regulation that is not consistently and adequately protecting South Africa's water resources against eutrophication; and (vi) a lack of skilled water scientists and engineers.

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

4.4.4.4 Microbial pollution

The contamination of water resources by faecal pollutants poses significant risks to human and animal health since numerous pathogens are often associated with faeces. Microbial water quality measures the microbiological conditions of water to human health. The overall purpose of the microbial monitoring programme is to assess and manage the health risks to water users due to faecal pollution of water resources.

Faecal coliforms and E. coli are the best indicators for the assessment of recent faecal pollution, and they also indicate the potential presence of pathogenic bacteria, viruses, and parasites. Faecal coliform and E.coli are measured, and results are compared to the South African Water Quality Guidelines shown in the table below.

Table: 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

The microbiological results indicate that all the collected samples had high microbial contamination and the water from that source was not suitable for drinking. This would pose a high risk of infections to human health if water was consumed directly from the source. However, treating the water at the household level can reduce the potential health risk in some cases where water is not severely polluted with faecal contamination.

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

4.4.4.5 Chemical

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

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

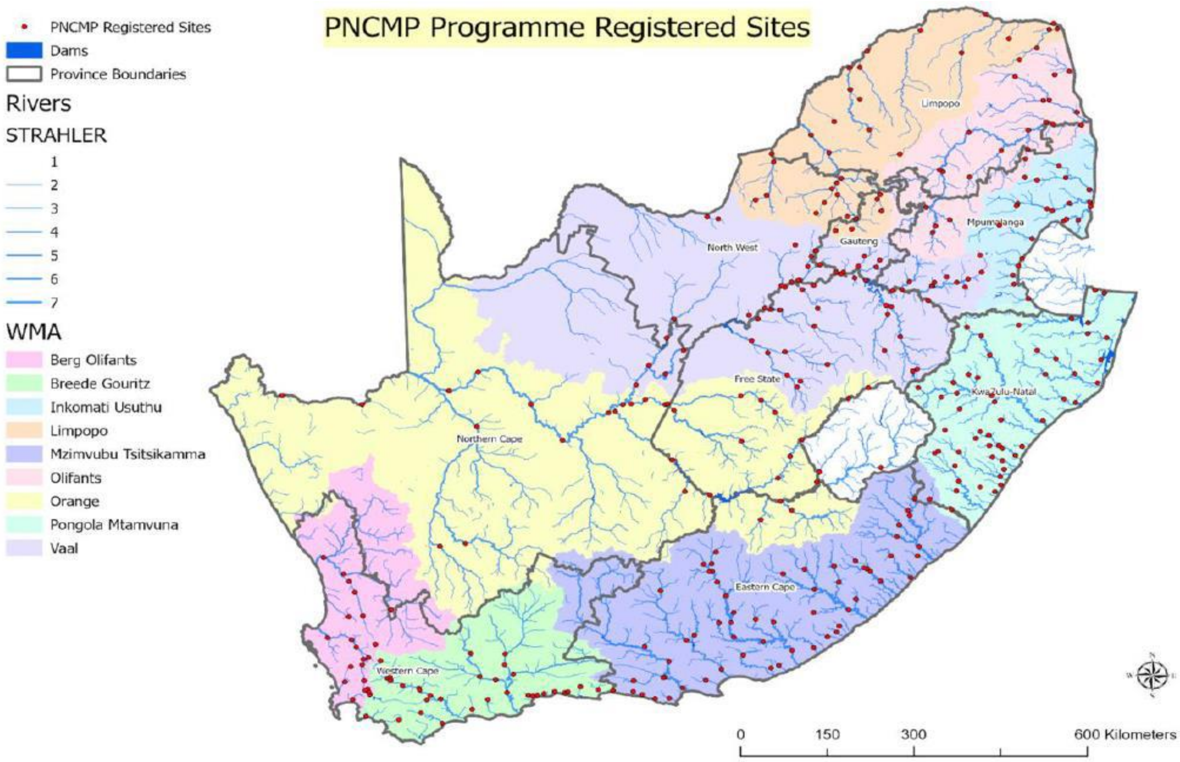


Figure: The location of priority NCMP sampling sites is situated across South Africa

Salinity

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

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

Potential Problems with Wastewater Works

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

Case study: KwaZulu-Natal surface water resource quality post the floods

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

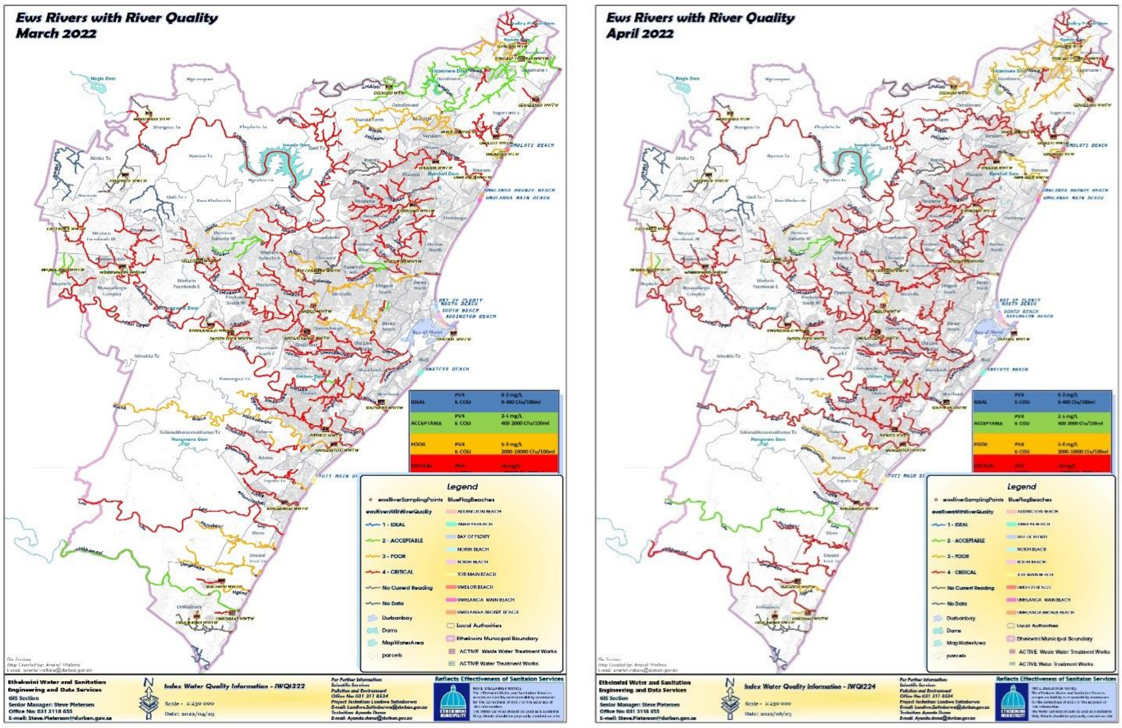


Figure: River water quality March and April 2022 in KZN

In this regard, the eThekwini Municipality jointly with Department of Health issued a public awareness notification highlighting beach closures, hot spot rivers, dangers of using contaminated waters, and what the city was doing to fast-track infrastructure repairs. The flood-related damage resulted in the failure of the entire sewerage infrastructure network, posing a severe threat to water quality. Some of the major rivers affected are Thongathi, Umdloti, Ohlanga, Umngeni, Umbilo,Umhlathuzana, Umlazi, Isipingo, Imbokodweni, Amanzimtoti and

Amahlongwana in eThekwini Metro; Mvoti, Uthukela, Mbizana, Nonoti, in iLembe District; Uvongo, Nkhongweni in Ugu District.

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

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

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

4.4.5 National surface water storage

The national dam storage levels for the past two hydrological years, i.e. 2020/21 and 2021/22, have been the highest for most of the months in the past five hydrological years as indicated in the figure below. This is true, especially after the beginning of summer rainfalls received between December and April 2022 for the eastern parts of the country.

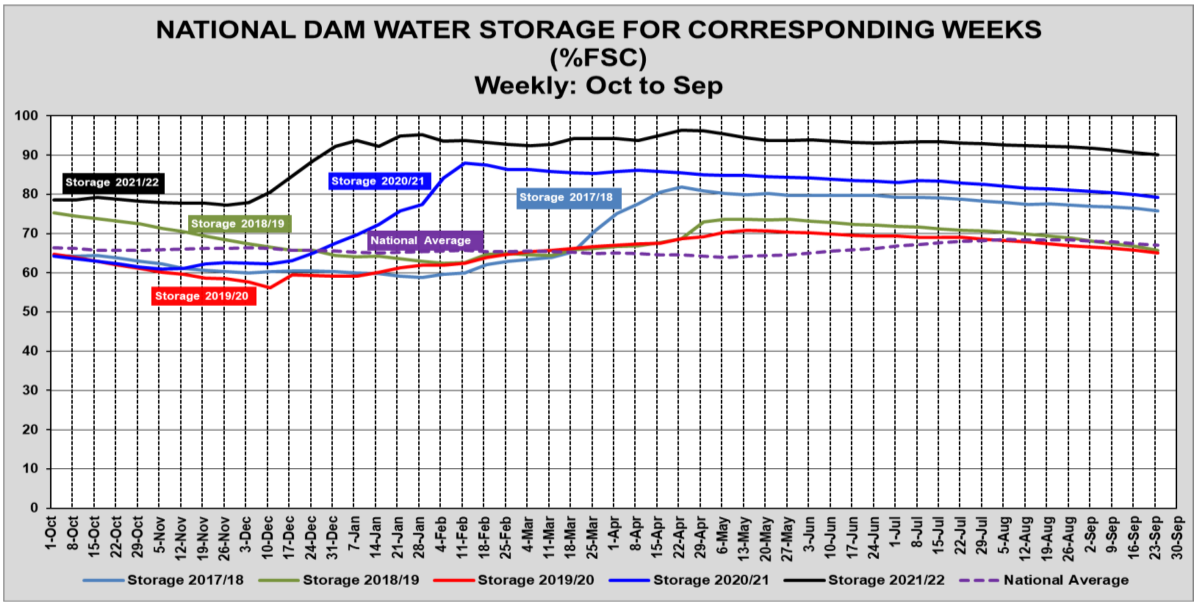


Figure: National dam storage levels for the past five years compared to a national average

The table below show the classification of surface storage levels for provinces ranging from critical storage levels, closer to dead storage of the dams (<10% of Full Supply Capacity (FSC)); at risk of non-supply (>10% - <50% of FSC); optimal water levels for supply operations (>50% -<100%); and >100% of FSC (Full or spilling dams). At the end of the hydrological year, (September 2022), approximately 4% of the dams were at critical storage levels, 11% were at risk, and over 85% were either spilling or at optimal storage levels.

Table: Surface storage at the end of September 2022

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

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

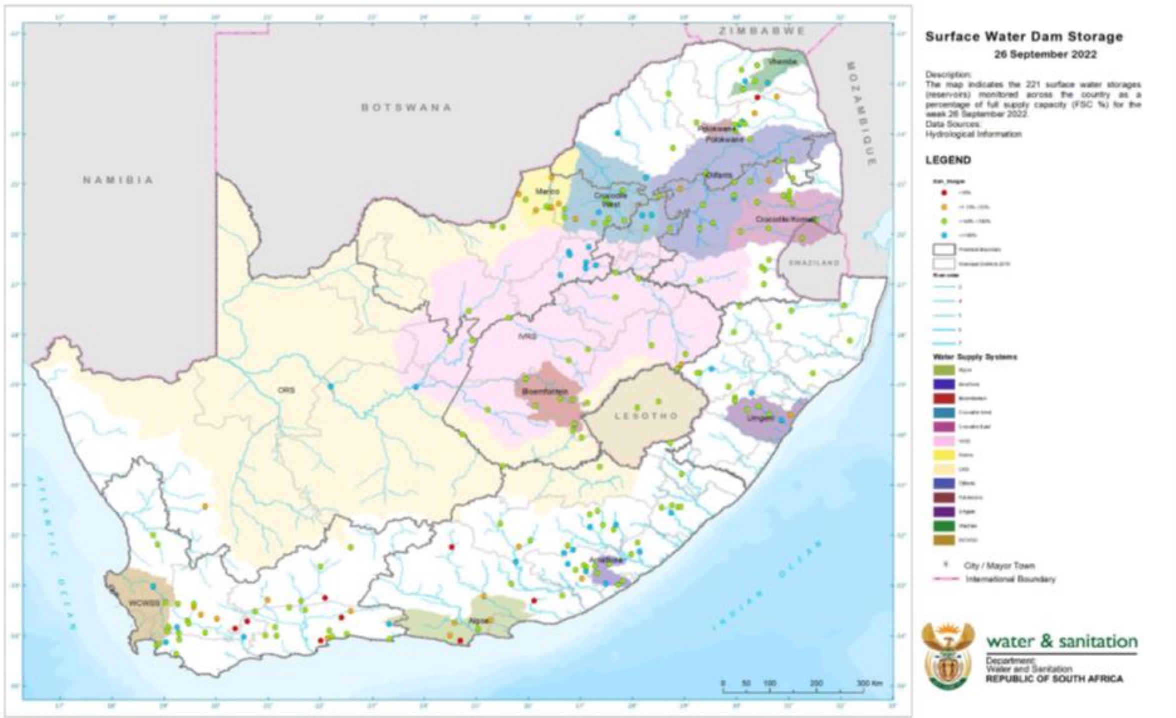


Figure: Water supply system and dam storage – end September 2022

Table: Dams below 10% of Full Supply Capacity (FSC) September 2022

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

Areas experiencing moderate to severe drought are still prevalent in the Sekhukhune District in Limpopo, West Coast District, Sarah Baartman, Central Karoo, and the Garden Route District in the Western Cape. This is further confirmed by dams at critical dam levels (<10% of FSC) within these districts. An exception is the Middle Letaba Dam which is on the boundary of Vhembe and Mopani District, although with no drought mapped out from the Spatial Precipitation Index, the land use changes, and water use activities within the catchment of the Middle-

Letaba Dam are likely the cause of reduced streamflow and affecting the water resource yield at this dam over the years. The river catchment of the Middle-Letaba Dam requires further assessments.

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

4.4.5.1 Provincial storage

For the hydrological year 2021/22, 50% of the time, the dam levels for all Provinces were above the long-term median storage levels. An increase or recovery to above the long-term median from last year is notable for the Eastern Cape and KwaZulu-Natal provinces.

4.4.5.2 Water management area storage

The 2021/22 storages have been above the historical median for all water management areas. A similar pattern is observed for the past year (2020/21) for all WMAs except for the Mzimvubu-Tsitsikamma WMA. Notably, all median storages for the 2021/22 hydrological year are higher than the past year for all WMAs, apart from the Berg Olifants and Breede Gourits WMAs. However, the dam storage levels in these two WMAs remained higher than the long-term median dam levels.

4.4.5.1 District municipality storage

The Central Karoo District Municipality (DM), Amathole DM, and Buffalo City DM have experienced a significant increase compared to last hydrological year. In contrast, the Cape Winelands DM, West Coast DM, Lejweleputswa DM, Overberg DM, OR Tambo DM, Mopani DM, and Ngaka Modiri Molema DM have experienced the worst decline in dam levels compared to last hydrological year.

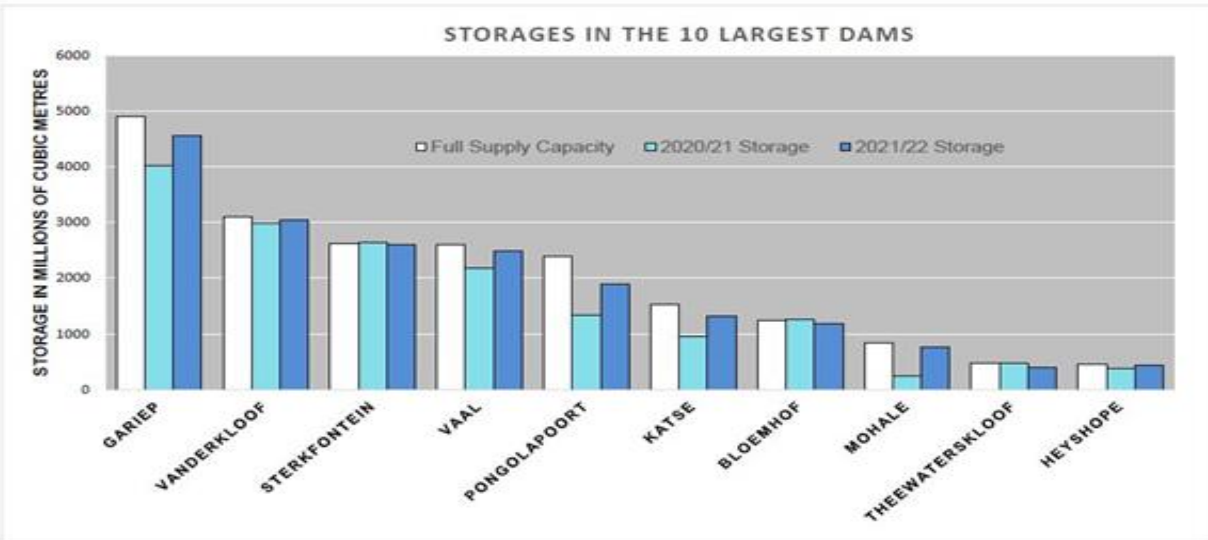


Figure: Storage volume comparison 2020/21 & 2021/22 of the ten largest dams, as at the end of September

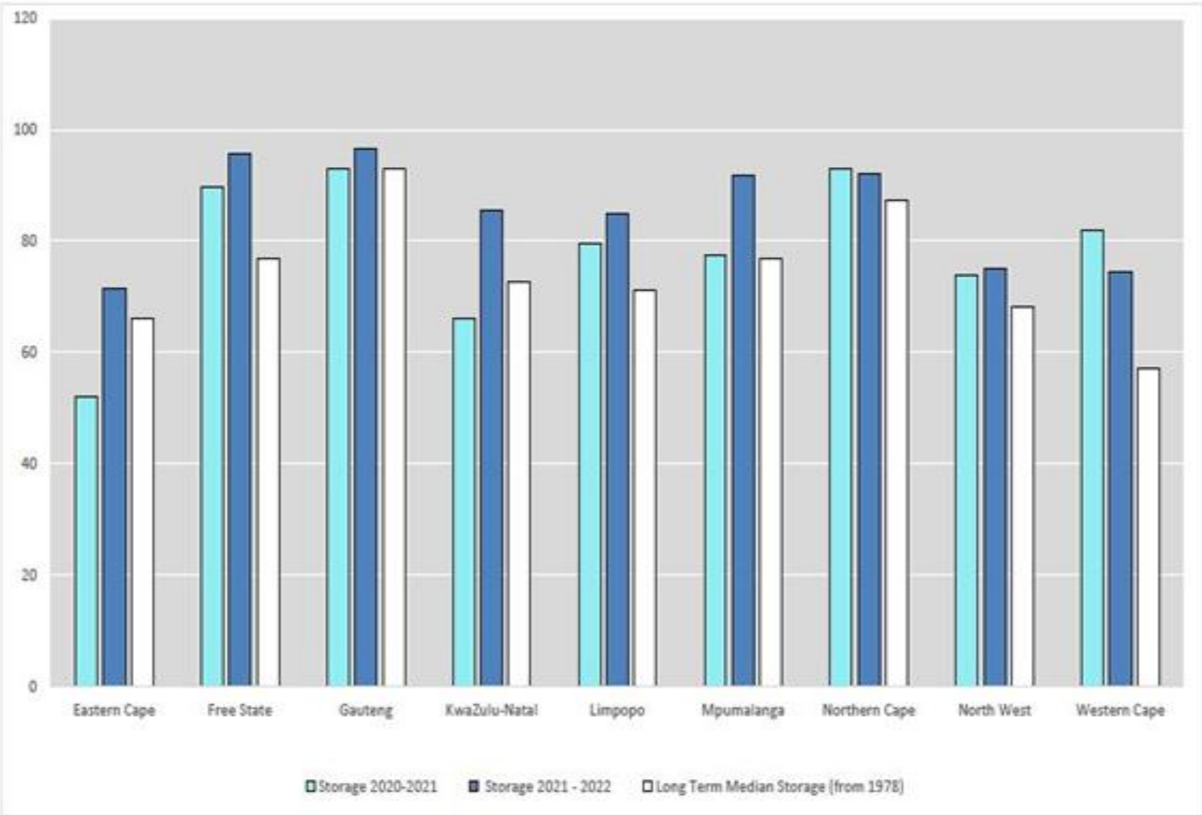


Figure: The storage situation in each Province during 2021-2022, compared with the previous hydrological year and the media

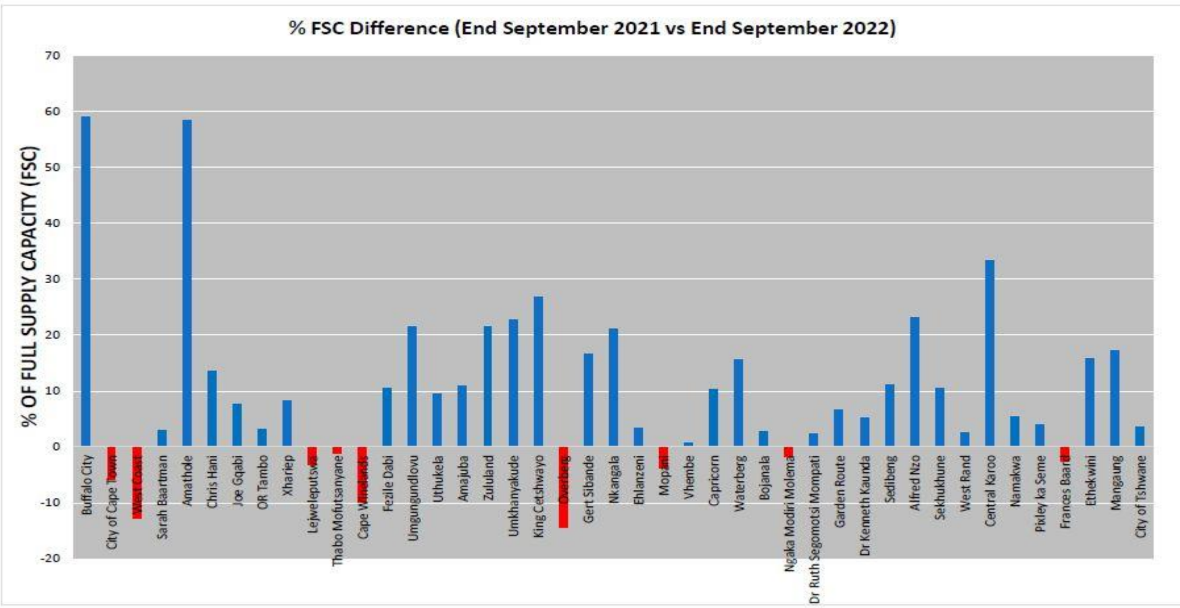


Figure: Difference in water storage levels per District Municipality September 2021 vs September 2022

4.4.5.2 Water supply systems and restrictions

A recovery or an increase in dam levels in water supply systems is observed for all water supply systems from last year at the same time of reporting. This is true except for the Cape Town water supply systems, which has experienced a decline from the previous hydrological year by 15% of FSC. Areas experiencing moderate to severe drought are still prevalent in the Sekhukhune District in Limpopo, West Coast District, Sarah Baartman, and Central Karoo, and the Garden Route District in the Western Cape. Some parts of the country are still experiencing dry conditions, for example, the southern parts of the Eastern Cape, parts of the Northern Cape, and the southwestern parts of the Western Cape province.

The Department of Water and Sanitation implements water use restrictions in these areas that are experiencing dry conditions, which affect dam storage levels in standalone dams or dams within a water supply system or cluster to avoid the risk of failure of water supply or non-supply to the various water use sectors, including users with a high assurance of water supply such as strategic users in the power generation industries. The Algoa Water Supply Systems (WSS) remain with water restrictions in response to the low water storage levels. Notably, restrictions have been lifted for the Amathole WSS as the system recovered reasonably well since the February/ March flooding events. Due to infrastructure limitations, permanent restrictions are still applicable for the Polokwane in Limpopo and Bloemfontein systems in the Free State province.

4.4.6 Status of groundwater

4.4.6.1 Groundwater level status

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

The groundwater level value is presented as a percentage of the groundwater level status (GwLS). The historical groundwater level monitoring record is assessed per borehole to ensure significant results and understanding. The groundwater level status of the geosites is averaged within the topo-cadastral 1:50 000 map sheet grid. The groundwater level status is not linked to groundwater availability and storage levels within an aquifer but only gives an indication of the water level. The groundwater level status approach allows the comparison of groundwater level data of any geosite/borehole on the same scale.

The figure below depicts the groundwater level status over the years from September 2019 to 2022. September 2021 and 2022 have water levels recovering, showing more geosites with above 50% GwLS, particularly in the Northern Cape province and interior of the country. This corresponds with the increase in rainfall percentage anomalies over the past two hydrological years, and the prevalence of above 75% GwLS in the interior can be attributed to the above-normal rainfall trends in the past two years. Due to the localised nature of groundwater aquifers, there is an increasing need to understand better the groundwater data monitored at a local level, such as by local municipalities or villages and by other water sector institutions such as South African Environmental Observation Network (SAEON) in conjunction with the national monitoring database.

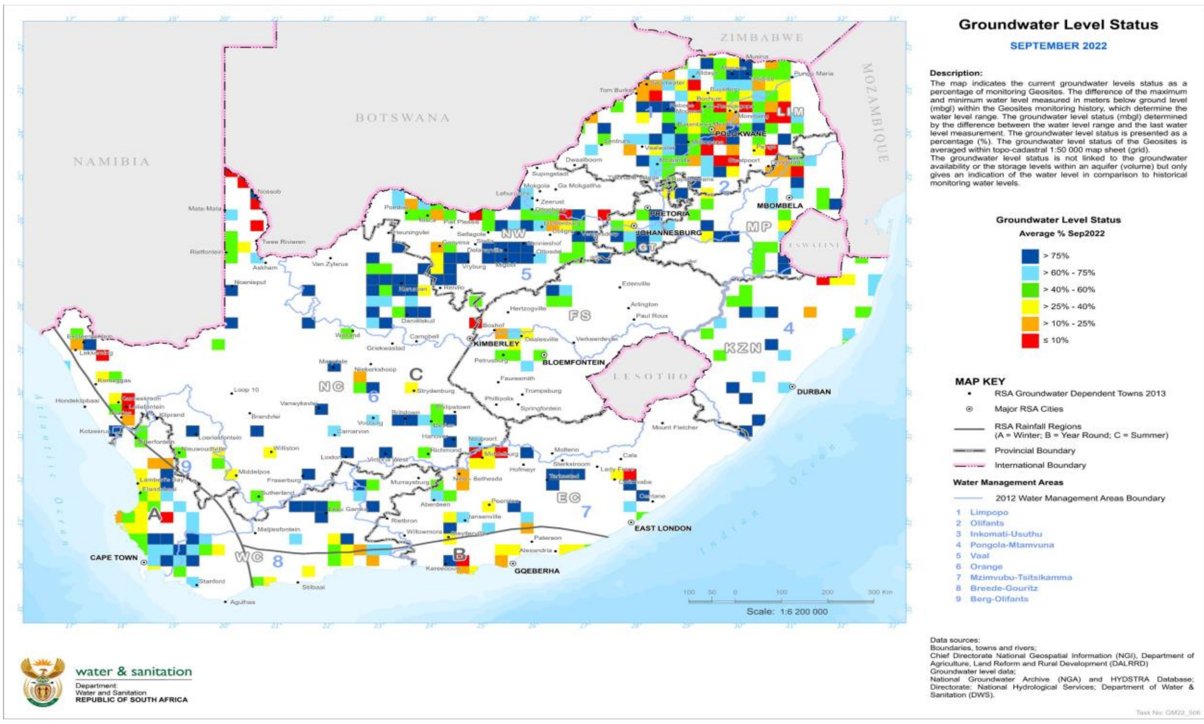


Figure: Groundwater level status as at September 2022

4.4.6.2 Groundwater risk map

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

The average groundwater level status (GwLS) is presented against the percentiles of the historical groundwater levels in the figure below. The graph provides a visual presentation to indicate drought conditions. Restrictions on groundwater abstraction can be implemented timeously before any negative impacts occur. Each grouping of boreholes will have a different severity range - seven percentile ranges.

The groundwater level value is a percentage of the groundwater level status (GwLS). The groundwater level status is not linked to groundwater availability and storage levels within an aquifer but only gives an indication of water level based on individual geosites entire historical groundwater level monitoring record.

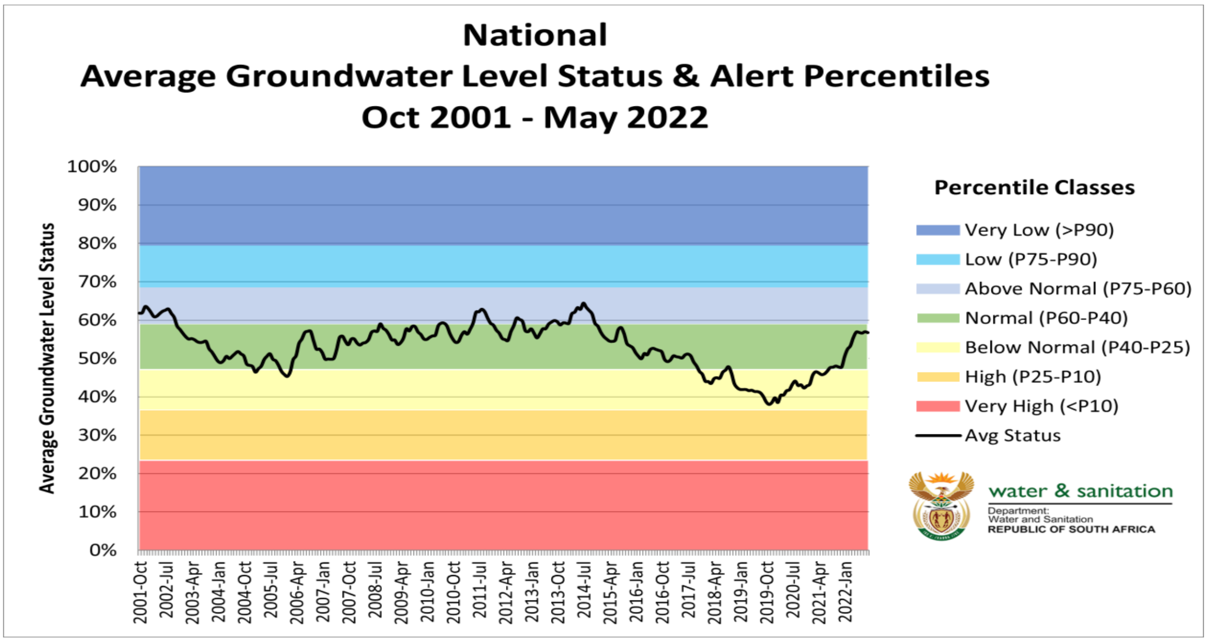


Figure: National average groundwater level status severity

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

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

4.4.6.3 Strategic groundwater resource areas and groundwater quality

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

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

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

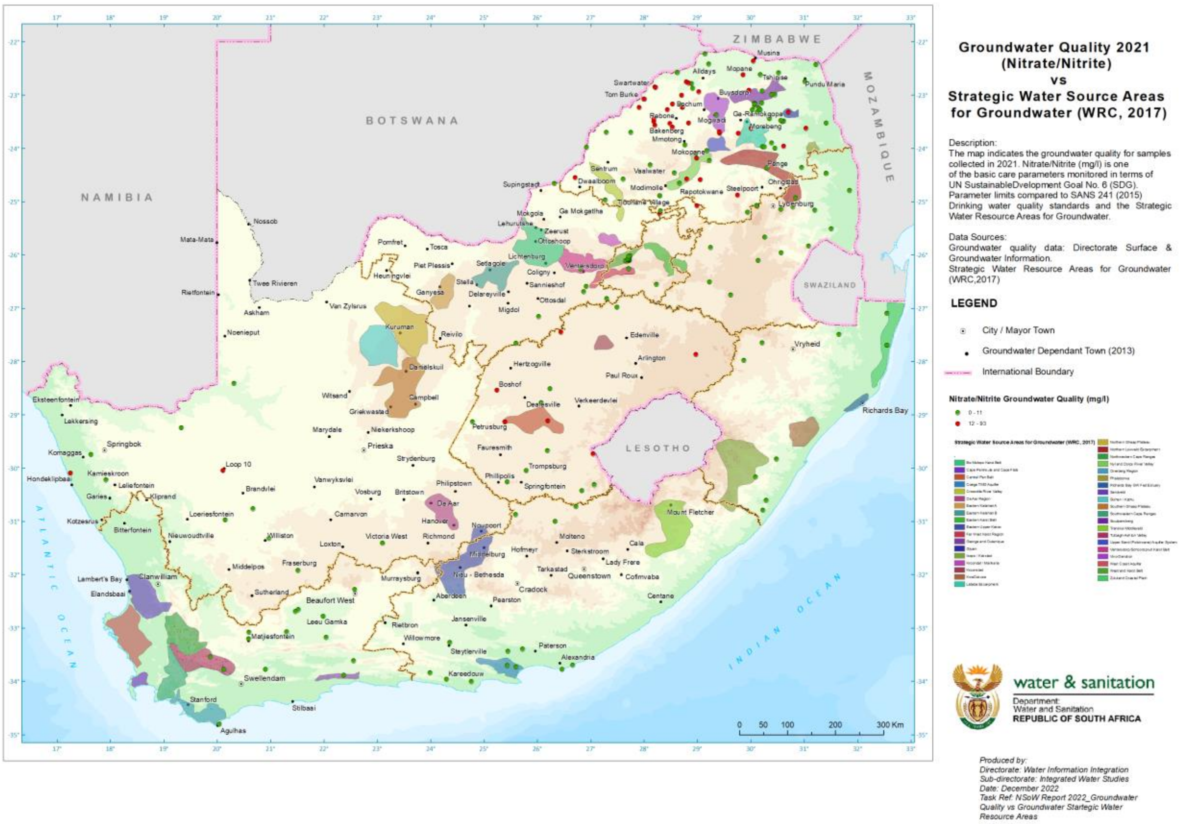


Figure: 2021 Groundwater quality within Strategic Water Source Areas for groundwater

The current water situation in South Africa provides strong motivation for protecting SWSAs to ensure a sustainable and equitable water supply. Currently there is no specific policy, legislation, or regulation that specifically protects strategic water source areas, including their groundwater counterparts. The legal measures available for protecting water sources include but are not limited to the National Water Act No. 36 1998, National Environmental Management Act No. 107 of 1998 (NEMA), and Spatial Planning and Land Use Management Act No. 16 of 2013, to name a few. Some of the effective ways identified by Le Maitre *et al* (2018) to protect Strategic Water Source Areas are: (1) Under NEMA Section 24(2A), which allows the minister to prohibit granting of environmental authorisations in certain geographical areas; (2) Adding a chapter on Water Source Area protection to the new Water and Sanitation Act, prohibiting activities in certain geographical areas affecting water quality and quantity.

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

Remediating anthropogenic pollution of groundwater sources objectives will be to prevent contamination of drinking water sources and to restore the aquifer to a natural or "safe" state. Remediation should be (a) preceded by a detailed characterisation of the source area; and (b) guided by quantitative risk assessment.

4.4.6.4 Groundwater use per economic sector

Groundwater is registered in terms of the provisions in the National Water Act, of 1998. This information is available on the Department of Water and Sanitation's Water Use Authorisation and Registration Management System (WARMS) database from which the provincial figures of the currently registered water use per sector have been derived for up to September 2022. The economic sectors compared for groundwater use in the nine provinces are: (i) Agriculture irrigation; (ii) Agriculture watering livestock; (iii) Mining; (iv) Schedule 1; (v) Water supply service; and (vi) Others (aquaculture, industry, power generation, and recreation).

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

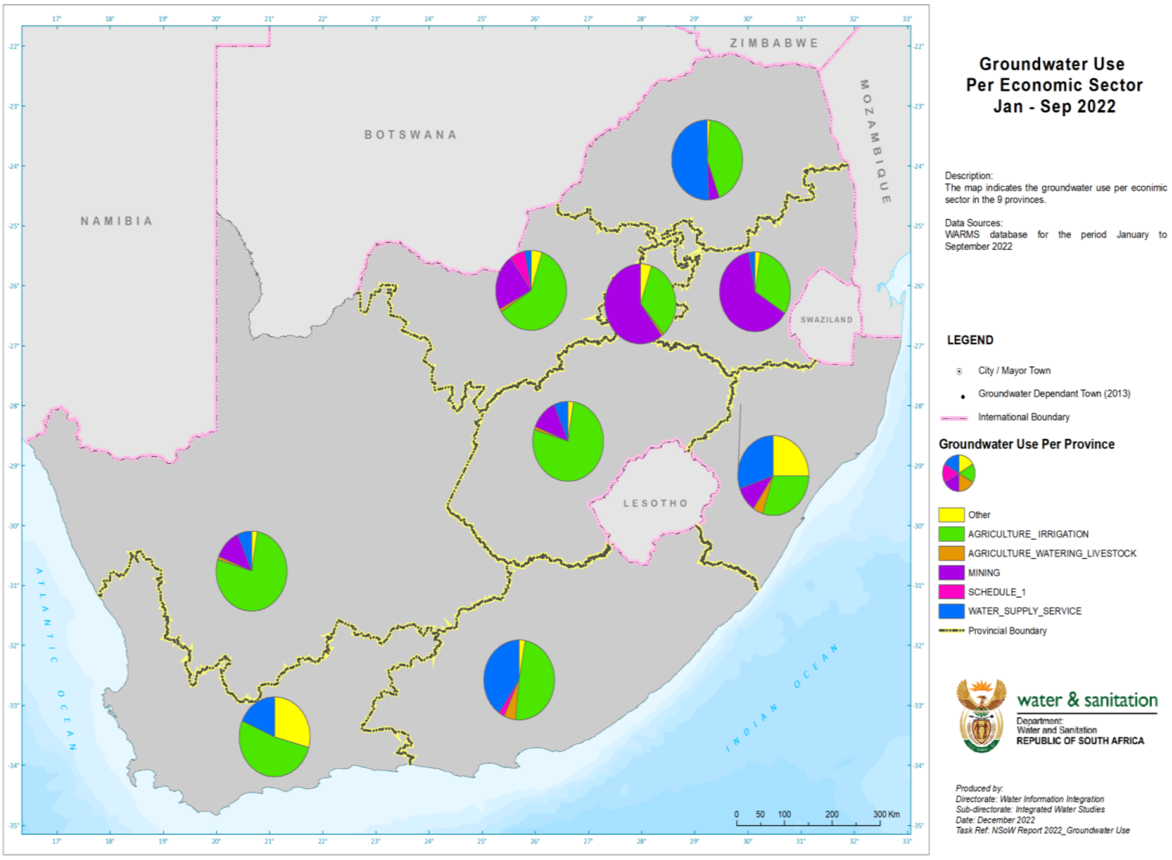


Figure: Groundwater use per economic sector, 2022

4.4.7 Accounts for strategic water source areas

The following section is an edited extract of Accounts for Strategic Water Source Areas, 1990 to 2020 report. Readers are encouraged to read this report for more, in-depth, fully referenced, information.

4.4.7.1 Accounts for Strategic Water Source Areas

Strategic Water Source Areas (SWSAs) are national ecological infrastructure assets that are essential for water security, which in turn underpins national development goals such as inclusive growth, employment creation and reducing poverty. Ecological infrastructure refers to naturally functioning ecosystems that generate or deliver valuable services and benefits to people and the economy. Water-related ecological infrastructure includes wetlands, rivers, riparian areas and SWSAs, and their associated catchments, which contribute to the production of clean water, flood moderation, prevention of erosion and drought resilience, also supporting resilience to climate change. Ecological infrastructure is just as important as built infrastructure, such as dams that hold water which flow from upstream SWSAs, and ecological infrastructure in good condition often enhances the effectiveness of built infrastructure.

SWSAs for surface water have been calculated to supply water that sustains half of the country's population, two thirds of national economic activity, 70% of irrigated agriculture and more than 90% of urban water users, originating from just 8% of South Africa's land area.

4.4.7.2 Profile of SWSAs in relation to biomes, provinces and Water Management Areas

Strategic Water Source Areas (SWSAs) are located across the country stretching over several biomes, provinces and Water management Areas. In total, they cover 10 020 720 ha or 8,2% of South Africa's mainland. SWSAs vary greatly in size, with Southern Drakensberg SWSA having the largest extent of 2 013 693 ha (of which 1 842 165 ha falls within South Africa) and Table Mountain SWSA having the smallest extent of 47 246 ha. See the below table for more details on different groupings.

SWSAs organised from west to east, with grouping for graphs, full extent of each SWSA, area within South Africa (in hectares), and proportion

Order from west to east	Grouping for graphs	SWSA name in full	Abbre-viated name	Full extent (ha)	Extent within SA (ha)	Proportion of SA mainland	Proportion of SWSA within SA
1	Group 1	Table Mountain	TMn	47 246	47 246	0,0%	100,0%
2		Boland	Bol	608 054	608 054	0,5%	100,0%
3		Groot Winterhoek	GrW	518 310	518 310	0,4%	100,0%
4		Langeberg	Lan	171 527	171 527	0,1%	100,0%
5		Swartberg	Swa	77 983	77 983	0,1%	100,0%
6		Outeniqua	Out	304 237	304 237	0,2%	100,0%
7		Kouga	Kou	63 099	63 099	0,1%	100,0%
8		Tsitsikamma	Tsi	322 208	322 208	0,3%	100,0%
9		Amathole	Ama	200 112	200 112	0,2%	100,0%
10		Eastern Cape Drakensberg	ECD	1 603 365	1 452 814	1,2%	90,6%
11		Southern Drakensberg	SDb	2 013 693	1 842 165	1,5%	91,5%
12	Group 2	Northern Drakensberg	NDb	1 031 475	868 838	0,7%	84,2%
13		Maloti Drakensberg	MDb	1 204 544	154 716	0,1%	12,8%
14		Mfolozi Headwaters	MfH	192 049	192 049	0,2%	100,0%
15		Enkangala Grassland	EGr	858 643	788 092	0,6%	91,8%
16		Upper Vaal	UVa	139 415	139 415	0,1%	100,0%
17		Upper Usutu	UUs	619 675	539 322	0,4%	87,0%
18		Mbabane Hills	MbH	1 000 296	295 775	0,2%	29,6%
19		Mpumalanga Drakensberg	MpD	837 248	837 248	0,7%	100,0%
20		Wolkberg	Wol	259 627	259 627	0,2%	100,0%
21		Soutpansberg	Sou	234 682	234 682	0,2%	100,0%
22		Waterberg	Wat	103 201	103 201	0,1%	100,0%
Total				**12 410 689**	**10 020 720**	**8,2%**	**80,7%**

Biome composition of SWAs

As shown in the figure below SWSAs span five of South Africa's nine biomes. SWSAs in the western part of the country fall mainly in the Fynbos biome and cover 24,6% of the biome. In the central and south-eastern parts of the country, SWSAs fall predominantly in the Grassland biome. The Grassland biome is the second largest biome in South Africa and plays an important role in water provision, evident by the fact that 63,4% of the total area of SWSAs falls in this biome. In the northeastern part of the country SWSAs fall mainly in the Savanna biome. Indigenous forests occur in most SWSAs but make up small proportions of SWSAs, reflecting partly that the Forest biome is South Africa's smallest biome, making up less than 0,5% of the mainland. Forests tend to occur in patches, few of which cover areas greater than 1 km^2 , with areas greater than this common only in the southern Cape and Lowveld Escarpment. Added together, indigenous forests cover only 2,2% of SWSAs. However, 47,8% of indigenous forests in South Africa occur in SWSAs.

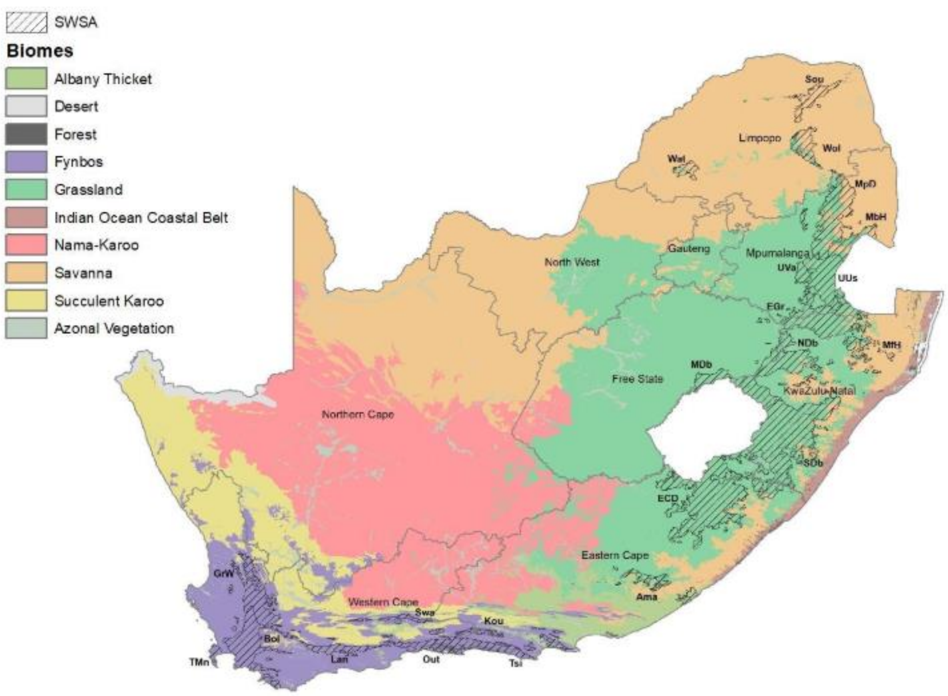


Figure: SWAs in relation to terrestrial biomes

Provincial distribution of SWAs

SWSAs for surface water occur in six of South Africa's nine provinces, as shown in the Table below. SWSAs cover 33,5% of KwaZulu-Natal, 26,5% of Mpumalanga, 14,0% of Western Cape, 12,9% of Eastern Cape, 4,8% of Limpopo and 2,1% of Free State. Gauteng, North West and Northern Cape do not contain SWSAs of national importance for surface water. However, these provinces do contain water source areas that are important from a provincial perspective.

Table: Provincial distribution of SWAs

Province	Total area of province	Area of province covered by SWSAs (ha)	Proportion of province covered by SWSAs	Names of SWSAs in province
Eastern Cape	16 884 228	2 181 081	12,9%	Amathole, Eastern Cape Drakensberg, Kouga, Southern Drakensberg, Tsitsikamma
Free State	12 982 488	276 057	2,1%	Enkangala Grasslands, Maloti Drakensberg, Northern Drakensberg, Upper Vaal
Gauteng	1 817 814	0	0,0%	
KwaZulu-Natal	9 329 945	3 121 956	33,5%	Enkangala Grasslands, Mfolozi Headwaters, Northern Drakensberg, Southern Drakensberg
Limpopo	12 574 338	601 032	4,8%	Mpumalanga Drakensberg, Soutpansberg, Waterberg, Wolkberg
Mpumalanga	7 649 527	2 027 078	26,5%	Enkangala Grasslands, Mbabane Hills, Mpumalanga Drakensberg, Upper Usuthu, Upper Vaal
North West	10 487 080	0	0,0%	
Northern Cape	37 285 988	0	0,0%	
Western Cape	12 955 045	1 813 516	14,0%	Boland, Groot Winterhoek, Kouga, Langeberg, Outeniqua, Swartberg, Table Mountain, Tsitsikamma

Distribution of SWAs in relation to Water Management Areas

SWSAs occur in all of South Africa's nine WMAs, as shown in the Figure below. SWSAs cover 43,9% of the Inkomati-Usuthu WMA, 34,5% of the Pongola-Mtamvuna WMA, 15,5% of the BreedeGouritz WMA, 12,3% of the Mzimvubu-Tsitsikamma WMA, 9,6% of the Berg-Olifants WMA, 5,7% of the Olifants WMA, 2,6% of the Limpopo WMA, 1,2% of the Vaal WMA and 1,1% of the Orange WMA. Almost all SWSAs fall across more than one WMA.

Figure: SWAs showing Water Management Areas boundaries

4.4.7.3 Land accounts across all SWAs

Key findings from the land accounts for SWSAs include the following:

- In 2020, 68,7% (6 888 660 ha) of the total area of all SWSAs remained natural or semi-natural, compared with 70,6% in 1990. This means there was a net decrease of 181 141 ha in natural or semi-natural land cover in SWSAs over the 30 years from 1990 to 2020.
- In 2020, the six intensively modified land cover classes (commercial field crops, subsistence crops, orchards and vines, timber plantations, urban and mines) made up 28,8% (2 885 994 ha) of the total area of all SWSAs, compared with 27,2% in 1990. This was a higher proportion than for South Africa's mainland as a whole, in which intensively modified land cover made up 15,7% in 1990 and 16,2% in 2020.
- The proportion of timber plantations was much larger in SWSAs than in South Africa's mainland as a whole in both 1990 and 2020. In 2020, timber plantations made up 13,9% of the total area of SWSAs compared with 1,7% of the total area of South Africa's mainland.
- Among the intensively modified land cover classes, the largest net increase in absolute terms between 1990 and 2020 in all SWSAs combined was an increase of 71 847 ha (5,4%) in timber plantations, from 1 319 754 ha in 1990 to 1 391 601 ha in 2020. Spatially, timber plantations are more abundant in the east of the country than in the west.
- Among the intensively modified land cover classes, the largest net percentage increase between 1990 and 2020 in all SWSAs combined was a 51,9% increase in mines, from 3 444 ha in 1990 to 5 233 ha in 2020. The second largest net percentage increase was a 16,5% increase in urban areas, from 395 052 ha in 1990 to 460 329 ha in 2020.
- Commercial field crops made up 6,3% (633 212 ha) of land cover across all SWSAs in 2020. SWSAs with the largest extent of commercial field crops in 2020 were Southern Drakensberg (154 382 ha), Enkangala Grassland (52 394 ha) and Boland (52 328 ha). SWSAs with the highest proportion of commercial field crops in 2020 were Upper Vaal (28,4%), Maloti Drakensberg (22,1%) and Langeberg (16,6%).
- Subsistence crops made up 2,5% (248 893 ha) of land cover across all SWSAs in 2020. SWSAs with the largest extent of subsistence crops in 2020 were Eastern Cape Drakensberg (105 368 ha), Southern Drakensberg (68 693 ha) and Northern Drakensberg (25 515 ha). SWSAs with the highest proportion of subsistence crops in 2020 were Eastern Cape Drakensberg (7,3%), Mfolozi Headwaters (5,7%) and Southern Drakensberg (3,7%).
- Orchards and vines made up 1,5% (146 726 ha) of land cover across all SWSAs in 2020. SWSAs with the largest extent of orchards and vines in 2020 were Boland (66 302 ha), Groot Winterhoek (19 998 ha) and Mpumalanga Drakensberg (19 704 ha). SWSAs with the highest proportion of orchards and vines in 2020 were Boland (10,9%), Soutpansberg (6,8%) and Wolkberg (6,6%).
- Timber plantations made up 13,9% (1 391 601 ha) of land cover across all SWSAs in 2020. SWSAs with the largest extent of timber plantations in 2020 were Mpumalanga Drakensberg (330 024 ha), Southern Drakensberg (329 108 ha) and Upper Usutu (216 149 ha). SWSAs with the highest proportion of timber plantations in 2020 were Upper Usutu (40,1%), Mpumalanga Drakensberg (39,4%) and Mbabane Hills (22,0%).
- Urban areas made up 4,6% (460 329 ha) of land cover across all SWSAs in 2020. SWSAs with the largest extent of urban areas in 2020 were Southern Drakensberg (123 349 ha), Eastern Cape Drakensberg (79 084 ha) and Soutpansberg (36 968 ha). SWSAs with the highest proportion of urban areas in 2020 were Table Mountain (39,8%), Soutpansberg (15,8%) and Amathole (7,8%).
- Mines made up 0,1% (5 233 ha) of land cover across all SWSAs in 2020. SWSAs with the largest extent of mines in 2020 were Upper Vaal (1 216 ha), Northern Drakensberg (1 027 ha) and Mpumalanga

Drakensberg (948 ha). SWSAs with the highest proportion of mining land cover in 2020 were Upper Vaal (0,9%) and Table Mountain (0,4%).

- SWSAs with the highest proportion of natural or semi-natural land cover in 2020 were Kouga (99,1%), Swartberg (98,5%), Waterberg (92,7%), Groot Winterhoek (87,1%) and Northern Drakensberg (81,7%).
- Three SWSAs had less than 60,0% natural or semi-natural land cover in 2020: Upper Usutu (40,9%), Table Mountain (50,4%), Mpumalanga Drakensberg (51,3%). 60,0% natural or semi-natural land cover represents a threshold for retaining ecological functioning of the landscape. Ecological functioning in these SWSAs is likely to have been substantially impacted.
- SWSAs that were at or close to the threshold of 60,0% natural or semi-natural land cover in 2020 were Upper Vaal (60,1%), Southern Drakensberg (60,4%), Wolkberg (63,4%), Soutpansberg (63,4%) and Mbabane Hills (64,8%).
- SWSAs in which there were net increases of greater than 20 000 ha in intensively modified land cover (for all intensively modified land cover classes combined) between 1990 and 2020 were: Southern Drakensberg (56 011 ha), Enkangala Grassland (51 186 ha), Eastern Cape Drakensberg (42 042 ha), Upper Usutu (21 544 ha) and Northern Drakensberg (21 384 ha).
- SWSAs with a net percentage increase of greater than 10,0% in intensively modified land cover (for all intensively modified land cover classes combined) between 1990 and 2020 were: Kouga (123,8%, from a low base of 21 ha), Enkangala Grassland (35,7%), Northern Drakensberg (19,1%), Eastern Cape Drakensberg (16,1%), Upper Vaal (14,2%) and Mfolozi Headwaters (10,6%).
- SWSAs with a combination of a relatively low proportion of natural or semi-natural land cover (close to or below 60,0% in 2020) and large net increases in intensively modified land cover in either absolute or percentage terms between 1990 and 2020 were Upper Usutu, Upper Vaal and Southern Drakensberg.
- SWSAs in which there were large increases in intensively modified land cover in both absolute and percentage terms between 1990 and 2020 were Enkangala Grassland (51 186 ha or 35,7%), Eastern Cape Drakensberg (42 042 ha or 16,1%) and Northern Drakensberg (21 384 ha or 19,1%).

4.4.7.4 *Accounts for protected areas across all SWSAs*

Accounts for protected areas in SWSAs track the size and composition of the protected area estate within SWSAs. Key findings from the accounts for protected areas in SWSAs include the following:

- The size of the protected area estate in all SWSAs in 2020 was 1 896 732 ha or 18,9% of the total extent of SWSAs, compared with 1 393 914 ha or 13,9% in 1990. This represents an increase of 502 818 ha (36,1%).
- In comparison, the proportion of South Africa's mainland protected was 6,3% in 1990 and 9,2% in 2020. This means that the proportion protected in SWSAs was more than double the proportion protected for South Africa as a whole in both 1990 and 2020.
- The protected area types that contributed most to the protected area estate in SWSAs in 2020 were Nature Reserves (39,6%), Mountain Catchment Areas (19,2%) and Forest Wilderness Areas (12,8%). In contrast, the protected area types that contributed most to the protected area estate in South Africa's mainland as a whole in 2020 were Nature Reserves (44,5%), National Parks (37,4%) and Protected Environments (7,1%). Mountain Catchment Areas, Forest Wilderness Areas and Forest Nature Reserves play a notably larger role in protection of SWSAs than they do in protection of South Africa's mainland as a whole. National Parks play a notably smaller role in protection of SWSAs than they do in protection of South Africa's mainland as a whole.

- Protected area types with the greatest increases in extent in both absolute and percentage terms in all SWSAs combined between 1990 and 2020 were Nature Reserves with an increase of 233 268 ha (45,1%) and Protected Environments with an increase of 154 582 ha (1 332,3%). There were no increases in the extent of Forest Wilderness Areas and Mountain Catchment Areas in SWSAs over the period 1990 to 2020.
- SWSAs with the largest extent protected in absolute terms in 2020 were Groot Winterhoek (329 335 ha), Boland (263 604 ha) and Southern Drakensberg (256 338 ha). SWSAs with the highest proportion protected in 2020 were Swartberg (76,5%), Kouga (72,3%) and Groot Winterhoek (63,5%). These three SWSAs were also among the five SWSAs with the highest proportion of natural or semi-natural land cover in 2020. An overall spatial pattern was that SWSAs in the west of the country tended to have a greater proportion protected than those in the east (with some exceptions).
- SWSAs with the smallest extent protected in absolute terms in 2020 were Amathole (6 304 ha), Upper Vaal (10 465 ha) and Mfolozi Headwaters (13 143 ha). SWSAs with the lowest proportion protected in 2020 were Eastern Cape Drakensberg (1,1%), Amathole (3,2%) and Mfolozi Headwaters (6,8%).
- SWSAs that had the greatest absolute increase in extent protected (all protected area types combined) between 1990 and 2020 were Southern Drakensberg (63 835 ha), Mpumalanga Drakensberg (55 557 ha) and Enkangala Grassland (53 686 ha). SWSAs that had the greatest percentage increase in protection between 1990 and 2020 were Soutpansberg (2 369,7%), Waterberg (1 322,2%) and Upper Usutu (1 265,5%).
- National Parks made up 10,3% (195 181 ha) of the protected area estate in SWSAs in 2020, which was 1,9% of the total extent of all SWSAs. SWSAs with the largest extent of National Parks in absolute terms in 2020 were Tsitsikamma (67 221 ha), Outeniqua (60 290 ha) and Waterberg (23 939 ha). SWSAs with the highest proportion of National Parks in 2020 were Table Mountain (40,7% of SWSA extent), Waterberg (23,2%) and Tsitsikamma (20,9%).
- Nature Reserves made up 39,6% (751 008 ha) of the protected area estate in SWSAs in 2020, which was 7,5% of the total extent of all SWSAs. SWSAs with the largest extent of Nature Reserves in absolute terms in 2020 were Boland (142 950 ha), Southern Drakensberg (98 353 ha) and Mpumalanga Drakensberg (75 487 ha). SWSAs with the highest proportion of Nature Reserves in 2020 were Kouga (72,3% of SWSA extent), Swartberg (59,9%) and Mbabane Hills (25,2%).
- Protected Environments made up 8,8% (166 185 ha) of the protected area estate in SWSAs in 2020, which was 1,7% of the total extent of all SWSAs. SWSAs with the largest extent of Protected Environments in absolute terms in 2020 were Enkangala Grassland (41 678 ha), Soutpansberg (38 906 ha) and Upper Usutu (37 226 ha). SWSAs with the highest proportion of Protected Environments in 2020 were Soutpansberg (16,6% of SWSA extent), Upper Usutu (6,9%) and Enkangala Grassland (5,3%).
- Forest Nature Reserves made up 6,6% (125 200 ha) of the protected area estate in SWSAs in 2020, which was 1,2% of the total extent of all SWSAs (Table 15). SWSAs with the largest extent of Forest Nature Reserves in absolute terms in 2020 were Southern Drakensberg (48 654 ha), Boland (26 804 ha) and Mpumalanga Drakensberg (15 090 ha). SWSAs with the highest proportion of Forest Nature Reserves in 2020 were Langeberg (6,7% of SWSA extent), Boland (4,4%) and Southern Drakensberg (2,6%).
- Forest Wilderness Areas made up 12,8% (243 523 ha) of the protected area estate in SWSAs in 2020, which was 2,4% of the total extent of all SWSAs. SWSAs with the largest extent of Forest Wilderness Areas in absolute terms in 2020 were Southern Drakensberg (84 866 ha), Groot Winterhoek (81 418 ha)

and Northern Drakensberg (32 704 ha). SWSAs with the highest proportion of Forest Wilderness Areas in 2020 were Groot Winterhoek (15,7% of SWSA extent), Langeberg (7,6%) and Wolkberg (5,8%).

- Mountain Catchment Areas made up 19,2% (363 253 ha) of the protected area estate in SWSAs in 2020, which was 3,6% of the total extent of all SWSAs. SWSAs with the largest extent of Mountain Catchment Areas in absolute terms in 2020 were Groot Winterhoek (209 692 ha), Boland (81 259 ha) and Langeberg (43 926 ha). SWSAs with the highest proportion of Mountain Catchment Areas in 2020 were Groot Winterhoek (40,5% of SWSA extent), Langeberg (25,6%) and Swartberg (16,6%).
- Four SWSAs include portions of World Heritage Sites. Southern Drakensberg SWSA and Northern Drakensberg SWSA include portions of the uKhahlamba Drakensberg World Heritage Site, mostly overlapping with other protected area types in these SWSAs. Mpumalanga Drakensberg SWSA and Mbabane Hills SWSA include portions of the Barberton Makhonjwa Mountains World Heritage Site.

4.5 Status of land degradation in South Africa

South Africa is a signatory to the United Nations Convention to Combat Desertification (UNCCD), focussed on combatting Desertification, Land Degradation and Drought (DLDD), and providing strategic objectives to guide stakeholders and partners to achieving Land Degradation Neutrality (LDN). The convention requires that parties submit country reports every 4 years, and the South African National Biodiversity Institute (SANBI) compiled the report on behalf of the national Department of Forestry Fisheries and the Environment (DFFE) (the focal point). The national report is captured and presented using an online reporting system known as PRAIS4 (Performance Review and Implementation Assessment v4).

The national report can be found at this url: https://reporting.unccd.int/api/country/ZAF/report/official/pdf/. The 2022 national report covers the period 2016-2019 as stipulated in UNCCD decision 15/COP.13. The next national report is due in 2026 and will cover the period 2020-2023. The PRAIS4 system is highly structured and leaves little room for comment; consequently the team undertaking the reporting produced a technical document which details many of the technical considerations and limitations of the report. The technical report can be found at this url: http://hdl.handle.net/20.500.12143/8728. Readers are encouraged to read the national report and technical reports for more in-depth, fully referenced information.

Strategic Objective 1: To improve the condition of affected ecosystems, combat desertification/land degradation, promote sustainable land management and contribute to land degradation neutrality

Land cover change and soil organic carbon maps do not suggest extensive degradation (ca. 1.3%), but the analyses for land productivity do. Partly, this result arises because the protracted drought that occurred during the reporting period (2016 – 2019) creates the impression of high degradation in many remotely sensed outputs. The results for land productivity differ widely between the various models that the UNCCD secretariat encourages data analysts to use in the TRENDS.Earth package, varying from ca. 12.2% to over 30%, depending on the models and input data used (satellite observations of vegetation and climate). In addition, the models did not agree on which areas were degraded, with some regions identified as improved in some models, but degraded or stable in others. South Africa used the pixel RESTREND and CHIRPS satellite data, because this accounted for rainfall variation in estimating land productivity. This yielded a value of 29.6% of the country judged to be degraded over the reporting period, when combined with areas identified as degraded by the other two indicators (land cover change and soil organic carbon). Given that degraded area is one of the key measures the UNCCD requires for each country, a ground-truthing exercise to confirm or refute these degradation/productivity maps outputs is essential, to identify which model will be most reliable for future reporting. It should be noted that the UNCCD categories of grassland, tree covered areas, etc., do not work particularly well for South Africa, given that South Africa has large areas of shrubland that do not behave in an ecologically similar way to grassland.

Strategic Objective 2: To improve the living conditions of affected populations

South Africa used the GINI coefficient to measure income inequality, as that is the recommended measure for middle income countries. South Africa's GINI coefficient (0.63, on a scale of 0 for all equal, and 1 for greatest inequality) has declined slightly, but remains amongst the highest for countries in the world who measure such indices. About 84.5% of the country's urban population, and 52.5% of its rural population (72.7% overall) have access to safely-managed drinking water. There was a slight improvement in access to safe drinking water over the reporting period (2016-2019). 25% of the population was considered to live in degraded areas over the reporting period. This exposure to degradation did not differ markedly between the sexes.

Strategic Objective 3: To mitigate, adapt to, and manage the effects of drought in order to enhance resilience of vulnerable populations and ecosystems.

With the exception of 2017, in the years between 2016 and 2019 inclusive, more than 70% of the country's area experienced some form (i.e., mild, moderate, severe or extreme) of drought, measured using SPI (Standard Precipitation Index). In 2017, 59% of the country's area experienced drought. Drought is a natural part of the country's wet and dry cycles, but in recent years, these regions have also experienced high maximum temperatures, which exacerbate drought and its effects on biota, agriculture and human wellbeing. It may be more accurate to consider SPEI (Standardized Precipitation-Evapotranspiration Index) in future reports, which although more challenging to calculate, will capture these temperature effects, which may be under-appreciated at present. In 2016, ca. 50% of South Africa's population was exposed to some form of drought, in 2017 and 2019, this figure was 40%, and in 2018, 80% were exposed to drought. There were no marked differences between the sexes in this exposure. Drought Vulnerability Index (DVI) measures the vulnerability of the population to drought. It considers social, economic and infrastructural factors. These include literacy rates, what percent of the population is rural, life expectancy, GDP per capita, agriculture as a percentage of GDP, and access to safe drinking water. It does not consider the chances of drought occurring, but rather the ability of society to deal with droughts when they occur. South Africa's DVI declined from 0.34 to 0.33 over the reporting period. Females seem to have a slightly lower DVI than males (for 2019: 0.34 for females, 0.32 for males).

Strategic Objective 4: To generate global environmental benefits through effective implementation of the United Nations Convention to Combat Desertification.

South Africa's Red List Index is declining (0.782 in 2016; 0.775 in 2019). The average proportion of Terrestrial Key Biodiversity Areas covered by protected areas in South Africa has increased very slightly (31.1 in 2016; 33.07 in 2019).

Strategic Objective 5: To mobilize substantial and additional financial and non-financial resources to support the implementation of the Convention by building effective partnerships at global and national level

Trends in resourcing of the activities of the convention are generally positive. Domestic public resources and international donor funds dominate in terms of annual value. Resources to support implementation of the Convention coming from domestic private channels are largely unknown.

4.6 State of oceans and coasts

The following section is an edited extract of the: (i) South African National Coastal Assessment Technical Report 1: Hotspot Detection, 2020; (ii) South African National Coastal Assessment Technical Report 2: Case Study Analysis, 2020; (iii) Oceans and Coasts Annual Science Report, 2022; (iv) National Coastal Climate Change Vulnerability Assessment: Vulnerability Indices, 2020; and National data and information report for marine spatial planning, 2021 and readers are encouraged to read these reports for more, in-depth, fully referenced, information.

Coastal zones throughout the world have historically been among the most heavily exploited areas because of their rich resources. In coastal countries today, an estimated half of the total population live in coastal zones, and migration from inland areas to the coast is increasing. Not surprisingly, there is also a rising conflict between the need for immediate consumption or use of coastal resources and the need to ensure the long-term supply of those resources. The enjoyment of the coastal zone by a wide variety of users and the view of the coast as a national asset and legacy for future generations is of the utmost importance for the promotion of its current and future sustainable use.

"South Africa occupies the southern tip of Africa, its coastline stretching 2,798km from the western desert border with Namibia to the border with Mozambique in the east"

South Africa's coastal environment is a rich and diverse national asset, providing important economic and social opportunities for the human population. As a result, coastal populations have developed a strong reliance on these resources for commercial opportunity and gain, food, recreation, and transport. Also, coastal resources have facilitated job creation and general economic upliftment in coastal regions.

Historically, the industrial centre in South Africa was in the interior of the country near the gold mines along the Witwatersrand. However, over the years the country's economy evolved from a strong dependence on primary extraction activities (e.g. mining) to increased manufacturing and service industries to lately becoming increasingly dependent on port facilities for the export of such processed products. Consequently, the coastal cities have developed and expanded rapidly.

30%
of South Africa's population lives within 60 km of the coast

Since the 1980s the major coastal cities of Cape Town, Port Elizabeth, East London, Durban, and Richards Bay have experienced the fastest economic growth of all cities in the country.

The coastal environment of South Africa is therefore –

- An *economic place* where commercial, recreational and subsistence activities take place;
- A *social place* where people enjoy themselves and come to relax and find spiritual peace; and
- A *biophysical place* where land, sea and air meet and interact, and where beaches, sand dunes, rocky headlands and estuaries support a wide range of coastal biodiversity.

Importantly, these three components are interrelated with the social and economic value of coastal systems, largely depending on the health and productivity of the biophysical component.

The estimated contribution of coastal resources (without regulatory services) to the South African economy is in the order of some R 57 billion (US$ 5.7 billion). The direct economic benefits from coastal resources in South Africa are estimated to be approximately 35 percent of the country's annual gross domestic product (GDP). Direct economic benefits include the marine fishing industry, port and harbour development and attractive lifestyles, and recreational and tourism opportunities offered by a coastal location. Furthermore, the coast provides indirect economic benefits such as the erosion control provided by coastal features such as dunes and high cliffs which protect built and natural features along the coast (including roads, buildings and farmlands) from the damaging effects of waves and wind, and it allows waste assimilation, detoxification and recycling through coastal wetlands, forests and grasslands.

These indirect benefits account for an additional 28 percent of the country's GDP. In addition to the economic benefits, the coastal environment provides enormous social benefits that many people enjoy. For some people, the coast is a place of cultural or spiritual significance and many South Africans also see the coast as a place of recreation. It supports coastal population livelihood, by providing building materials, food and other benefits that are difficult to measure in monetary terms. The coast also provides many educational and scientific opportunities which are not easily quantifiable in monetary value. Tourism, recreation and leisure activities have developed into a global growth industry and South Africa's coast has particular value in this regard.

4.6.1 Marine offshore environments

South Africa has a complex, interesting and diverse marine environment. This is largely driven by direct influences from three ocean basins: the Atlantic, Indian and Southern oceans that all meet at the Mallory Escarpment and Trough (approximately 300 km south of Cape Infanta). The currents that originate in each of these ocean basins and sweep through the South African Exclusive Economic Zone (EEZ) are strongly contrasting and, in turn, are a key driver of the rich national marine biodiversity. The "offshore" follows the definition in the National Biodiversity Assessment 2018, Marine Technical Report, and refers to the portion of the marine environment that is deeper than the fair-weather wave base (approximately 40–50 m depth, i.e., the mid shelf and deeper) in the mainland Exclusive Economic Zone.

The Benguela Current in the Atlantic Ocean brings cool, nutrient-rich polar water up the west coast, with sea-surface temperatures typically between 13˚C and 15˚C. Upwelling cells are characteristic in this area, driving high productivity. Upwelling is the result of ocean and wind interactions bringing nutrients from deep waters to the surface where sunlight stimulates photosynthesis and production of phytoplankton. This forms the basis of a complex food web, in turn increasing the overall volume of biological productivity at all levels.

Areas of upwelling are found where the wind is strongest and where the continental shelf is narrowest and deepest. In fact, the Benguela Current is one of the most productive regions in the world, underpinning many commercial fisheries. The cool ocean conditions also drive aridity along the west coast, with far fewer estuaries and land-based supplies of nutrients and sediment flowing into the sea; however, the orange river is a notable exception.

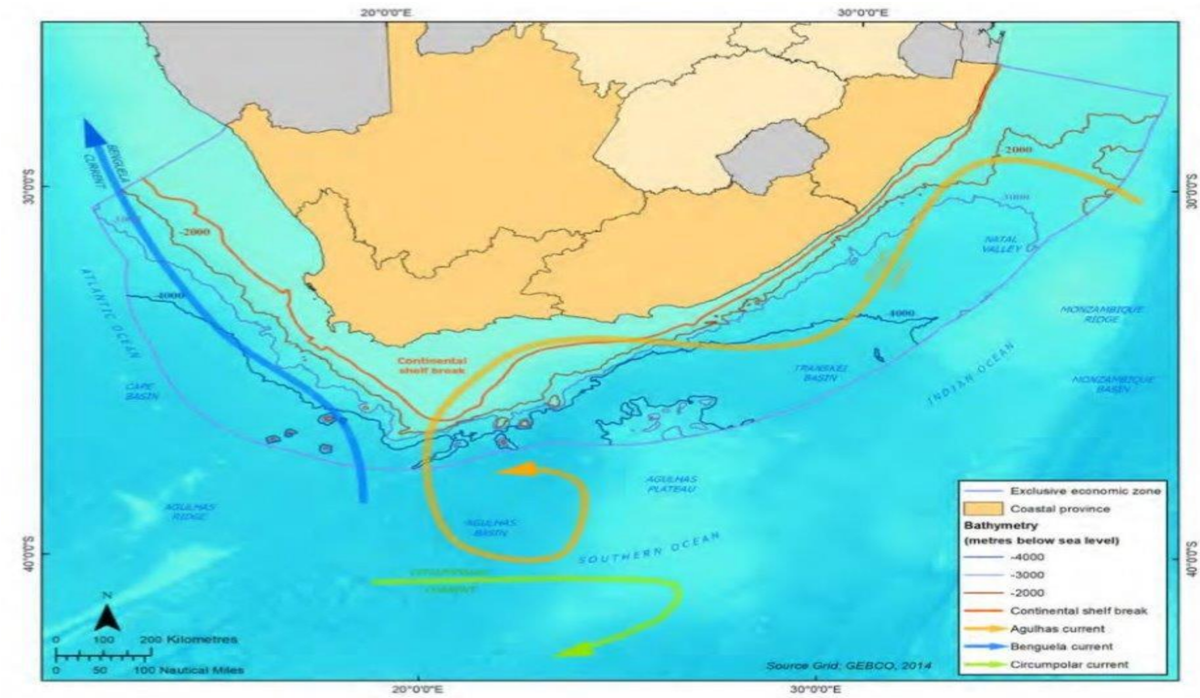


Figure: Oceanography of South Africa's Exclusive Economic Zone with ocean currents.

In contrast, the Agulhas Current System from the Indian Ocean on the east coast becomes established between southern Mozambique and Durban. The Agulhas Current is a fast-flowing western boundary current that brings warm (ca. 25°C), nutrient-poor tropical water from the equatorial region of the western Indian Ocean down the South African east coast. It comes close inshore along the eastern seaboard because of the narrow continental shelf on this side of the country. It gets pushed further offshore southwards of East London, where the continental shelf widens, and meets the Benguela Current at Cape Agulhas, where it retroflects (turns) and flows eastward back toward the Indian Ocean. Although these warm waters have low nutrient levels, they support very diverse biota from the species-rich indo-pacific region. However, upwelling of cold, deep, nutrient-rich water onto the shelf can occur as cyclonic lee eddies move downstream along the inshore edge of the Agulhas Current, which in turn enhances phytoplankton biomass and subsequent productivity on the shelf. Coral reefs, mangroves and large river inputs from estuaries along the east coast characterize the shelf waters. The latter is a result of the South African east coast and adjoining interior having a higher rainfall than that on the west coast. This is because heat and moisture (from the Agulhas Current) are transferred from the ocean to the atmosphere, resulting in higher rainfall and thus, more estuaries and terrigenous inputs flowing into the sea than that along the west coast. Because the water in the Agulhas Current is so nutrient poor, delivery of land-derived nutrients to the sea by these estuaries are very important, particularly from large estuaries such as the uThukela Estuary that in turn underpin marine communities as far offshore as the continental shelf in some places.

Although each current itself is interesting, it is the confluence of the Agulhas and Benguela Currents along the south coast that is important for large-scale oceanic and climate processes. Warm, salty water from the Agulhas Current leaks through into the Benguela Current, mostly in the form of Agulhas rings (but also eddies and filaments) that pinch off at the point where the Agulhas Current turns on itself to flow back into the Indian Ocean (the point of retroflection), in a process that appears to be wind driven. This leakage provides a significant source of salt and heat for the Atlantic Ocean, influencing the Atlantic meridional overturning circulation, and in turn, influencing large-scale climate patterns.

The Southern Ocean brushes the southern extent of South Africa's mainland Exclusive Economic Zone, meeting the other two ocean basins around the Mallory escarpment and trough. It plays a role in the origin of the Benguela Current that influences the South African west coast but has a more direct influence on South Africa's sub-Antarctic territory: the Prince Edward Islands. The Antarctic circumpolar current and associated Antarctic and Sub-Antarctic polar fronts are highly productive and are important for generating the productivity that supports the islands' myriad of top predators.

The strong contrasts in temperature, productivity and depth from east to west, and offshore, results in six ecoregions around the South African mainland, including four shallow and shelf ecoregions, namely: (i) the Southern Benguela; (ii) Agulhas; (iii) Natal; and (iv) Delagoa; and two deep ocean ecoregions: (v) the southeast Atlantic (western oceanic); and (vi) southwest Indian (eastern oceanic), with two subregions nested into each of the southern Benguela and Natal ecoregions. Within each of these ecoregions and subregions is a rich diversity of ecosystem types that range from shallow, subtropical coral reefs to cold-water abyssal habitats that are scattered with seamounts.

There has been substantial effort over the last five years to improve the map of marine ecosystem types in South Africa. The latest map draws from historical and new data of bathymetry, oceanography, sediment and biodiversity collected using a range of technologies, e.g., remote sensing, grab sampling, and underwater video surveying using remotely operated vehicles and/or drop cameras. These data have been used to delineate 150 ecosystem types in much finer detail than ever before, of which 86 types are considered offshore. This is a key advance in our understanding of the marine realm, which was made as part of South Africa's National Biodiversity Assessment 2018, with the following descriptions of the ecoregions drawing heavily from the marine ecosystem classification and mapping chapter of the marine technical report –

- The **southern Benguela ecoregion** extends along the entire South African west coast from Namibia to Cape Point, and is sub-divided into a northern Namaqua subregion and southern Cape subregion. The ecoregion comprises of cool temperate ecosystem types with communities that are generally less diverse, but highly productive and have higher biomass compared to those on the east coast. These ecosystem types include kelp forests, cold-water corals, canyons, and a variety of ecosystem types with diverse benthic substrates. The continental shelf on the west coast is strongly influenced by fluvial inputs from the orange river, and is much wider than the shelf on the east coast.
- The **warm temperate Agulhas ecoregion** incorporates the shelf area from Cape Point in the west to the Mbashe river to the east, and includes the central and eastern Agulhas bank bounded by the Agulhas Falklands fracture zone. The complexity of the oceanography and geology in this area at the southern tip of Africa gives rise to a rich diversity of features and warm temperate ecosystem types, such that this is generally the ecoregion of highest species endemism in the South African marine realm. It includes the full range of benthic substrates, from muds to rock and reef, and interesting features like the Agulhas, Alphard and Browns Banks (that form the widest part of the national continental shelf), seamounts, Mallory escarpment and trough, and the recently discovered Kingklip koppies and Kingklip ridge. The Agulhas bank is shallower than -150 m in the east and slopes gently towards the south. Sea surface temperatures over most of the Agulhas bank are generally 16˚C in winter and 21˚C in summer.

  Concentrations of nutrients over the Agulhas bank are not as high as on South Africa's west coast but are sufficient to support a productive marine biological community. The region is important for numerous ecological processes including spawning, larval retention, recruitment, connectivity and provision of nursery and foraging areas for a variety of species, some of which are commercially important. Examples of these species include invertebrates, fish, whales, sharks and turtles.
- The **narrow, subtropical Natal ecoregion** on the east coast extends from the Mbashe estuary up To Cape Vidal. It comprises two subregions: the river-influenced KwaZulu-Natal Bight subregion in the north; and

southern KwaZulu-Natal and Wild Coast subregion in the south. This ecoregion contains key features like coral reefs and canyons, and a range of shelf ecosystem types driven by diverse types of benthic substrates. Notably, the uThukela river delivers substantial volumes of sediment and nutrients to the marine environment and is the key driver of the KwaZulu-Natal Bight subregion. Consequently, there are many muddy ecosystem types in this area and the continental shelf is wider here than the rest of the South African east coast.

- The **Delagoa ecoregion** extends northwards from Cape Vidal to Bazaruto island in Mozambique. The South African portion of this tropical ecoregion is characterised by a very narrow continental shelf, several submarine canyons and no riverine inputs, with only two groundwater-fed estuaries. The result is clear nutrient-poor waters where algae and zooxenthellate corals, particularly soft corals, dominate shallow reefs.

Further offshore are two deep water ecoregions: the southern Indian ecoregion to the east, and southeast Atlantic ecoregion to the west. The bathymetry of the Southern Indian ecoregion slopes down from north to south, with the Southwest Indian mid slope flanking the border with Mozambique, gently dropping through the lower slope to the abyss along the eastern edge of the national exclusive economic zone. Bathymetry through the southeast Atlantic ecoregion slopes similarly to that in the Southwest Indian ecoregion, with the shallower lower slope in the north and deeper abyss in the south. The abyssal habitat in both ecoregions is interrupted by various seamounts that play a key role in elevating local productivity.

4.6.2 Marine inshore environments

The inshore marine environment includes the shores along South Africa's 3,650-km long mainland coastline and the inner shelf, which extends to the fair-weather wave base at approximately 40-50 m depth. South Africa has microtidal (<2 m tide range), mostly exposed shores with waves ranging about 1-4 m in average conditions, and semidiurnal tides (two tidal cycles per day). The strongly contrasting oceanographic and climatic conditions from west to east, are similarly apparent along the South African inshore region, giving rise to a plethora of coastal ecosystem types, with a concomitantly rich biodiversity that has high rates of endemism. Note that the four shelf ecoregions and subregions, described under the marine offshore environment section, also include inshore ecosystem types.

The west coast of South Africa is cold and dry, forming the cool temperate Southern Benguela ecoregion. However, only some of the inshore broad ecosystem groups split into the two subregions, e.g., rocky and mixed shores split, but not sandy shores. Dunes along this coast are much smaller given the limited rainfall and limited delivery of terrigenous sediment from only a few estuaries. The Orange River in the north-western corner of the country is a notable exception as it is a significantly large system with substantial fluvial inputs to the marine environment. The country's longest dissipative beaches are found along the west coast, with other interesting ecosystem types including Langebaan Lagoon, several important bays (e.g. St Helena Bay and Saldanha Bay), kelp beds, temperate reefs, and small islands that support top predator colonies. Robben island is the largest island in the country's mainland Exclusive Economic Zone and is a cultural World heritage site. As for the offshore ecosystem types, diversity is generally lower on the west coast compared to the rest of the country's inshore area. However, it has the highest productivity; communities on the west coast thus have the largest biomass. Notably, though, much of the north-west coast has been modified by mining diamonds that are part of the fluvial deposits of the orange river.

The inshore component of the Agulhas ecoregion includes a series of log-spiral bays along the south coast, with each bay historically connected to the next by a headland bypass system: rivers of sand that used to flow over the land in large wind-blown dune-sheets. These headland bypass systems have almost all been stabilised with invasive trees and coastal development, resulting in sand-starved beaches downstream, and consequently, accelerated coastal erosion. Given the prevailing wind and wave direction, the western arcs of the bays are generally more sheltered compared to the eastern ends that are much more exposed, with the bays themselves serving as retentive systems. The capes of these bays tend to be exposed rocky shores, with a notably rocky, cliff-backed section of coast around Tsitsikamma. Given that the Agulhas ecoregion includes the confluence of the Agulhas and Benguela currents, the rates of endemism here are particularly high for coastal species. Key ecosystem types along the south coast include kelp beds and temperate reefs, and small islands that support colonies of top predators, such as seabirds and seals. There are also large transgressive, barchan and barchanoid dunes in this ecoregion: all massive sheets of fine, wind-blown sand lining the shores, particularly to the southeast. The most impressive of these is the Alexandria Dunefield in Algoa Bay (east of Port Elizabeth) that extends 50 km along the shore, and 2 km inland at its widest point, and is the largest mobile active coastal dunefield in the southern hemisphere.

The Wild Coast in the Natal ecoregion is a very rocky portion of the South African shoreline, largely comprising a combination of rocky shores, boulder shores, and rocky cliffs, incised by small estuaries and pocket beaches. For many species, this part of the coast is a transition zone between the warm temperate Agulhas and subtropical Natal ecoregions. As noted already, the Agulhas Current brings warm conditions to the east coast and is a key driver of the abundant rain in this region. The result is that most of the country's 290 estuaries flow into the sea along these eastern shores, delivering much terrigenous sediment and nutrients to the coast and adjacent marine environment. Together with rainfall and wind, this supports formation of some of the largest parabolic dunes in the country, rising almost 200 m high, covered, and backed by dense coastal forest, particularly in the Delagoa ecoregion and northern part of the KwaZulu-Natal Bight subregion. Furthermore, it results in more sandy shores on the east coast compared to the rest of the country that has proportionately more rocky shores. The east coast also supports subtropical coral reef and seagrass communities, especially on the north-east coast. The Delagoa ecoregion also includes beaches that serve as the only turtle nesting grounds in South Africa.

4.6.3 The socio-economic marine environment

The marine environment of South Africa is an asset of great importance and a major focal point for human habitation and socio-economic activities. As a maritime nation with jurisdiction over one of the largest exclusive economic zones in the world and with a large portion of South Africa's population dependent on a wide variety of marine resources for their income and well-being, the ocean represents a significant socio-economic asset with high potential for the unlocking of further contributions for socio-economic development.

People have lived at various places along the South African coasts since the early Stone Age. Evidence that coastal inhabitants supplemented their diet with intertidal shellfish, fish and seabird eggs along the east and south coast dates back to at least 100,000 years and to 50,000 years along the west coast. Until today, subsistence use of coastal marine living resources continues throughout South Africa and still plays a significant role in the lives of many. Colonisation had a significant spatial impact on patterns of coastal use among the inhabitants that had been living along the South African coastline.

Today, South Africa's coastline lies across the four provinces of the Northern Cape, Western Cape, Eastern Cape and KwaZulu-Natal. There is great diversity between these provinces in social, cultural, economic and institutional terms given their different histories:

The Northern Cape is South Africa's largest province, taking up almost a third of the country's total land area. However, the province is sparsely populated with only about 1.2 million people. Mining is an important industry with diamond mining occurring in the ocean along the coast.

Situated on the south-western tip of the African continent, the Western Cape with its wide beaches and breath-taking scenery, complemented by a rich variety of cultures, historical landmarks, world-class restaurants and entertainment, is a world-famous tourist destination. With approximately 6.7 million people, around 12 percent of the South African population lives here. Some 75 percent of all South African fishing takes place along the Western Cape coastline. The ports of Saldanha Bay and Cape Town are strategically located to serve as maritime trade hubs.

The Eastern Cape is South Africa's second-largest province after the Northern Cape, taking up 13.9 percent of the total land area. The province has a population of more than 6.5 million people. Recreational, small-scale and commercial fishing as well as maritime transport are important sectors.

KwaZulu-Natal is one of the country's most popular holiday destinations. It includes South Africa's lush subtropical east coast, stretching from Port Edward in the south to Mozambique in the north. More than 11 million people live here, making up approximately 20 percent of the South African population. KwaZulu-Natal has a diverse industrial sector, with industries associated with imports and exports having developed around the ports of Durban and Richards Bay.

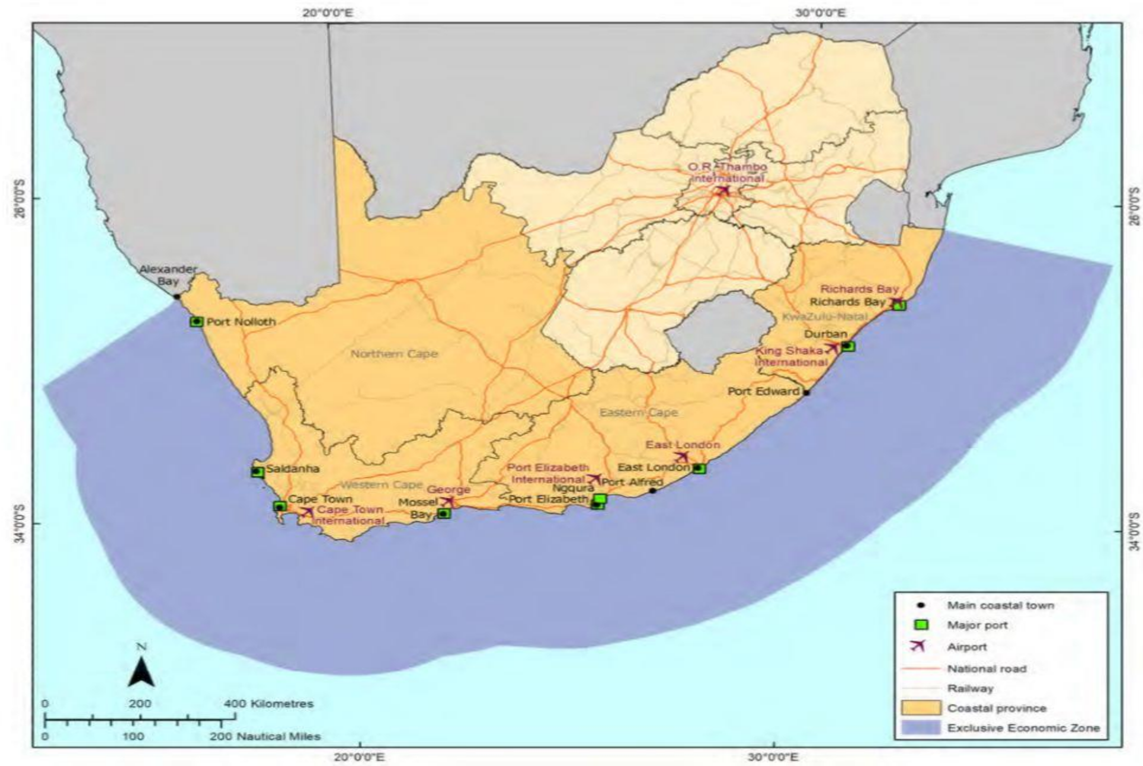


Figure: Coastal provinces, major settlements, key terrestrial infrastructure

The socio-economic context is shaped by the marine and coastal resources and areas which provide opportunities for the various industries. Commercial and recreational use of marine and coastal resources is relatively new in South Africa, dating back only less than 100 years. Key sectors with significant interests in the marine environment and substantial socio-economic impact (e.g. in terms of employment) are: (i) fisheries and marine aquaculture; (ii) marine and coastal tourism; (iii) exploitation of geological resources (e.g. diamonds) and hydrocarbon (e.g. oil and gas); and (iv) maritime transport.

Virtually all of these sectors are growing in terms of their contribution to the country's economy on an annual basis. The South African Government, in an effort to strengthen its support to the growth of these sectors, established several industrial development zones, which are geographically designated areas in which industrial development is encouraged and enabled. All of the industrial development zones are located in or around major ports: the Coega, Richards Bay, East London, Saldanha Bay, and Durban with linking road, rail and aviation infrastructure. For example, the 861 km long heavy-haul Sishen – Saldanha railway line connects iron ore mines near Sishen in the Northern Cape with the port of Saldanha Bay in the Western Cape while the Mpumalanga – Richards Bay line, the second largest coal railway in the world, delivers more than 62 million tonnes of coal. This economic trend of industrial growth leads to an intensified use of the living and non-living resources the ocean provides, including increasing maritime-based import and export.

4.6.4 South African marine area uses and developments

The following section is an edited extract of the National Data and Information Report for Marine Spatial Planning, 2021 and readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African marine area uses and developments.

4.6.4.1 Coastal and underwater infrastructure

The South African coastline is in many parts a highly used section of the country. There are many activities that occur within the coastal environment including urban and rural development, transport, energy generation and transmission, food production and mineral extraction. Land on the coast is often limited. Decisions made about coastal land development can also impact on the marine area along the coast.

The on-land transport infrastructure enables connection between coastal towns, cities, provinces and the South African inland. This connects the hinterland – destinations of consumption and production points for goods in the country and beyond in the Southern African Development Community (SADC) region – with the maritime infrastructure, the country's ports, which provide the transport infrastructure link between land and sea.

Seawards, the coast provides the link to underwater infrastructure such as telecommunication cables and pipelines.

There are several submarine cable systems which serve South Africa's telecommunications needs by carrying telephone calls, internet connections and data. South Africa is currently connected to the rest of the world through a number of submarine cables that include but are not limited to the West African cable system (WACS)/SAT-3/SAFE, and the Seacom Eastern African submarine cable system (EASSy) and Africa-1. There are more than five active cables in South Africa's ocean with a combined length of more than 70,000 kilometres.

Pipelines are used for oil and gas in the offshore marine environment of South Africa, extending over 155 km from land to offshore platforms and over 170 kilometres from platform carrying products to gas-to-liquids plants. There are also pipelines close to the coastline used to discharge wastewater into the marine environment. No submarine power cables exist.

4.6.4.2 Commercial, recreational, and small-scale fishery

South Africa's marine waters are rich in living marine resources. Some of these resources have been exploited for many centuries, with evidence dating back 125,000 years. Industrialization of fisheries started just before the turn of the 20th century. Today, South Africa is one of the leading capture fisheries nations in the world and the 2nd

largest African marine capture fisheries nation after Morocco. South Africa is a net exporter of fishery products, primarily wild capture resources.

South Africa has a well-established fisheries sector that covers three types of fishery, i.e. commercial, recreational, and small scale. Whereas commercial fishing is fishing for marine species for commercial gain, recreational fishing means any fishing done for leisure or sport and not for sale, barter, earnings or gain. Small scale fishing means the use of marine living resources on a full-time, part-time or seasonal basis in order to ensure food and livelihood security.

The commercial fishery component is well established and has 22 recognized commercial fisheries with major fishing grounds situated along the continental shelf between St. Helena Bay and Port Elizabeth. Commercial fisheries are managed by restricting the total amount permitted to be caught by the permit holder (Total Allowable Catch, TAC), restricting the amount of effort (vessels, fishers or hours) applied to a particular resource (Total Applied Effort, TAE), or a combination of the two.

The demersal (bottom) trawl and long-line fisheries, targeting the Cape hakes and the purse-seine fishery targeting small pelagic species, yield the highest economic value and greatest landed tonnage. The traditional line fishery refers to a longstanding hook and line fishery based on an assemblage of 35 different species, particularly snoek. The mid-water trawl sector targets horse mackerel whereas hand-jig fishery targets chokka squid exclusively on the South Coast. Crustacean fisheries is comprised of a trap and hoop net fisheries, targeting West Coast rock lobster, a line trap fishery targeting the South Coast rock lobster, and a trawl fishery based solely on the KwaZulu-Natal coast targeting penaeid prawns, langoustines, deep-water rock lobster and red crab. Highly migratory tuna and tuna-like species are caught in areas beyond national jurisdictions and seasonally within the exclusive economic zone by the pelagic long-line and pole fisheries.

The wild capture fishery sector is an important part of the nation’s food supply, supports the livelihood of many coastal communities and is an avenue for economic opportunities. South Africans consume over 310 million kilograms of fish annually, ±50 percent of this is locally caught. Fisheries contribute roughly R9 billion to the country’s Gross Domestic Product (GDP), which equates to roughly 0.1 percent of the country’s GDP. Although this is relatively small in comparison to other sectors, fisheries is however more important for economic development in the Western Cape where 11 of the 13 proclaimed fishing harbours are situated. These contribute more the 5 percent to Gross Provincial Domestic Product. It is estimated that the direct employment in the industry constitutes at least 41,000 jobs, while an additional 81,000 people are indirectly employed in industries that are at least partially dependent on the fishing sector (net building, bait preparing, etc.).

Since then, catches in several South African fisheries have exceeded sustainable yields: In 2016, a total of 52 percent of stocks were considered not to be of concern, while 48 percent of stocks were of concern.

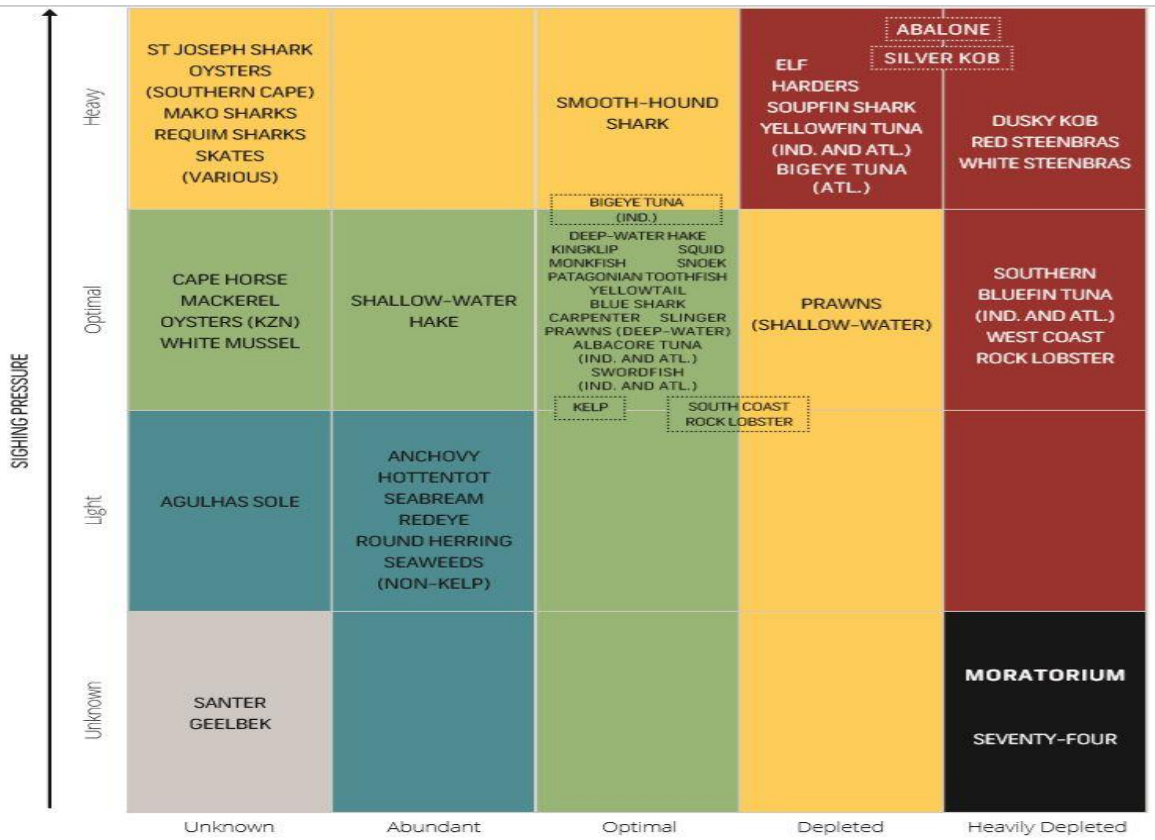


Figure: Summary matrix of stock status and fishing pressure

4.6.4.3 Marine renewable energy

Throughout history, human beings have always depended on and used different sources of energy. With the overwhelming evidence for anthropogenically induced climate change caused by the production of greenhouse gases from burning fossil fuels as a key driver, countries worldwide have recognized renewable energy resources within their energy policy as an alternative to finite fossil fuel resources. They also seek to achieve future energy security and aim to mitigate the effects of climatic change induced by human activities.

South Africa currently relies on fossil fuel-based energy sources to meet close to 90 percent of its energy demands. The Government of South Africa is therefore committed to cutting down carbon dioxide emissions and is putting increased focus on renewable sources of energy. This change in energy policy is in numerous ways prompting new human uses of space throughout the world and in South Africa – including in the ocean. One such use is the installation of technologies and associated infrastructures on land and at sea to win renewable energy.

Currently, only offshore wind energy has – internationally – reached an acceptable level of development to be considered competitive. However, there are other less developed technologies that harness naturally occurring non-depletable sources of energy from the oceans, including through wave and tidal energy, energy from currents, ocean thermal energy and salinity gradient energy.

South Africa's marine environment is endowed with vast reserves of renewable energy due to the oceanic conditions and the geographic positioning of the country. With a coastline of over 3,000 km in length and being situated at the tip of Africa, the South African coastline is exposed to the warm waters of the Agulhas current to the east, the cold waters of the Benguela current to the west and the full power of the Southern Ocean on the south.

Although no marine renewable energy production currently takes place in South African marine waters, the ocean has been identified as a potential source of such marine renewable energy. This drive towards quantifying the South African marine energy potential has generated interests in the spatial allocation of dedicated areas for deployment of marine renewable energy technologies in the marine environment.

4.6.4.4 Maritime and underwater cultural heritage

South Africa's ocean space is filled with a rich and diverse maritime and underwater cultural heritage that includes shipwrecks, submerged pre-historic landscapes of palaeontological and archaeological significance, pre-colonial stonewalled and woven intertidal fish traps, and sacred sites to which oral traditions are attached.

During the 15th century trading between Europe and the East expanded rapidly and the shipping trade route became increasingly busy and important as demand for exotic goods increased. South Africa's geographical position at the midpoint on this route became fundamental to the continuation of trade and, as such, its recent history is inextricably linked to the history of the rest of the world.

Over time, colonies, ports, and refreshment stations were established along the coast, with the oldest being what is today known as Cape Town, which then expanded to other areas of southern Africa and beyond. The popularity and dangers of the maritime trading route is reflected in the approximately 2,800 historical shipwrecks of different nationalities that are scattered around South Africa's coast. In addition to these wrecks, our maritime heritage includes many other associated sites such as the country's maritime infrastructure like lighthouses, historical harbours, and dockyards.

The record of South Africa's long association with the ocean and the country's coastline is however much broader than just shipwrecks and maritime structures, and it extends far back into pre-history. The archaeological record that constitutes this heritage includes large numbers of coastal fish traps, submerged pre-historic landscapes, maritime-themed rock paintings, and archaeology associated with coastal natural sites. Acheulean hand axes which may be up to 1.5 million years old have been recovered from the seabed in Table Bay near Cape Town and may be indicative of submerged prehistoric landscapes dating from when sea levels were considerably lower during past glacial periods. A handful of rock art depictions of sailing vessels believed to have been painted by South Africa's indigenous San and Khoi populations' hint at contact between local people and early European mariners. Stone walled fish traps are also often found along the South African coastline and, though there is some debate regarding their origin, they are an intrinsic part of the country's rich maritime heritage and provide a unique insight into the development of innovative fishing technology.

MAIN COASTAL AREA	NUMBER OF KNOWN AND MAPPED SHIPWRECK SITES (30% OF SHIPWRECK SITES IN SOUTH AFRICAN WATERS)	NUMBER FISH TRAP SITES WITH ONE OR MORE FISH TRAPS (AND TYPE)
ALEXANDER BAY – SALDANHA	105	2 (stone-walled)
SALDANHA – CAPE POINT	300	3 (stone-walled)
CAPE POINT – HERMANUS	38	0
HERMANUS – MOSSEL BAY	116	53 (stone-walled)
MOSSEL BAY – PORT ELIZABETH/GQEBERHA	73	4 (stone-walled)
PORT ELIZABETH/GQEBERHA EAST LONDON	65	0
EAST LONDON – DURBAN	103	0
DURBAN – MOZAMBIQUE	29	1 (woven)
PRINCE EDWARD ISLANDS	1	0

4.6.4.5 Marine and coastal tourism

South Africa has an astonishingly diverse variety of natural habitats, flora and fauna, histories, cultures and traditions. Its scenic 3,000-kilometer coastline and abundant marine resources and cultural resources are key natural assets that have enabled the country to become one of the prime marine tourism destinations on the African continent.

Coastal tourism refers to land-based recreational activities taking place on the coast for which the proximity to the sea is a condition including their respective services, whereas marine tourism refers to sea-based recreational activities as well as their land-based services. Coastal and marine tourism therefore focuses on recreational activities along the coastal zone on land bordering the marine environment and/or in the marine environment itself.

Coastal and marine recreational activities range from walking on a beach to participating in fishing or marine wildlife cruises. A significant coastal tourism sector takes advantage of historic sites, picturesque fishing villages, vast and desolated beaches, coastal protected areas, and linked golf courses.

The tourism industry in South Africa has grown considerably since the country's first democratic elections in 1994. The number of foreign tourist arrivals increased from just more than 3 million in 1993 to over 10 million international tourists in 2016. 74.3 percent of these international tourists arriving in South Africa come from the Southern African Development Countries region. In addition, 28 million domestic tourism trips were recorded in 2014. Coastal provinces receive approximately 25 percent of the international tourists visiting South Africa.

In recent years, a thriving wildlife tourism industry has established itself in areas around South Africa, allowing visitors to experience cetaceans, seabirds and dramatic coastal scenery. A growing boat-based whale watching industry exists, associated with the massive recovery of Southern Right and Humpback Whale populations along the coast. South Africa is internationally known for its white shark cage diving. Dive tourism is also a niche but growing tourism sector in South Africa. The cruise industry is also a sector that has grown considerably over the past years and has the potential to contribute significantly to the South African economy.

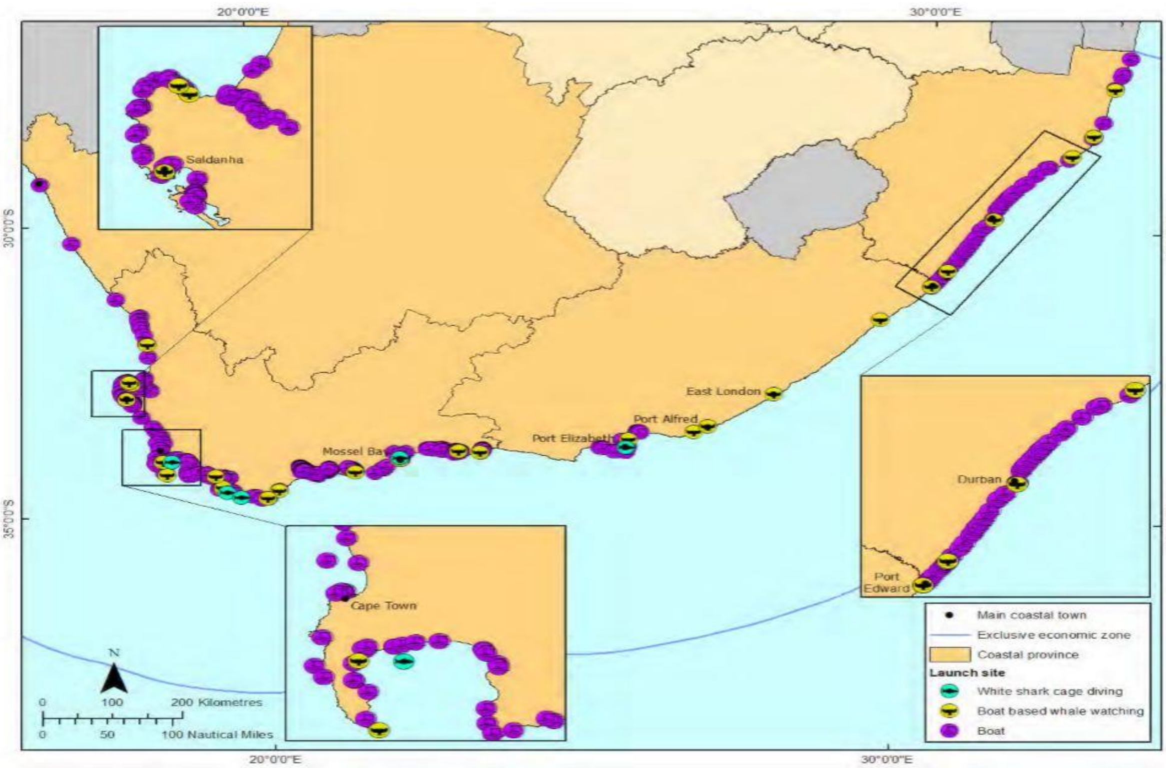


Figure: Location of boat-based whale watching and white shark cage diving sites

4.6.4.6 Maritime transport and ports

South Africa is a maritime nation with several major ports. South Africa occupies a geostrategic position on a major, globally significant sea-trading route that lies at the heart of the South-South trade and connects the markets of Asia, Europe and the Americas.

Maritime transport is an integrated system that involves the design, construction, operation, management, servicing and maintenance of merchant, leisure and other ships in the service of seaborne trade, conducting offshore operations and transporting people and cargo by sea. The country's ports provide the transport infrastructure between land and sea and are critical to enabling the movement of goods and people, connecting to the hinterland through a port, connected roads and rail infrastructure to and from destinations of consumption and production points in the country, throughout the region and into the world. Ports are a key part of the South African maritime navigation infrastructure.

There is a high concentration of vessels moving off the South African coastline with vessels not necessarily calling at a South African port. The amount of cargo transported around the Cape of Good Hope is significant: An estimated 7,000 vessels pass around South Africa's coastline annually, of which many are laden tankers carrying in excess of 30 million tonnes of crude oil. There are approximately twelve thousand cargo vessels calling at the South African ports annually. The commercial ports are Richards Bay, Durban, East London, Ngqura (Coega), Port Elizabeth, Mossel Bay, Cape Town, Saldanha Bay and Port Nolloth. 58 percent of South Africa's gross domestic product is based on trade and 98 percent of South Africa's trade volume moves by ships. In addition, the country generates a significant 3.5 percent of the world's seaborne trade volume. The types of shipping include containers, vehicles, general cargo, bulk (iron-ore, coal, etc.), and tankers (oil, fuel, sulphuric acid, etc.).

Figure: Key routes for maritime transport based on global datasets. The key maritime transport routes are defined as top 10 percent quantile of maritime transport

4.6.4.7 Mineral and petroleum resources exploration and exploitation

South Africa holds rich reserves of minerals and hydrocarbons – especially on land but also at sea. The process of mineral exploration results in finding and mapping concentrations of minerals that would merit commercial exploitation through physical extraction. The South African mining industry, especially on land, contributes significantly to the country's economy, provides employment opportunities and as such supports poverty reduction and empowerment. There is significant potential for growth of the sector offshore given the experience and knowledge of the industry and based on the potential of the geological resource base in the sea. Known mineral resources and hydrocarbons in the South African ocean space are diamonds, potassium, phosphate, glauconite, heavy metals, manganese, oil and gas. In addition, salt production takes place along the coast of South Africa.

4.6.4.8 Sea and freshwater abstraction

South Africa is a semi-arid, water stressed country. Rainfall is unevenly distributed throughout the country and coastline with higher rainfall on the East Coast compared to the South Coast with the West Coast harnessing the least rainfall. It is estimated that, based on rising population, economic growth projections, scarcity of resources as well as current use and efficiency levels, South Africa will demand 17 percent more water than exists by 2030.

The careful monitoring and management of available water resources is critical for the wellbeing of the citizens of the country since South Africa is a water scarce country. Water abstraction is the process of taking or removing water, temporarily or permanently from its natural source for domestic or industrial use. In South Africa, water is abstracted from freshwater sources such as rivers. Increasingly, sea water is also abstracted in South Africa and desalinated due to an increasing demand and – simultaneously – decreasing availability of freshwater.

Reduction of freshwater flow through abstraction has severe consequences for marine biodiversity and resources through impacts on physical habitat, reduced nutrient inputs and alterations to important ecological processes. Abstraction of sea water is not critical but the discharge of the saline brine as a result of desalination is an issue.

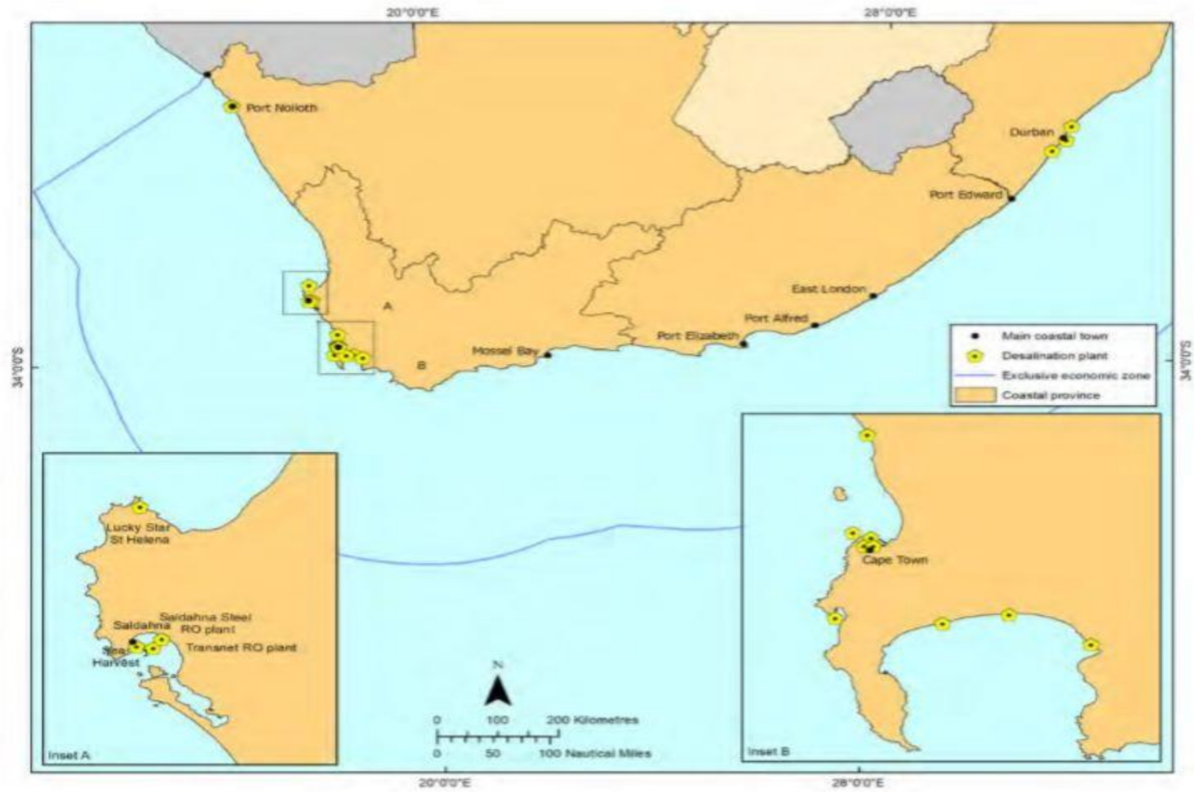


Figure: Location of desalination plants in the year 2019

4.6.4.9 Wastewater discharge

Wastewater is water which is no longer needed, and which has been generated and adversely modified in terms of quality through human influence after its domestic or industrial use. It is generally a mixture of domestic wastewater from baths, sinks, washing machines and toilets, and wastewater from industry. It will often also contain rainwater run-off from roofs and other impermeable surfaces which often contains oil residues comprising heavy metals, pathogenic microorganisms as well as litter. Wastewater discharge means the disposal of wastewater effluent to the environment.

In South Africa, like in many other countries, the disposal of wastewater originating on land into the marine environment is common and a recognized wastewater management measure. There are statutory requirements that apply to wastewater treatment and disposal with health and environmental quality standards.

Figure: Location of waste discharge outfalls

4.6.5 The national coastal assessment

4.6.5.1 Hotspot Detection: the most important findings in a nutshell

The figure below indicates that almost one third of South Africa's population lives in the coastal zone, although population density varies greatly across the four coastal provinces, ranging from below 10 people per km^2 in the Northern Cape to over 680 people per km^2 in the Western Cape with the Eastern Cape having densities just above 400 people per km^2. For the majority of the country, growth rates of the coastal belt exceed the national average. Other than the major metros, most of the growth is taking place on the east coast, stretching from Port Alfred in the Eastern Cape through KwaZulu-Natal to the boundary with Mozambique. For some settlements in this region, the population is expected to almost double until 2050, posing serious pressure not only on the coastal urban centres but also rural areas and natural environment. This growth in non-urban areas will require new development and adaptation approaches beyond prevailing traditional land management systems currently implemented in some of these areas. In contrast to the east coast, the population growth expected along the Northern Cape coast is well below 10 percent, given the scarcity of natural resources to sustain larger populations. Many of the observed east-west differences in socio-economic aspect have their origin in historical apartheid land management regulations.

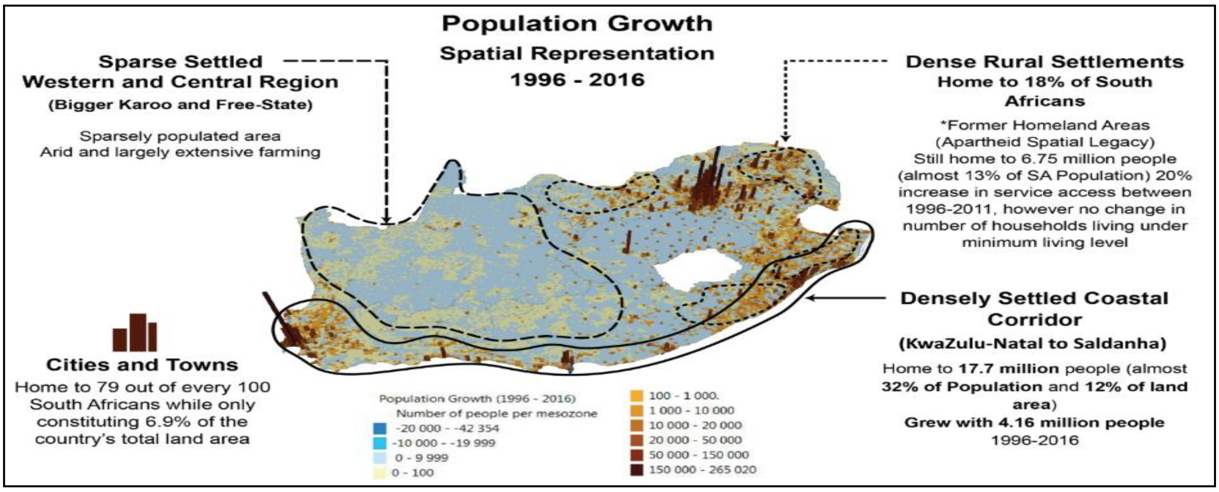


Figure: South African population growth between 1996 and 2016

National decision making, therefore will have to be cognisant of these national population projections and has to ensure that the expected rapid development is managed properly, especially in areas where complex land-ownership systems (e.g. traditional land management systems) are expected to complicate matters, e.g. South Africa's east coast between Port Alfred and St Lucia.

4.6.5.2 People and socio-economic vulnerabilities

The history of natural disasters – and the recent COVID-19 Pandemic - has demonstrated the disproportionality of their impact on different communities, as this is largely a function of preparedness and socio-economic status. In preparing for disasters, it is therefore critical to have spatially explicit information on the profile of population distribution, as well as socio-economic vulnerability in order to prioritise action toward the most vulnerable communities that inherently have low resilience to external impacts (e.g. natural disasters) without intervention.

The information at settlement and neighbourhood scale (1x1km) and at town level (7x7km resolution) was sourced and disaggregated to match the National Coastal Assessment's spatial scales which shows the gradient of, for example, socio-economic vulnerability within all coastal towns and cities. The figure below shows that very highly vulnerable neighbourhoods can be spatially identified at this level.

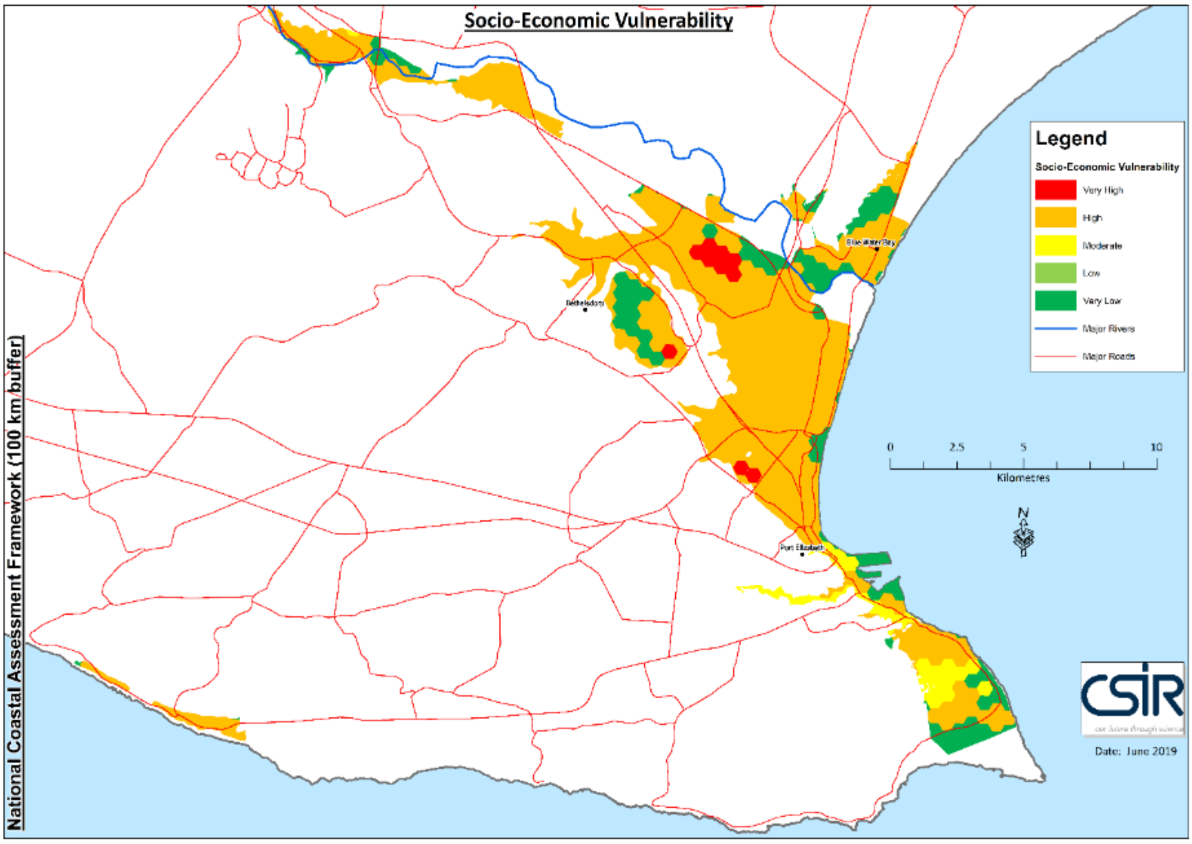


Figure: Socio-economic Vulnerability Index at neighbourhood level for the Port Elizabeth region and Eastern Cape

4.6.5.3 Coastal flood risk and urban development

Coastal flood hazard was assessed using a 5x5m pixel size digital elevation model and the distance of buildings to the coastline. The area assessed reached from the coastline to the 40m elevation contour inland. This flood assessment considers the propagation of ocean still water inland, e.g. through storm surges, but does not include sea level rise. An assessment on the number, location, and types of buildings in the coastal zone was conducted using the SPOT building count datasets from 2011, 2016 and 2017 respectively, with a total of 1,085,684 buildings present in the coastal zone assessed in the most recent dataset. The table below shows the distribution of these buildings per province and per coastal flood risk class in 2017.

Table: Number of buildings in the respective coastal flood risk zones in 2017

Flood risk	total national	% of national	NC	WC	EC	KZN
5 - very high	66	0.01	2	61	2	1
4 - high	1 453	0.13	120	1 208	105	20
3 - medium	26 052	2.40	565	21 569	2 371	1 547
2 - low	170 097	15.67	1 351	119 825	28 928	19 993
1 - very low	888 016	81.79	1 702	663 433	107 211	115 670
Total no. of buildings	**1 085 684**	**100**	**3 740**	**806 096**	**138 617**	**137 231**
% of national	**100.00**		**0.34**	**74.25**	**12.77**	**12.64**

Between 2011 and 2017 the total number of buildings in the coastal zone increased by 75.5% from 618,383 buildings in 2011 to 1,085,684 in 2017, symptomatic of the very high development pressure on South Africa's coastal areas, and the trend expected to continue into the next decades.

A key concern is the large number of buildings that have been constructed in the "high" flood risk zones in the Western and Eastern Cape, especially those associated with health care and education. It is strongly recommended that these high-risk areas be assessed in greater detail at the local level to establish whether, protective structures are in place or could be provided, or whether relocation needs to be considered as adaptation to potential flood risks.

Table: Overview of types of buildings per risk zone in South Africa in 2017

	Cumulative physical risk classes		
Building type	**Very high**	**High**	**Moderate**
Transport	5	342	1242
Residential	5	6455	56156
Health care facilities	0	5	85
Education	0	14	228
Institutions	4	49	253
Commercial	3	331	2763
Industrial	8	153	1297
Total no. buildings	**38**	**8415**	**67764**

4.6.5.4 Mining versus nature conservation

Mining of mineral resources in the coastal belt of South Africa comprises of onshore mining activities largely at small scale, with the exception of dune mining between Richards Bay and St Lucia. Whatever the scale, these activities have severe impacts on these sensitive coastal environments. Along the west coast, onshore and nearshore diamond mining occurs at a large scale, scarring large areas of the terrestrial coastal shore. Given its high levels of occurrence along the coast, even small-scale sand mining is also causing severe impacts in estuaries and on beaches. These activities are also significantly reducing sediment transport to the adjacent beaches and nearshore marine environment, increasing their vulnerability to erosion.

4.6.5.5 Tourism versus other coastal land use

About 50 percent of South Africa's tourism and recreational activities are located along the coast. Tourism plays a major economic role in the coastal urban nodes but also increasingly in the rural coastal growth centres. Coastal tourism and recreation largely depends on the aesthetic appeal and environmental intactness of natural coastal landscapes, vegetation, beaches and coastal and marine fauna, requiring specific attention to habitat destruction (e.g. mining) and pollution management (solid and liquid). Furthermore, spatial planning and development should aim at sensibly directing touristic routes to the coast through the harmonious integration of land uses, e.g. avoidance of optically unappealing (industrial or residential) development in tourism hotspots.

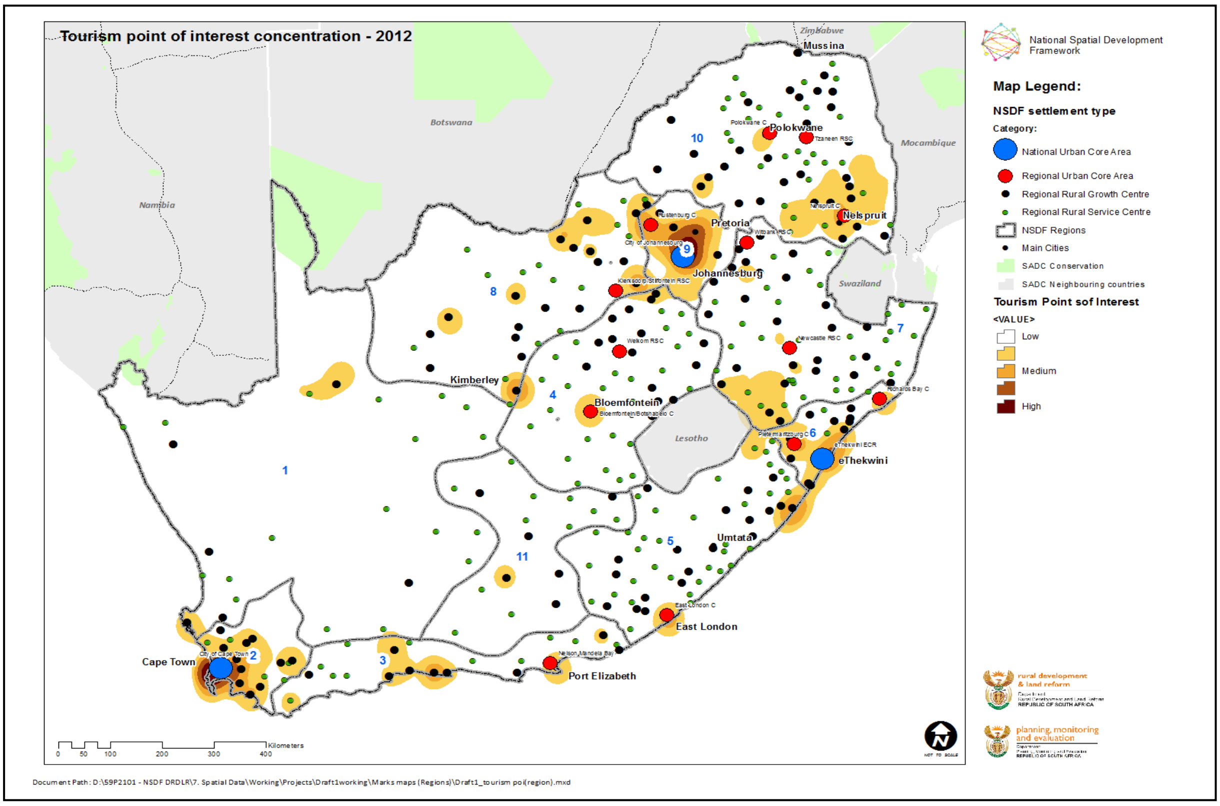


Figure: National Tourism Hotspot Areas

Furthermore, future tourism development should take cognisance of the coastal flood and erosion risk and avoid identified risk zones or adopt infrastructure designed to reduce the impact of potential coastal hazards (e.g. by building on stilts or building "mobile" structures that can be removed before heavy weather impacts or that can be evacuated and sacrificed). In the latter scenario, the use of materials not harmful to the environment should be obligatory (e.g. wood).

4.6.5.6 Ports & harbours – existing and planned

Eight major commercial ports are located along South Africa's coast at Saldanha, Cape Town, Mossel Bay, Port Elizabeth, Ngqura (Coega), East London, Durban and Richards Bay. Additional commercial ports are under consideration to support the inland mining industry, possibly at Alexander Bay and along the KwaZulu-Natal coast.

About 60 percent of South Africa's economy depends on maritime trade (import and export) of goods and mining products through these ports which are located in major urban and metropolitan development nodes that are also places of high tourism interest. This poses a particular challenge to municipal and port authorities to align their current spatial management and future development requirements to ensure long-term socio-economic and environmental sustainability for both economies.

Figure: Proclaimed and un-proclaimed ports and fishing harbours in Operation Phakisa

Operation Phakisa, a national initiative to boost South Africa's Ocean Economy, also focuses on the development and upgrading of fishing harbours along the coast, to create income for local communities and to also potentially act as drivers for harbour-related tourism. Such development, however, should be cognisant of projected future development growth, carrying capacity constraints of the natural environment to growth (e.g. availability of fresh water) and realistic estimations of tourism numbers. Further, if subsistence small scale fishing industry is proposed, sustainability of resources and access to markets must be ensured.

4.6.5.7 Coastal pollution

Pollution sources along coastal environments are multiple, originating from land and the sea. Land-based sources include industrial and municipal wastewater discharges (see location of discharge points in the Figure below). While these point source discharges are relatively well regulated through nationally legislated permits, diffuse storm water runoff remains a major problem. Storm water together with solid waste (e.g. litter) is primarily associated with densely populated coastal settlements (see Figure below), although solid (plastic) pollution can be redistributed by rivers, wind and ocean currents over large distances. The quantification of storm water and solid waste pollution in coastal areas remains poorly documented given its diffuse nature, thus posing major challenges to attempts to manage this waste effectively.

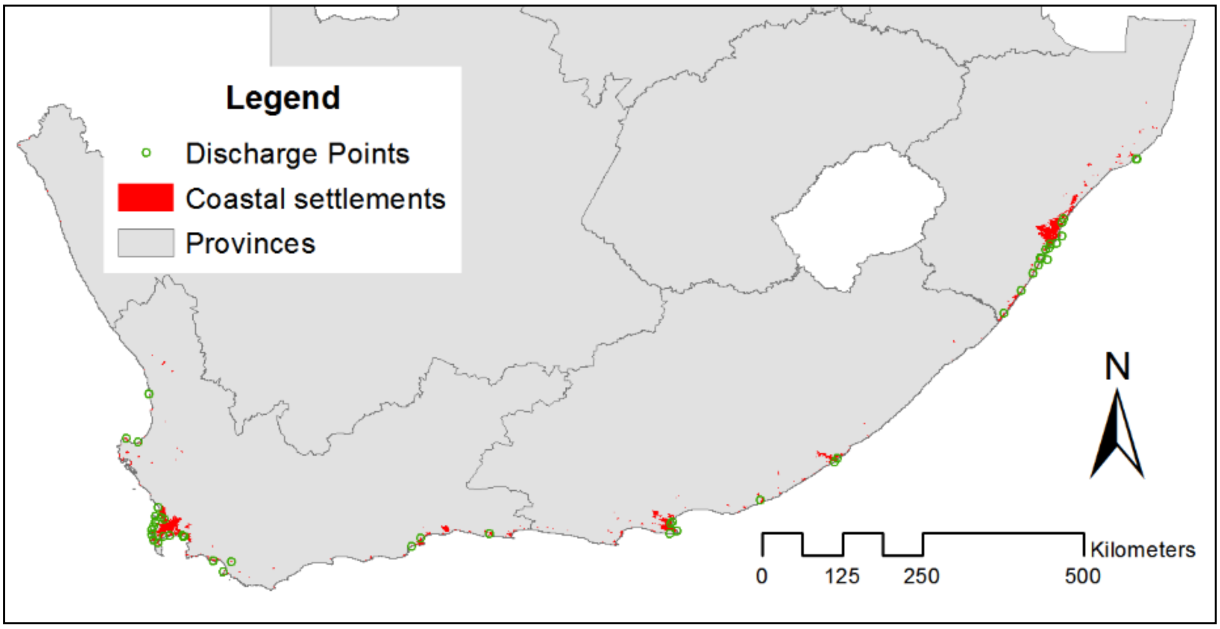


Figure: Location of wastewater discharge points and coastal settlements

Oil pollution from ships is a major source of pollution at sea, with a significant relation between oil pollution incidences and cargo vessel routes, while recorded nearshore spills coincide with the location of ports. However, further studies are needed to establish if the apparent relation between cargo vessel tracks and offshore oil spill occurrences is statistically significant. If so, this would help in developing pro-active mitigation plans for areas at high risk.

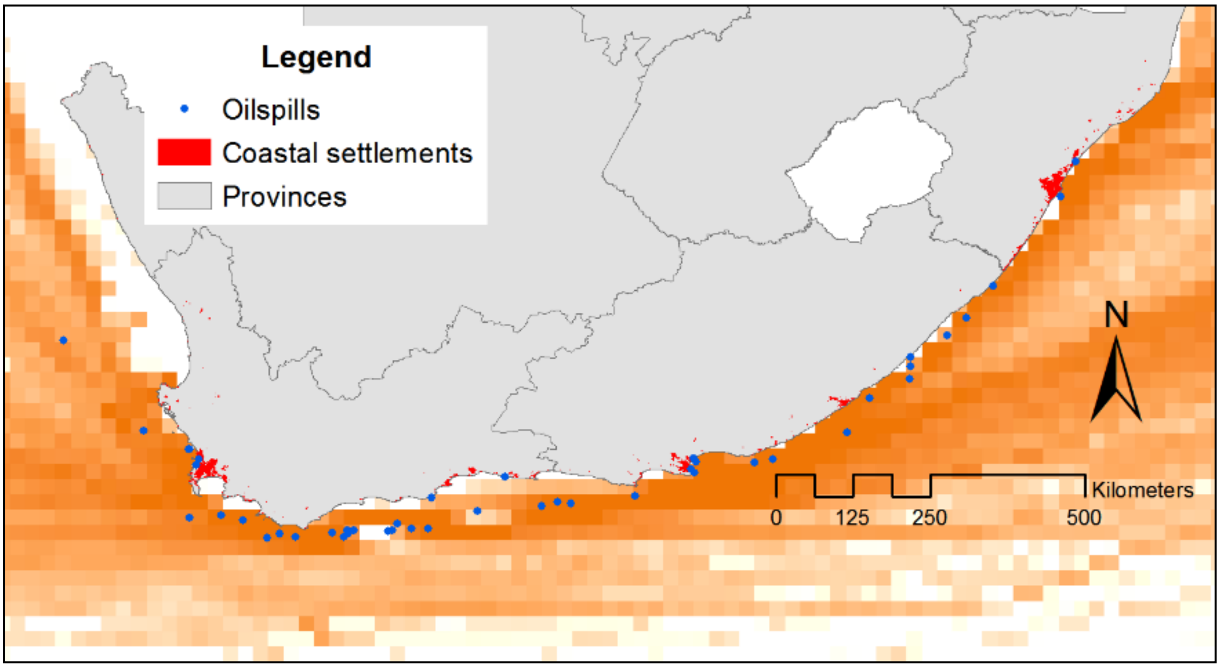


Figure: Location of recorded oil spill occurrences between 2008 and 2016 in relation to the location of coastal settlements and In-Transit Visibility (IVT) cargo vessel tracks

4.6.6 Status of coastal biological environment

The biological coastal aspects were assessed in close alignment with ongoing projects at SANBI, such as the National Biodiversity Assessment (NBA) 2018 and the update of the National Vegetation Map. Data produced by SANBI and other institutions in the context of those two projects provided the main input to align results from the National Biodiversity Assessment and the National Coastal Assessment projects.

The degree of transformation of the natural environment, the Red List threat status of coastal ecosystems, the ecosystem protection levels and the conservation value of coastal ecosystems were assessed. The spatial area considered for the biological assessment in the National Coastal Assessment were those which were classified as "coastal" or "estuarine" in the NBA 2018. Semi-coastal vegetation types, which partly reach very far inland, were only included up to the 40m elevation contour.

The assessment of coastal biological environment revealed that the degree of transformation (i.e. loss) and the causes of coastal habitats loss vary greatly across the coastal provinces as illustrated in the below table.

Table: Natural and transformed area in the SA coastal zone

Area [km^2]	NC	WC	EC	KZN	SA total
natural	6 295	6 398	3 139	2 766	**18 599**
transformed	462	3 851	1 797	5 398	**11 508**
total [km^2]	**6 757**	**10 249**	**4 936**	**8 164**	**30 106**
Area [%]					
natural	93	62	64	34	**62**
transformed	7	38	36	66	**38**

While the overall condition of the terrestrial habitats in the Northern Cape is very good, closer scrutiny shows that severe habitat loss is affecting the Alexander Bay Coastal Duneveld and Namib Seashore Vegetation of which, only 12 percent and 9 percent respectively are left. Such habitat loss is largely a result of extensive surface mining of diamonds.

The Western Cape comprises of the most diverse coastal vegetation, given its large spatial extent, proximity to both the Atlantic and Indian Ocean elements and diverse geological features. While the total habitat loss is "only" 38 percent, results show that out of the total 53 vegetation types, 16 have lost 50 percent or more of their original coverage. Along the west coast, this loss is largely attributable to agriculture, while along the south coast the loss is caused by urban and industrial expansion.

KwaZulu-Natal showed the greatest loss of natural coastal vegetation, with 66 percent being transformed, largely due to extensive (sugar cane) agriculture and urban expansion. In the Eastern Cape, the loss of natural vegetation with 36 percent is moderate and largely related to urban and peri-urban low-density development.

The loss of habitat largely affects individual vegetation types, given their natural environment providing certain benefits for human activities, such as good soils and sufficient rainfall for agriculture, as is the case in the Northern and Western Cape provinces. The extent of land-use pressure on specific ecosystems is reflected in the Red List ratings, frequently classifying those habitats experiencing the greatest loss as "Endangered" or "Critically endangered". However, there are several measures in place to protect threatened and valuable ecosystems. For example, terrestrial coastal protection ranges from National Parks which provide the highest degree of habitat and biodiversity protection to provincial, municipal and private Reserves and Parks. Currently, an average of 9.6 percent of the total coastal area experiences some degree of protection. The greatest percentage of protected coast is located in the Northern Cape (11.8 percent) while the lowest percentage can be found in KwaZulu-Natal (6.3 percent). The table further shows that out of the 2,947km^2 which are protected, 2,417 km^2 are well protected, which is 7.4 percent of the total coastal area.

In contrast, of the 290 estuaries assessed in the NBA 2019, only about 32.8 percent are well protected. More than half of all “poorly protected” estuaries occur in KwaZulu-Natal. A spatially explicit analysis will have to show, how many of the “poorly protected” estuaries in fact are in need of better protection and how many are, for example, too remote or too small from being negatively impacted by human activities.

As for the marine environment, the Marine Protected Areas (MPA) data were used as baseline. Many of the MPAs extent into the coastal zone. According to these data, currently about 240,345 km^2 of South Africa’s oceans are protected as MPAs, the majority (170,011km^2) around Prince Edward Island, and about 70,335km^2 in the near-shore of the mainland. Of the 70,335km^2 in the near-shore, 65,763 km^2 were designated only recently (2019/2020). As a result, about 5 percent of South Africa’s oceans are now formally protected.

4.6.7 Conflicts between natural environment aspects and human activities

Based on the findings of the National Coastal Assessment, it can be concluded that areas of conflict are largely concentrated around settlements and in areas with high agricultural or mining potential. The immediate impacts of human activities range from total habitat destruction or transformation to gradual impacts, the latter being much more difficult to detect and map on a national scale. Gradual degradation can be the result of habitat fragmentation, e.g. through construction of roads; uncontrolled coastal access through sensitive dune vegetation; selective species removal; or reduced ecosystem functioning, e.g. through changes in the water cycles and pollution and simple disturbance by visitors and vessel traffic.

Potential conflicts between conservation and human activities is illustrated in the Figure below with the overlap between marine Protected Areas (red polygons) and areas designated to marine diamond mining on the west coast. A major challenge in addressing these types of management issues lies in the strong sector-based nature of mandates, where conservation and mining are governed under different departments (DFFE and Mineral Resources respectively) and different legislation. Similar conflicts may arise where Marine Protected Areas overlap with highly frequented vessel trajectories.

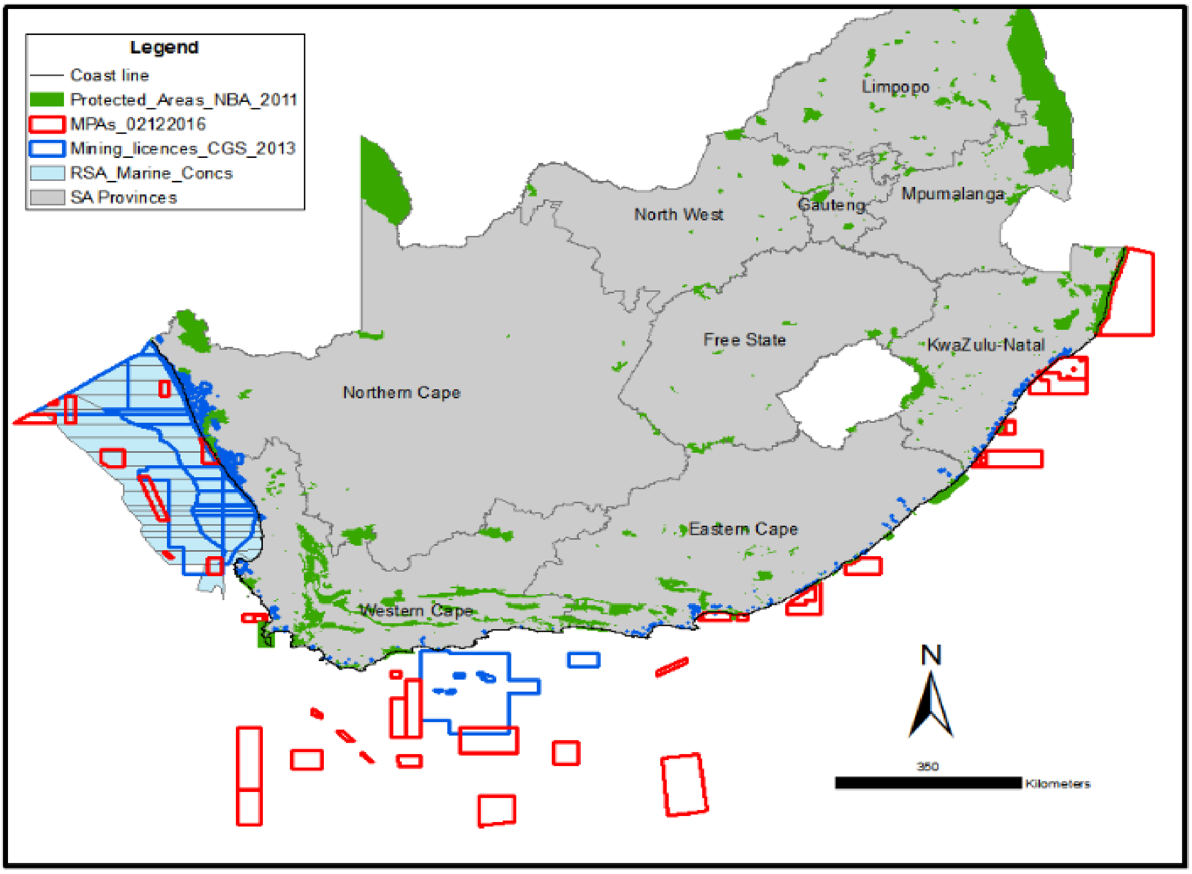


Figure: Overlay of protected areas and mining data for the whole coast

Overlap between mining and conservation areas is less prevalent in terrestrial coastal area, more site specific investigations are required to establish any indirect effects of mining on conservation areas e.g. through dust or permanent noise.

4.6.8 Hotspot analysis: the most important findings in a nutshell

4.6.8.1 Richtersveld Local Municipality, Northern Cape Province

The Richtersveld Local Municipality is the northern most coastal municipality on South Africa's west coast. It is an area where restricted coastal access and onshore and nearshore mining activities are regarded as the most prevalent challenges.


Figure: Port Nolloth

The total population of the Richtersveld Local Municipality is 11,982. About 50.8 percent of these people reside in the coastal towns of Port Nolloth (6,092 inhabitants) and 14.5 percent in Alexander Bay (1,736 inhabitants). The remaining 4,154 inhabitants are dispersed over various smaller settlements and farms. The average population density of 9.82 people per ha in towns in the NC coastal region is very low.

The climate is arid and water scarcity prevents intense agricultural land-use and high population density. Due to the proximity to the cold upwelling Benguela current the average annual temperature in Alexander Bay is only 15.9°C and the average annual rainfall is 50 mm. The average annual temperature in Port Nolloth is 14.7 °C, and the average annual rainfall here is 72 mm. Vegetation is very sparse and consists mainly of dwarf desert shrubs, grasses and annual plants. The Richtersveld vegetation is recognised as a global biodiversity hotspot. Given the harsh conditions however, vegetation growth is slow and takes very long (i.e. decades to centuries) to recover from disturbance.

Due to the Benguela current upwelling marine life and productivity is high. Extended kelp forest along the coast provide habitat for a highly diverse biota. The ocean off the NC coast is considered one of the richest marine ecosystems in the world, with the waters being unpolluted, nutrient-rich and abundant in marine life. This high level of productivity supports a rich biological diversity. It includes an abundance of important resource species, such as lobster, kelp, mussels, limpets and seals.

The Orange River Estuary is the largest estuary in the Richtersveld Local Municipality and forms part of the Orange River Mouth Transboundary RAMSAR Site. The sediment input from the river is important for flatfish in the nearshore environment in the mouth vicinity. Despite the estuary's national importance as a RAMSAR site, it is heavily modified through mouth manipulation, reduction in base flows, the construction of berms, dykes and levees across the saltmarshes, the impacts of mining operations, nutrient pollution from agricultural return flow, illegal gillnetting, grazing in saltmarshes, a golf course and roads. Most abiotic and biotic processes are severely compromised.

Given the low population density, coastal pollution from settlements, such as sewerage, littering and stormwater, is generally low.

Given the low density of settlements there is very little infrastructure and few buildings at risk from coastal erosion. The mixed shore is relatively steep, therefore exposing very little infrastructure to flooding through coastal storm events. Altogether, six buildings in Alexander Bay and Port Nolloth have been identified to be at very high risk of coastal erosion and one building has been identified to be at very high risk of flooding.

Diamond mining is the main economic activity along the Northern Cape coastline. Mining takes place offshore from boats, nearshore in cofferdams and onshore by surface mining. Mining concessions are issued for almost the entire dry coast and the entire coastal and offshore area. Mining on the dry shore has been taking place for over a century, and most mines have been fully exploited and have been abandoned, and the remaining licenses will expire in the next 10 to 20 years.

In theory, the abundance of marine and coastal resources could maintain successful mariculture, fishing and fish processing industries in the NC. However, only a small fraction of the large number of fish caught off the NC coast are landed in the Province to contribute to its economy or local employment. The lack of suitable port infrastructure, insufficient allocation of fishing quota for financially sustainable fisheries and distance to markets have been identified as the main reasons for the low levels of exploitation of biological marine resources in this municipality.

While Port Nolloth is the central hub of tourism on the West Coast, with 9,164 bed-nights recognised in 2015, the Richtersveld Local Municipality is among the 30 least travelled municipalities in South Africa. Consequently, tourism does not contribute much to the local economy. The reasons for the lack of more intense coastal tourism range from the remoteness of the area, lack of access to the coast, the arid climate resulting in a shortage of potable water, and the impact of surface mining on the terrestrial coastal natural environment, which renders the landscape aesthetically unappealing to nature-based ecotourism (see Figure). There is only one Blue Flag beach in this municipality at Mc Dougall, just south of Port Nolloth. The Department of Tourism (2018) further lists a lack of natural resources and low confidence of the local population to engage in tourism as reasons for low tourism, together with scarce tourism related skills.

Figure: Typical West Coast mining operation

One of the major coastal management challenges in this municipality are the landscape scars left by terrestrial mining activities and resulting loss of tourism potential. Despite large stretches of the coast being unpopulated, large areas of the Richtersveld Coastal Duneveld and the Southern Richtersveld Yellow Duneveld are no longer in a natural condition. Of the 300 km^2 of impacted (not natural) habitat, only about 14 km^2 fall under “formal settlements”. Most of the area mapped as “not natural” falls into mining areas. Diamond mining operations were initiated in the Namaqualand coastal zone in the 1920s, and, prior to 1991, mining companies were under no legal obligation to rehabilitate areas that were mined. Given the harsh climate, damaged natural vegetation can take decades or even centuries to regain its natural condition. Mining scars therefore leave the landscape aesthetically unappealing, and reduce its value for alternative economies, such as tourism.

Resource use conflict exists between the mining cofferdams and local fisheries. With terrestrial environment now fully exploited by mining, the nearshore coastal environment is now being mined through the construction of cofferdams. This practise berms off a part of the nearshore with earth walls, sea water is drained and the exposed sea floor is then mined for diamonds. This mining practise removes or destroys all marine biota in the cofferdam area and is therefore detrimental to local small-scale fisheries, which rely on intact nearshore coastal environments as important habitat and breeding grounds for economically important fish and crayfish.

It is suggested that further investigation should be conducted on the feasibility of post-mining infrastructure use for mariculture (e.g. abalone) to support alternative income sources in abandoned mining areas.

A third area of conflict exists around the terrestrial mining activities and the related restrictions to access these areas present for the public. The local population perceives restricted coastal access as the main limiting factor to the use of coastal resources for recreation and livelihoods. On the Richtersveld coast there are between 0 to 6 access points per 500 m of coast. Unlike other areas on the South African coast, there is no visible densification of coastal access points near coastal settlements. Furthermore, no densification is visible in areas where roads are close to the coast. According to the stakeholders, the mapped road network in most cases is not accessible to the public as large areas are closed off for mining activities. Verification if the roads in the area are public or private, and whether the mapped coastal access points might be inaccessible to the public as well was not possible in this project. Further, no relationship between the proximity of ongoing or past mining activities and coastal access point density is evident apart from the area south of Port Nolloth, where no coastal access points are recorded for wide stretches of the coast. However, given the very slow recovery rate of the vegetation in the region it is not possible to assess the actual age of coastal access lines visible on a remote sensing image. It might be that some of the visible paths to the coast were created (many) decades ago (when the adjacent mining areas were still active) and have since been abandoned.

Figure: Given the very slow recovery rate of the vegetation on the West Coast it is not possible to assess the actual age of coastal access lines

It has been recommended that local authorities engage with the mining companies to assess public needs for coastal access, identify the purposes of such access (e.g. recreation, small scale fisheries) and where access restrictions in (abandoned) mining areas can be lifted.

4.6.8.2 Mossel Bay Local Municipality, Western Cape Province

The Mossel Bay local municipality in the Western Cape Province was selected as an example of a municipality where residential strip development has occurred. Tourism is important in this area, and it is dependent upon the natural beauty of the open coast, estuaries, Blue Flag beaches, good water quality and access to the coast. Threats in this area are coastal erosion, sand mining and pollution from wastewater treatment works and stormwater. A commercial port and related vessel traffic also pose a potential pollution risk, e.g. in terms of oil spills.

Figure: Mossel Bay

Mossel Bay town is the largest coastal development in this Local Municipality. Several (mostly small) formal settlements occupy most of the remaining coast. The total population in 2011 was 59,031. This grew to an estimated 99,319 in 2018, a significant increase in only seven years, reflective of the considerable development pressure in the area. The average population density in the Mossel Bay coastal belt is 6 people per ha, with a maximum density of 135 people per ha in sections of Mossel Bay town. While the population density and development sensitivity in this municipality are relatively low (compared with other coastal municipalities), areas in the Groot Brak area and in Mossel Bay town have the highest socio-economic vulnerability of all coastal towns on the South African coast. High socio-economic vulnerability indicates very little resilience to environmental hazards at the household level. Of particular concern are areas where high socio-economic vulnerability coincides with high population sensitivity, as is the case in parts of Mossel Bay town. People living in these neighbourhoods are more vulnerable to socio-economic pressures, resulting in likely slow recovery from the impact of e.g. COVID-19 on the economy and declining tourism in the region.

This municipality has seen a large-scale loss of natural environment. Only about 31 km of the total 80 km coastline currently remains undeveloped. Of the 2,015 km^2 coastal, semi-coastal and estuarine vegetation about 780 km^2 and 101 km^2 are transformed into formal and informal settlements respectively, and a further 680 km^2 has been lost to agriculture. Untransformed coastal environments frequently show signs of gradual degradation, e.g. through trampling through the dunes. This development pressure contributes to the fact that none of the seven estuaries in this Local Municipality are in good condition.

This high degree of transformation and fragmentation of the natural environment in the Mossel Bay Local Municipality finds expression in its conservation status: no formally protected areas, Critical Biodiversity Areas or Ecological Support Areas are located in the municipality.

In the Mossel Bay Local Municipality, coastal pollution from industrial and Wastewater Treatment Works (WWTW) effluent arises from three main sources. In the case of Hartenbos WWTW, the wastewater often does not comply with national standards, causing pollution that regularly contributes to fish kills in the estuary. A further source of impact on coastal water quality is the desalination plant in Mossel Bay town.

Stormwater runoff, especially from the port and industrial areas, is also likely to contribute to coastal pollution. Given the relatively small scale of operations, these impacts, if present, are likely to be highly localised. Stormwater runoff from numerous smaller towns, as well as contaminated drainage from golf estates and runoff from agricultural areas along this stretch of coast will also contribute to pollution (e.g. nutrient enrichment) in some of the estuaries. As a source of pollution originating offshore, a number of oil spill incidents from ship-to-ship accidents, bilge dumping and incidents in harbours along the South African coast were recorded.

Given the high development density in this municipality, the exposure of buildings and infrastructure to coastal flood and erosion is higher than in the Richtersveld Local Municipality. More than 25 km of roads were identified to be at high or very high flood risk and more than 90 km of road appear to be a risk of coastal erosion. About 5 km of railway tracks appear to be at risk of coastal erosion, too. For all road and railway lines in the high and very high flood and erosion risk classes, ground-truthed data should be collected to confirm the findings of this report and to inform risk assessment.

This assessment found that 26 buildings are located in high flood risk areas and 3,037 buildings are located in areas with high erosion risk. The vast majority of buildings located in zones with high flood or erosion risk are formal housing structures. Commercially used buildings form another significant group. Local assessments should verify these findings and prompt adaptation plans as appropriate.

Tourism plays a major role in the economy of this municipality. Local attractions include the boot-shaped Post Office, the Garden Route Casino, 60 km of beaches, and an array of natural, cultural, and historical attractions. A commercial port in Mossel Bay town plays a role for the local economy too. Today, the Port of Mossel Bay caters mainly for fishing and service craft for the local oil industry.

One of the perceived most pressing coastal management challenges arises from provision and/or restriction of coastal access. The number of recorded coastal access points per 500 m of coast ranges between zero to 18 points. The upper limit here (18) translates to access points, on average, every 27 m, which is clearly excessive. These areas of high access point density occur in Boggoms Bay and Glentana Bay. The low correlation with the density of permanent population suggest that these access points are related to tourism. Local authorities should make an effort to close superfluous access paths and guide (seasonal) tourism more effectively. This will improve the aesthetic (and environmental) value of the area, and at the same time limit wind erosion risks.

Another coastal management challenge arises from the WWTW discharging into the vicinity of recreational and Blue Flag beaches. It is recommended that the local municipality closely monitors the water quality on these beaches and improves the quality of the water leaving the WWTWs.

4.6.8.3 *Algoa Bay: Nelson Mandela Bay Metro and Sundays River Local Municipality, Eastern Cape Province*

To assess Algoa Bay as a system, both municipalities which benefit from and impact the Bay (Nelson Mandela Bay Metropolitan Municipality and Sundays River Valley Local Municipality) were assessed together. Nelson Mandela Bay (NMB) Metropolitan Municipality is a coastal Metropole with two ports, while Sundays River Valley (SRV) is municipality with a unique natural coastal environment that boasts rich diversity, high endemism in flora and fauna, complex oceanographic patterns and a rich cultural heritage.

A major challenge in this area is the current projected expansion of urban land use, industrial ports usage with related vessel traffic and pollution, and the tourism that largely depends on the pristineness of the natural environment, specifically the beaches.

The population density reflects the marked contrast between the two municipalities. Sundays River Valley Municipality’s total population was 54,504 people in 2011, with no settlements at all being present in the coastal zone. Nelson Mandela Bay Metropolitan Municipality's total population was 1,152 million in 2011. Accordingly, the average population density in NMB Metropolitan Municipality is 24.66 people per ha, reaching a maximum of 359.4 in some places. SRV municipality's average population density is 1.45 people on average, with a maximum of 2.34 people per ha in some inland places. For comparison, the average population density for all South African coastal settlements is 25 people per ha and the maximum density is 731.

It is noteworthy that the average settlement fabric vulnerability of NMB (i.e. the condition of neighbourhoods/precincts with regards to their accessibility to basic services (water, sanitation, refuse removal, electricity), access to adequate housing, and undesirable densities (e.g. informality) present in certain built-up areas) is higher than the national average. Similarly, the average socio-economic vulnerability at household level of this municipality is higher than the national average. Mitigation for socio-economic vulnerability, settlement fabric vulnerability and population sensitivity should be prioritised by the authorities, especially where high vulnerabilities coincide.

The natural environment contributes significantly to the economy of the two municipalities in Algoa Bay. The climate in Port Elizabeth is warm and temperate. NMB municipality is highly urbanised, with most of the 27 percent of land being in a non-natural condition converted to formal residential areas. In contrast, in SRV Local Municipality 15.8 percent of the total area was non-natural as of 2014, most of the converted land being used as cropland. In contrast to Mossel Bay, large areas of Algoa Bay's natural environment are protected. Most of SRV Local Municipality's coast is protected as part of the Addo National Elephant Park. Recently proclaimed Marine Protected Area and Islands are important breeding colonies for birds. The coastal vegetation type affected worst by habitat loss is the endemic Algoa Sandstone Fynbos, which now covers less than 50 percent of its original distribution in NMB.

There are seven estuaries located in NMB. The largest is the Swartkops Estuary, with an estuarine functional zone (EFZ) of 2,911 ha supporting the third largest salt marsh in South Africa. It has large beds of the submerged macrophyte *Zostera capensis*. Given the high development pressure in this municipality, most of the estuaries are impacted by pollution, nutrient enrichment, modifications in freshwater inflow and/or fishing pressure. The Maitlands Estuary is the only estuary in a relatively good condition, but it is a small system.

As for sources of coastal pollution, there are four land-derived wastewater discharges into Algoa Bay, all within the NMB. Large effluent volumes from the Fish Water Flats discharges have contributed to deterioration of water quality in the receiving waters, mostly exceeding the assimilative capacity of the receiving environment. A new pipeline is currently being built from Cape Recife to Driftsands, so the volume of effluent discharged at Driftsands is expected to increase. In the Sundays Municipality, agricultural development in the catchment of the Sundays River is significantly contributing to eutrophication in the Sundays Estuary.

Contaminated stormwater runoff from the highly urbanised coastal areas within the NMB and runoff from the commercial port and industrial areas is likely to contribute significantly to the total coastal pollution in this area. Given the presence of two ports in Algoa Bay and the related high cargo vessel density, the risk of oil spills in the Bay is high. It is recommended that the local authorities have an effective oil spill response plan in place, in order to minimise the impact from potential marine pollution on the natural environment (and also the valuable Blue Flag beaches and other recreational sites), especially in the MPAs.

Given the contrasting development in the municipalities, the risk arising from coastal flooding and erosion differs. In SRV, no railways and buildings and hardly any road infrastructure are located in areas exposed to flood and erosion.

In contrast, in NMB 1,303 buildings were located in high erosion risk zones and 820 in medium erosion risk areas. Of high concern is the rate of increase of buildings in the high and medium flood risk zones in this municipality, with an increase from 5 to 40 buildings in the high flood risk zone, and 237 to 469 buildings in the medium risk zone in only five years between 2011 and 2016. This development trend in high-risk zones has been observed for other coastal cities in South Africa.

The usage type of the buildings in the coastal risk zone is also a concern, the majority being formal housing (728) and commercial buildings (246). A red flag is one health care facility in the high-risk zone. Ground-truthed data should be used to assess how safe the structures in the high-risk zone are. This should inform the need to relocate structures.

Nelson Mandela Bay is the economic powerhouse of the Eastern Cape Province. Two ports in Algoa Bay, Port Elizabeth and Ngqura at the mouth of the Coega river, and the related industries are central for coastal activities in the area. The main economic sectors in NMB are manufacturing (25 percent), community services (23 percent), finance (23 percent), trade (13 percent) and transport (13 percent). In the SRV community services, trade, finance, agriculture, transport and construction are important sectors. The Bay is also important for pelagic and squid fisheries.

The second economic leg of the region is tourism. However, the use of the coast for tourism and leisure activities in the SRV Local Municipality and NMB differs. The SRV Local Municipality coast is largely protected as part of either a National Park (the Alexandria Dune Fields and the Addo Elephant Park) or Marine Protected Area. Despite the existence of large sandy beaches, no beach tourism takes place in the SRV Local Municipality apart from a small stretch on its western most coast. In contrast, the coast of NMB is used extensively for tourism activities that include recreational beach use, diving and whale watching. Several small local nature reserves attract tourists as well.

The intense and highly diverse land use activities of Algoa Bay's coasts pose significant challenges on coastal management. The first challenge arises from the high degree of coastal industrialisation and preservation of natural beauty and pristineness.

Port-related industries are of great importance for both municipalities. At the same time, the natural beauty and pristineness of the coast in both municipalities serve as a magnet for tourism. However, in NMB, Blue Flag beaches, being certified for safe water quality, occur fairly near wastewater treatment outlets and estuaries with reportedly poor water quality. As is the case for many of the Algoa Bay Blue Flag beaches, stormwater poses a potential pollution risk as well.

Vessel traffic and port operations have some potential to impact on Blue Flag beaches, MPAs, whale watching and diving industries. Oil spills can lead to large scale environmental pollution. Marine mammals are susceptible to collisions with vessels and vessel noise pollution probably affects these mammals and other marine fauna. Given the concentrated and diverse activities and risks on the NMB coast, the general probability for environmental disasters is high. Potential impacts should be considered, assessed using ground-truthed data, and mitigation measures and plans put in place.

The second coastal management challenge in Algoa Bay arises from the provision of access and accessibility of the coast for tourism and recreation. GIS analysis in this project found that, considering the dense urbanisation of the NMB coast, the recorded number of access points in this municipality is surprisingly low.

Most of the coast in the SRV Local Municipality does not have any officially registered pedestrian access points. However, investigation of Google Earth imagery showed a high number of access paths to the vegetation border of the Alexander Dune Field Most of the total of 76 access points. These appear to be informal walkways. It is, however, not always possible to determine from the Google Earth imagery if these paths are pedestrian walkways or "natural" tracks of (large) animals. As for the visible and recorded coastal access lines in the Richtersveld municipality, presence of access routes does not mean these are accessible to the public. While, many of the beachfront properties have direct accesses to the coast, access for the public remains a challenge on this coast. One example was reported in Algoa Bay at the border of the NMB Metro and SRV Local Municipality at Colchester, where access to the estuary is only available through a private beach and camping area. This situation is highly contentious with the local community which lacks access to the natural environment. Local authorities should seek a solution to provide access for the local community.

4.6.8.4 Port St Johns Local Municipality, Eastern Cape Province

The local municipality of Port St Johns in the Eastern Cape was identified by government as a national coastal development node. The area covers tribal lands, which pose specific challenges to regulated development in the area, and support communities that are vulnerable to a range of pressures. Natural resources play an important role in this area, with agriculture and tourism being the main economic sectors, and a high reliance on subsistence activities. The possible development of a small harbour and coastal mining will potentially conflict with the pristineness of the terrestrial and marine environment, and especially the Marine Protected Area.

In 2011, the total population was 156,136. This grew to about 168,000 in 2016 with 6,441 people living in the town of Port St Johns, the only formal town in the municipality located at the mouth of the Mzimvubu River estuary. The vast majority of the municipality's population lives in extensive traditional settlements.

In Port St Johns town, the average population density of 8.19 people per ha is very low. However, the entire Port St Johns Local Municipality has an average of 130 people per km^2, which is higher than the average population density in the O.R. Tambo District (121 people per km^2) and the wider Eastern Cape (41.5 people per km^2). Given the steep coastal terrain and limited accessibility there are hardly any settlements and buildings in the immediate vicinity of the open coast.

The average settlement fabric vulnerability in Port St Johns town is 3.18, which is very low. Considering that the vast majority of population in this Local Municipality lives in traditional settlements, access to basic services over the whole of the Local Municipality differs dramatically. In 2016, 36.9 percent of the households in the Local Municipality (12,543 houses) lived in formal housing, which is an increase from 24.6 percent in 2011. The number of households with access to piped water, however, decreased from roughly 12,000 in 2011 to 6,364 in 2016. While a large number of households does not have access to flush toilets or refuse removal, 82.7 percent of houses have access to electricity for lighting and 50.2 percent have access to electricity for cooking. About 91 percent of households have access to cell phones, but only 1.6 percent have access to internet.

The climate in Port St Johns is warm and temperate. Dominant natural coastal vegetation is the Transkei Coastal Belt grassland and scarp forest. Because of high rural settlement density and agricultural activity, 57.5 percent of natural vegetation has been lost. Of the 548 km^2 of non-natural area, about 1 km^2 is designated as formal settlement and 343 km^2 as traditional settlements. Given the high degree of transformation of natural environments there is only a very small area that is formally protected. Given the steep terrain, most of the estuaries along this coastline are in a natural to near natural state, subject to limited impact from land use change, nutrient enrichment and fishing.

The fragmented and threatened status of the natural environment in the Port St Johns Local Municipality potentially threatens ecosystem services upon which communities and the economy of the area relies. Future development plans should critically assess the impact on the natural environment and emphasise the maintenance and restoration of ecosystems to maintain the service provision for the local people, as well as for the purpose of the protection and maintenance of coastal biological resources.

Litter (and other form of pollution) comes primarily from the town of Port St Johns and to lesser degree, at Second Beach which is the primary beach amenity in the area. The large amount of households without official refuse removal leads to some localised accumulation of plastic pollution and litter in around human settlements and on the coast. This is a source of pollution in rivers, estuaries and ultimately to coastal waters and beaches, and might be a deterrent to ecotourism in the area.

There are no licenced land-derived wastewater discharges into coastal waters in the Port St Johns Municipal area. At times, conservancy tanks in town overflow into the streets and raw sewage is currently entering the Mzimvubu Estuary and possibly other watercourses in Port St Johns.

Recent plans have been initiated to develop a wastewater treatment plant, but it is not clear when these will be finalised, and where the plant will be located. The outflow from this plant should not pose a risk to the receiving environment.

The contribution of contaminated stormwater to coastal pollution in this municipality could not be assessed using GIS tools, because of the small size of formal- and the greater extent of traditional settlements. In the Port St Johns Local Municipality, however, only 38.5 percent of households have access to “formalised” sanitation (i.e. flushed or chemical toilets) and 20 percent have no access to sanitation. Furthermore, the high amount of houses without regulated refuse removal is likely to contribute to high litter and solid waste loads in stormwater. Providing access to sanitation and solid waste removal should be prioritised in this municipality, for protection of people in the area, as well as natural coastal environments.

Coastal risk in this municipality is very low, with virtually no buildings in Port St Johns town and in the traditional settlements in the surrounding area being located in medium to very high flood risk zones. The reason for this low coastal risk is likely the largely steep coastal terrain and the scarcity of flat, low lying area to develop.

No roads are located in very high erosion and flood risk zones. Only a few kilometres are located in the high flood and erosion risk zones (predominantly in the area east of the Mzimvubu estuary, which, given the relatively steep coast and the low development status, is not surprising).

In 2011 the unemployment rate in this municipality was 50.3 percent, with an economically active population of 16,079 people (i.e. 13.04 percent of its total population of 168,000), of which 8,090 were unemployed. Port St Johns Local Municipality has the lowest rate of economically active people in the whole O.R. Tambo District. Note that the economically active population (EAP) is defined as the number of people (between the age of 15 and 65) who are able and willing to work, and who are actively looking for work. It includes both employed and unemployed people. These figures do not include the number of people sustaining livelihoods from small scale agriculture. Agricultural activity supports 47 percent of all households in the municipality area.

In 2016 in the Port St Johns Local Municipality, the community services sector, including government services, was the largest sector accounting for 40.6 percent of the total local GVA. Trade (20.6 percent) followed by finance (15.5 percent) were the next moist important sectors. Tourism is one of the town’s main economic activities. It is based on the municipality’s beautiful scenery, its (remaining) natural vegetation and the pristine beaches, together with a number of historical buildings.

Information on trends in tourism in municipality are divergent. ECSECC (2017) states that numbers of tourists have been dwindled since 2006 while EOS (2017) states that “The tourism sector’s bednight supply in Port St Johns had increased steadily between 2005 and 2015.” The EOS (2017) work recognises that there may be some severe limitations in their assessment. According to the Port St Johns IDP (2014/2015), growth in visitor numbers has begun to slow down in recent years and this has been partly attributed to the state of the infrastructure in the town, including poor quality roads, unreliable water and lack of sanitation systems. Reasons for the decline in tourist numbers might be the low number of economically active and skilled population. Furthermore, while the coast and the beaches are very scenic, publicity on shark incidents has probably raised some concern with tourists.

Although Port St Johns has been touted as a potential small harbour development site, the feasibility if such development needs to be assessed, especially given the naturally high sediment loads carried by the Mzimvubu River. In reality, the natural environment will dictate the nature and scale of any small harbour development. There is potential for investment in waterfront precinct development, and infrastructure to support tourism initiative, providing economic stimulus to the area.

Most coastal management challenges in the Port St Johns Local Municipality are closely related to the general societal and developmental challenges in this municipality as described above. Several attempts have been made by government to uplift the developmental status of this municipality. Several of these initiatives relying on coastal resources, however, few have gained significant traction or borne desired dividends. Challenges to development might include the very low number of economically active people (13.04 percent of its total population in 2016) and low levels of education.

Should the planned coastal-related economic developments take place in Port St Johns eventually, it is strongly recommended that:

- The current developmental issues in this Local Municipality be addressed, namely sewerage and refuse management. Failing this an increase in population and tourist numbers will increase existing pollution pressures;
- Education and awareness be improved of the dependence of economic development and tourism on the intactness and pristineness of the Local Municipality's natural resources, namely beauty of landscape, good water quality, clean beaches, intact coastal vegetation; and
- Development should be planned and place where built infrastructure –
    - is safe from current and projected coastal flooding and erosion; and
    - does not obstruct natural and hydrodynamic processes, which includes controlled access of tourist streams through dune vegetation, to prevent vegetation degradation and increased risk of erosion.

4.6.8.5 *uMhlathuze Local Municipality, KwaZulu-Natal Province*

The uMhlathuze local municipality in the KwaZulu-Natal Province was identified as a study site as it encompasses an important industrial node, a major port in Richards Bay and tribal areas in its surroundings, with inherent social and economic vulnerabilities. The natural coastal dune to the north of the municipality is impacted by mineral mining, and future mining is planned within the municipal area. Coastal erosion is a major challenge. Mining activities are potentially in conflict with a tourism prerogative, which heavily depends on the landscape's beauty and diversity of plants and animals, especially in estuaries.

The total population of this Local Municipality was 334,459 in 2011 but is stated as 384,449 at the date of this report. The formal settlements Empangeni, the City of Richards Bay /Esikhawini, together account for about 60 percent of the population. In contrast to the Port St Johns Local Municipality, the population density in the traditional settlements (in terms of building density) is significantly lower than in the formal settlements.

The average population density in the municipality's formal coastal towns is 12 persons per ha. The maximum local population density is 188 people per ha in the small area of Vulindlela. Compared with national coastal population densities of 25 persons per ha on average and the maximum density of 731 persons per ha, uMhlathuze's population density is low.

Ninety-eight percent (98 percent) of all households in the municipality have access to water, 84 percent have access to adequate sanitation, and 100 percent have access to electricity. As a consequence, the Settlement

Fabric Vulnerability for formal settlements is below the national average for formal coastal towns. The total economically active population in this Local Municipality 100,078, the total unemployment rate is 27 percent. This means that economically, given the large industries in this municipality, the socio-economic vulnerability of formal towns in this Local Municipality is slightly below the national coastal average.

However, the prevailing dominant land use management system and land tenure system (relating to the town of Richards Bay and the dense traditional settlements in the Empangeni and Esikhawini area), may point to capacity challenges for the local authority and the occupiers of the land. This will require different approaches to land use and settlement development management for different land tenure or use regimes. The high sensitivity of institutional, land use management and land development regulatory systems is foreseen to impact coastal management.

The natural environment in this region is shaped its subtropical climate. The natural vegetation types for this municipality is largely Maputaland Coastal Belt, with KwaZulu-Natal Coastal Belt Grassland in the south and Maputaland wooded grasslands in the north. The high coastal dune belt is covered with Northern Coastal Forests. However, given the high population pressure and large area put to agriculture, forestry, and industrial use, only about 26 percent of the natural vegetation remains. Of the 590 km^2 vegetation lost, about 69 km^2 is now under formal settlement and 231 km^2 under traditional settlement. Most of the other area lost are now under sugar cane or forest plantations.

Three large estuaries with extensive mangrove areas and related flora and fauna occur in the area. While the Mlalazi estuary is in a near natural condition, the Mhlathuze and the Richards Bay estuaries are heavily modified.

Coastal pollution arises from three marine outfalls which discharge to open marine water offshore of Richards Bay. No quantitative data on the volume and quality of urban stormwater runoff were available for this project. Given the generally sandy and highly permeable condition of the soil and the high dune cordon along most of uMhlathuze's coast, relatively little surface runoff from traditional and non-urban settlements is expected to contribute to pollution on the open shore. However, the Richards Bay estuary is expected to receive high amounts of stormwater from industrial and the port areas, with a high risk of industrial pollution.

Furthermore, using the high cargo vessel density along the coast as a proxy for the potential risk of oil spill incidents, the uMhlathuze coast is at very high risk of impacts from oil spill incidents, or other shipping events. Recent history has seen shipping pollution event at the mouth of the Port of Richards Bay. Authorities should ensure/confirm that proper oil spill response plans are in place and ready to be executed at any time.

The uMhlathuze coast is dominated by very high dunes and strong wave action. While the high and largely undeveloped costal dune belt is not affected by coastal flooding, it is prone to increased risk of coastal erosion. Some coastal infrastructure has already been impacted. According to the erosion risk assessment conducted in this project, as of 2011 one building was located in the very high erosion risk zone, four were located in the high-risk zone and 244 buildings were located in the medium risk zone, most of them in the (traditional) northeastern part of Richards Bay's Meer en See suburb. Similarly, about 14 km of railway is located in the high erosion risk zone. Given the high development pressure in this municipality, present day numbers are likely to be higher. This municipality is urgently advised to assess the areas prone to coastal erosion specifically at a locally more relevant scale than provided in this report.

The economy in the municipality has transitioned from one based on sugar cane farming to industry. Today, Richards Bay is essentially an industrial town with layers of natural aesthetic and farming activity. The main economic sector in the municipality is manufacturing, which contributed 25 percent to the GDP in 2015. However, the main employment sector in the Local Municipality is trade. Richards Bay is considered the industrial and tourism hub of the municipality.

Although mining of minerals from the extensive dunes does not take place in the uMhlathuze municipality itself, but rather in the neighbouring Mfolozi Local Municipality, this industry contributes significantly to the economy in uMHlathuze, as location where the mined minerals are processed and where smaller local enterprises serve as suppliers in logistical, transportation and distribution services associated with mining.

The multi-purpose deepwater port of Richards Bay is the second largest exporter of steam coal in the world. The port is positioning itself as a growing destination for international cruise ships because of the close proximity to game parks and the St Lucia World Heritage Site. Richards Bay is located on the route between Durban and National Parks like the iSimangaliso World Heritage Site and other large Nature Reserves in northern KwaZulu-Natal. Its own – largely wetland related – abundance of birdlife has made Richards Bay one the area's prime attractions.

One of the coastal management challenges is the inter-municipal coastal mining and related dune restoration. As mentioned above, while the major mining companies are located in uMhlathuze, the mining activities themselves take place in the neighbouring municipality Mfolozi. This might pose administrative challenges to restoration of the dunes upon cessation of the mining activities. Further, while restoration of the natural dune forest environment is being attempted, the success of these initiatives is disputed by some scientists, as the current attempts might lead to a stasis in the intended naturally succession processes and significantly impoverish species diversity.

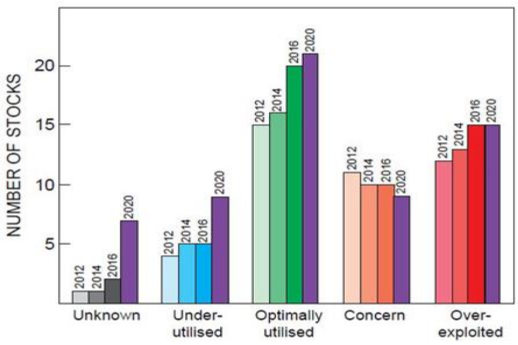
Further, while the results of the coastal risk assessment conducted in this project suggest the coastal erosion risk in this municipality to be low, local observations of infrastructure being lost to coastal recession, provide strong evidence to the contrary. It is recommended that additional risk assessments be conducted using more sophisticated approaches than those used in this (national scale) project.

All data from the National Coastal Assessment and Coastal Vulnerability study can be found on the Department's Coastal Viewer – https://mapservice.environment.gov.za/Coastal%20Viewer/

4.7 State of marine fisheries resources

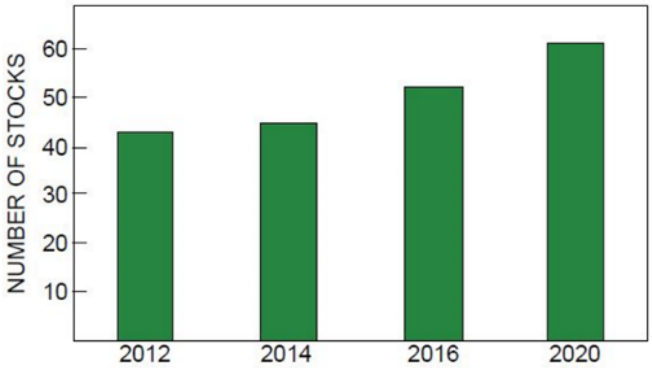
The Status of the South African Marine Fishery Resources, 2020 report reflects that the number of fish stocks reported has increased steadily from 43 in 2012 to 61 in the 2020. Among the species included for the first time are a number of linefish species (*black musselcracker, dageraad, Roman and white stumpnose*), five species of skate (which replace the generic 'skate' in the 2016 report), octopus and East Coast round herring and two species of shark (oceanic whitetip and great hammerhead). Species included in the 2016 report but excluded in the 2020 report include some other linefish species (*elf and white steenbras*) and requiem sharks.

The 2020 assessments indicate that 61 percent of stocks are considered not to be of concern (blue and green categories), while 39 percent of stocks are of concern (orange and red categories). These figures indicate an improvement over the past eight years, with 46 percent of stocks considered not to be of concern in 2012, 49 percent in 2014 and 52 percent in 2016.



There are some changes to the perception of certain fish stocks since the previous report in 2016. The number of stocks for which the status and fishing pressure are unknown increased from two to seven. The number of stocks considered under-utilised has increased from five in 2016 to nine in 2020. The number of stocks that are considered to be in an optimal state has increased from 15 in 2012 to 21 in 2020. The small net increase in 2020, compared to the 20 recorded in the 2016 report, is the result of five stocks moving into this category (two from unknown status, one from under-utilised and two from 'of concern') and three moving out of it (two to under-utilised status and one to 'of concern').

The number of stocks that are considered to be of concern has decreased from 10 in 2014 and 2016 to nine in 2020. The number of stocks considered to be over-exploited has remained at 15. This is the net result of the inclusion of new resources in this assessment since 2016 (dageraad, oceanic whitetip shark and great hammerhead shark), the exclusion of two resources included in the 2016 report (elf and white steenbras), the decline in status of one resource (shortfin mako sharks) and the improvement of status for Atlantic yellowfin tuna and silver kob.



For this summary appraisal, where a particular resource falls across two categories of stock status or pressure, precaution was applied and the resource has thus been assigned to the 'worst case scenario'. Perceptions of stock status may change with improvements in the information available for that stock. Thus either deteriorations or improvements in the perception of status may not necessarily be indicative of actual changes in the stock status.

4.7.1 Marine resources status

The below summarises each marine resource per their status in terms of harvesting, total allowable catch, operational management procedure, maximum sustainable yield and number of fish stocks for each marine resource. For detailed information refer to the Status of South African Marine Fishery Resources, 2020.

- **Abalone:** The status of the abalone resource continues to decline in response to extremely high levels of illegal harvesting and over-allocation of Total Allowable Catches (TACs).
- **Agulhas sole:** Uncertainty still remains regarding the true status of the Agulhas sole stocks. However, recent assessments took account of the increase in Catch-Per-Unit-Effort (CPUE) that was observed during 2017, and the results suggested a slightly more optimistic perception of resource status than had been the case in the 2016 report.
- **Cape hakes:** Recent updated assessments indicate that the deep-water hake resource was appreciably above the biomass level at which maximum sustainable yield (MSY) is obtained (B_{MSY}) from 2010 onwards. While this improvement in the perception of the resource could be partially attributed to the rebuilding strategy inherent in recent operational management procedures (OMPs), improvements to the assessment methodology and input data have had a major influence. Shallow-water hake remains well above the estimated maximum sustainable yield level.
- **Cape horse mackerel:** The most recent assessments for Cape horse mackerel indicate that the estimates of current spawning biomass are well above those that yield maximum sustainable yield.
- **Kingklip:** Recent research suggests that there are genetically separate stocks on the West and South coasts, but with some degree of gene flow between the two components. Recent assessment results suggest that the South Coast component of the resource is decreasing in abundance at about 0.8 percent per annum, whereas the West Coast component is increasing at about 2.4 percent per annum. The precautionary upper catch limit (PUCL) for this resource has remained stable in recent years.

- **Linefish:** Stocks of hottentot seabream, snoek, carpenter, santer, slinger, Roman and yellowtail are considered to be in good condition and are not over-fished. Silver kob, geelbeck and white stumpnose are considered depleted and continue to be over-fished. Collapsed resources, such as seventy-four, red steenbras, dageraad and dusky kob, require stronger intervention in order to rebuild stocks.

  The wellbeing of these fish stocks is linked to the ecological status of the estuaries. Reduced or regulated freshwater input, coastal development and pollution are altering estuarine habitats and threatening the wellbeing of dependent fish populations.
- **Monkfish:** Recent assessment indicates that while the resource has shown marginal increases on the West Coast, the increase is not as apparent as in previous years. The South Coast component of the resource appears to remain stable.
- **Netfish:** Harders, the main target of the beach-seine and gillnet fisheries, remain in a depleted state as a result of overfishing, illegal harvesting and adverse environmental conditions which disrupt breeding cycles.

  High bird-bycatch mortality, especially in unattended nets, led to legislation and permit conditions that prohibit unattended gillnets (either set or drift). The most vulnerable species are crowned cormorant *Microcarbo coronatus* and penguins in the sea, and African darters *Anhinga rufa*, reed cormorants *Microcarbo africanus* and great crested grebes *Podiceps cristatus* in the estuarine environment. More recently, an upsurge in poaching with gillnets has been accompanied by an increase in the retention of bird bycatch for food and African and Asian “traditional medicine” trade.
- **Oysters:** The oyster resource along the KwaZulu-Natal coast is considered to be optimally exploited, although uncertainty remains around the actual stock status. Similar uncertainty also remains regarding the status of oysters in the Southern Cape. Their level of exploitation, considered to be heavy, together with illegal harvesting from subtidal “mother beds”, remain causes for concern.
- **Patagonian toothfish:** Recent assessment of the Patagonian toothfish resources indicate that uncertainties still remain around the true status of the resource, largely due to the difficulties of accounting for the removal of fish from longlines by predatory marine mammals in the Catch-Per-Unit-Effort (CPUE) index.
- **Prawns:** Deep-water prawns are considered to be optimally exploited. The status of shallow-water prawns, however, is considered to be depleted, largely due to the closure of the mouth of the St Lucia Estuary blocking the recruitment of shallow-water prawns to the Thukela Bank.
- **Seaweeds:** Kelp resources are considered optimally exploited and stable in most areas, although some areas offer the opportunity for greater harvesting. Other seaweed resources generally also offer opportunities for increased harvesting.
- **Sharks:** Recent assessments indicate that slime skate, spearnose skate, biscuit skate and St Joseph are abundant, blue and smoothhound sharks are at optimal status, whereas yellowspot and twineye skates are depleted. Oceanic whitetip, great hammerhead, soupfin and shortfin mako sharks are considered heavily depleted.
- **Small invertebrates and new fisheries:** The status of white mussel remains unknown. Potential new fisheries currently under investigation include octopus and redeye round herring in KwaZulu-Natal.
- **Small pelagic fishes:** Small pelagic fishes are characterised by high levels of natural variability. Recent assessments indicate that sardine stocks are depleted, anchovy are considered at optimal status and West Coast round herring are considered abundant.
- **South Coast rock lobster:** The South Coast rock lobster resource is considered to be in an optimal to depleted state. In order to ensure rebuilding of the stock, fishing pressure on this resource is being maintained at light to optimal levels.

- **Squid:** The most recent assessment indicates a more positive outlook of resource status than did the 2016 assessment. The squid resource is currently estimated to be at around 41 percent of its pre-fished level. Fishing effort has been adjusted to be appropriate to this new perception of the resource.
- **Tunas and swordfish:** Stock assessments and country allocations for tunas and swordfish are the responsibility of the relevant regional fisheries management organisations (RFMOs). The statuses of swordfish (Atlantic Ocean), southern bluefin tuna (Indian and Atlantic oceans), yellowfin tuna (Indian Ocean) and Atlantic bigeye tuna are of concern.
- **West Coast rock lobster:** The West Coast rock lobster resource remains heavily depleted, with stocks currently being at only 1.8 percent of pre-fished levels. There is continued concern regarding the levels of illegal harvesting of the resource. Improvements to the assessment methodology and input data have had a major influence. Shallow-water hake remains well above the estimated maximum sustainable yield level.

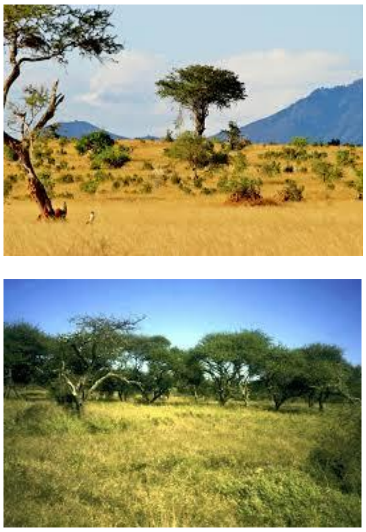
4.8 State of forests

The following section is an edited extract of the State of the Forests 2018 report and readers are encouraged to read the report for more, in-depth, fully referenced, information on the state of South Africa's forests.

In 1990, the world had 4 128 million ha of forest; by 2015 this area has decreased to 3 999 million ha. This is a change from 31.6 percent of global area in 1990 to 30.6 percent in 2015. There was a net loss of some 129 million ha of forest (natural and planted) from 1990 to 2015, representing an annual rate of -0.13 percent and a total that is equivalent to the total size of South Africa. Still, this should be understood in context: the net annual rate of loss has slowed from -0.18 percent in the 1990s to -0.08 percent over the last five-year period from 2010 to 2015. Between 2010 and 2015, there was an annual loss of 7.6 million ha and an annual gain 4.3 million ha per year, resulting in a net annual decrease in forest area of 3.3 million ha per year. The biggest forest area loss occurred in the tropics, particularly in South America and Africa, although the rate of loss in those areas has decreased substantially between 2010 and 2015. Average per capita forest area declined from 0.8 ha to 0.6 ha per person from 1990 to 2015.

South Africa has a surface area of 1 219 912 square kilometres (1.22 million km²), which is approximately 122 million hectares (ha). Forests cover just over 40 million ha of the country's land surface area (equivalent to about 32.7 percent).

Even though wooded vegetation covers more than a third of the country's land surface area, South Africa is generally regarded as a "low forest cover" country. Despite this "low forest cover" status, South Africa is regarded as a mega-biodiverse country ranking amongst the most biodiverse countries in the world. The natural forest biome, although the smallest (covering less than 500 000 ha) and most fragmented of all the seven biomes, has the highest plant diversity per hectare at 418 species per unit area compared to 98 species per ha for the fynbos biome.



Typical woodland forests, Source: google.com

In South Africa there are three main classes of forests, namely, woodlands (39 million ha), commercial plantations (1.19 million ha), and indigenous forests (492 700 ha).

4.8.1 Woodland forests

The Woodlands (wooded Savannahs) constitute the bulk of the South African forests, about 39 million hectares (about 32 percent). The economic contribution of woodlands was estimated at R17.03 billion to the annual Gross Domestic Product of the country in 2010. About 5.7 million hectares of the woodlands are in protected areas (around 16 percent of the total).

The majority of woodland forests occur in communal land and ownership of these is not clear. Some are in the National Parks and nature reserves cross the country.

In 2010, it was estimated that about 20 million tonnes of medicinal plants sourced from natural forest were traded at a street value of approximately R270 million. At present, approximately 300 tonnes of fern fronds are exported each year earning foreign exchange income to the annual value of more than R20 million annually.

The woodlands and natural forests are also inhabited by impressive wildlife that forms the corner stone of game farming and eco-tourism. Although there is some commercial timber harvesting allowed in natural forests, the majority of them are managed for conservation purposes, with an element of eco-tourism.

Woodlands, covering over one-third of the area of South Africa are well developed over the lowveld and Kalahari regions of the country and they are the dominant vegetation in Botswana, Namibia and Zimbabwe. The biome is defined by a well-developed grassy layer with a prominent woody layer of trees and shrubs.

Together with natural forests, woodlands provide a great variety of forest goods and environmental services from which a large number of the country's population benefit directly and indirectly. Many people are involved in woodcarving and other wood-based ornamentals derived from woodland forests.

Woodlands provide a safety net for many communities, as they are the most accessible forest resource for poor communities. The most prominent benefits include fuelwood for energy and sterilization of water through boiling whereby more than 12 million people benefit. They also provide medicinal plants for health care with approximately 27 million people accessing products from them.

Woodlands also provide fruits and other foods, wooden utensils, watershed protection and carbon storage. More than 800 000 people operate in the craft industry, which is heavily reliant on woodland resources and up to 100 000 households in South Africa engage in small-scale trade in forest products from woodlands. Due to their extent and vastness, woodland forests are neither adequately managed nor protected. As a result, wooded savannahs are heavily exploited.

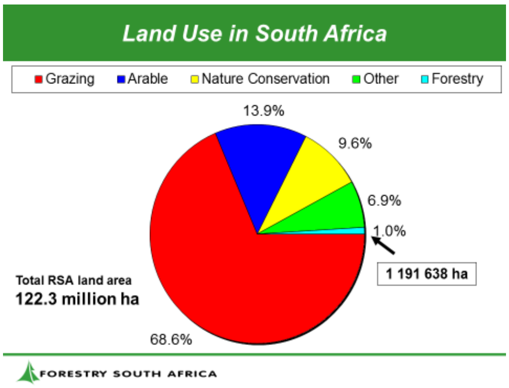
The rate of deforestation and degradation is currently unknown since there are no recent studies conducted to determine their statuses. However, it is common knowledge that deforestation and forest degradation are prominent in natural forests (moist forests) and open woodlands of the tropics, with the latter as the most affected due to poor protection from legislation and lack of enforcement and compliance capacity.

4.8.2 Plantation forests

In 2018, South African commercial plantation forests covered 1 194 663 hectares – an increase of 3 025 ha (0.3 percent) from 2018 when the area was recorded as 1 191 638 ha. Contrary to the South African situation where commercial plantation area has seen a steady decrease (with the exception of 2018) over the years, globally planted forest area has increased by over 110 million ha since 1990 and accounts for 7 percent of the world's forest area. The average annual rate of increase between 1990 and 2000 was 3.6 million ha. The rate peaked at 5.2 million ha per year for the period 2000 to 2010 and slowed to 3.1 million ha (2010-2015) per year due to a planting decrease in East Asia, Europe, North America, South and Southeast Asia.

There are a number of factors that the reduced area could be attributed to including, compliance with laws that require planting to be avoided on riparian zones and streams.

Plantations are generally grown for a specific purpose, for example, timber for mining, sawn timber or pulpwood. However, the actual sales mix at the time of harvesting invariably includes other forest products. In 2018, Softwood pine was mainly planted for sawlogs (about 75 percent) and hardwood contributed just over 2 percent of the sawlogs category. Hardwood (eucalyptus) were mainly for pulpwood (about 87,3 percent) with softwood contributing about 25 percent of the product. The proportion of commercial (plantation) forests in comparison to other landuses in South Africa is shown on the pie chart put together by *Forestry South Africa*.

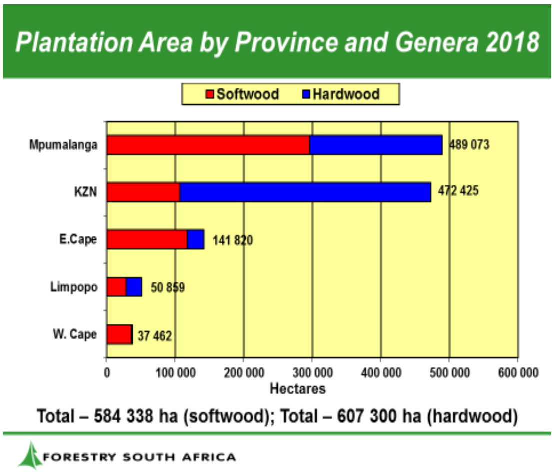


The table below provides a comparison of the distribution of commercial forestry plantations per province for the period 2017 to 2019. The table illustrates that there has been a constant decrease in area of the plantation estate over the past few years except in 2019 where 0.3 percent increase was recorded.

Table: Distribution of commercial timber plantations per province

Province	2019		2018		2017	
	Afforested area		Afforested area		Afforested area	
	Hectares	%	Hectares	%	Hectares	%
Limpopo	51 047	4.3	50 859	4.3	53 085	4.3
Mpumalanga	491 891	41.2	488 769	41.0	494 943	40.5
North West	304	0.0	304	0.0	304	0.0
Free State	-	0.0	-	0.0	-	0.0
KwaZulu-Natal	478 318	40.0	472 425	39.6	486 956	39.9
Eastern Cape	141 905	11.9	141 820	11.9	141 408	11.6
Western Cape	31 197	2.6	37 462	3.1	44 030	3.6
TOTAL	**1 194 663**	**100.0**	**1 191 638**	**100.0**	**1 220 726**	**100.0**

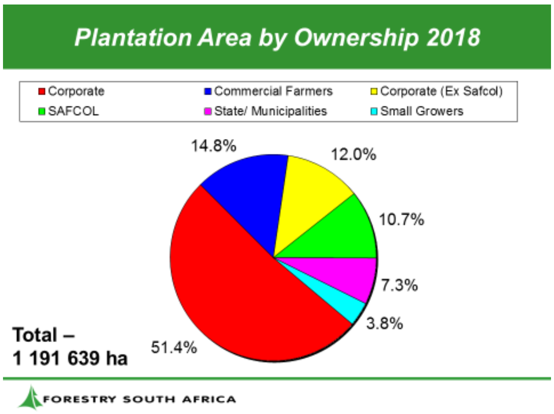
The most planted softwood species in South Africa is *Pinus patula* comprising 286 017 ha or 48.9 percent of the total softwood area in 2018. It occurs mainly in the provinces of Mpumalanga, KwaZulu-Natal and the Eastern Cape. Hardwoods are mainly grown for pulpwood and mining timber production on an eight to twelve-year rotation. The dominant hardwood species in South Africa is *Eucalyptus grandis* accounting for about 40 percent of the total hardwood area. Hardwoods occur mainly in Mpumalanga and KwaZulu-Natal.



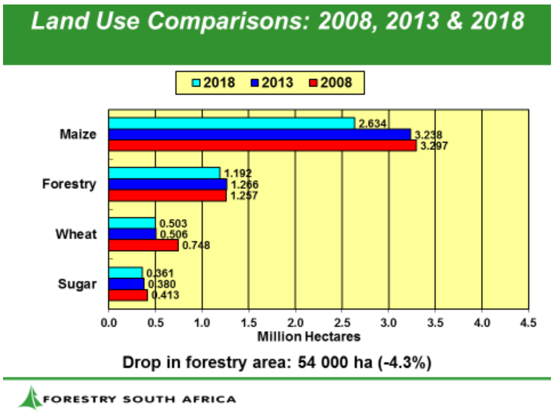
Most of the plantation area is planted with hardwood at 607 300 ha and these are mainly in the Province of KwaZulu-Natal (56.9 percent). Pine (softwood) plantations occupy 584 338 ha and are predominantly in the Mpumalanga Province (50.6 percent).

Commercial forestry plantations are an important and valuable segment of the South African economy and forest owners are required to maximise and sustain forest productivity. Various damaging agents are constantly hampering forest health and thus decrease productivity. It is important therefore to detect the presence and spread of these agents within plantations.

In 2018, the northern regions comprising Mpumalanga and Limpopo provinces accounted for 539 931 ha of commercial plantations in South Africa with 385 228 ha in private ownership and 154 701 ha under public ownership. The middle regions, KwaZulu-Natal, accounted for about 472 425ha of which 436 503 was in private hands and 35 923 under public ownership. The southern regions (Eastern Cape and Western Cape) constituted 179 282 ha of the country's commercial timber plantations. In the same period (2018), 151 182 ha was owned by the private sector with the public having a share of 28 101 ha.



Of all data from reported plantations 972 913 ha (82 percent) was under private sector ownership with the balance of 218 725 (18 percent) under public ownership. About 166 469 ha (14 percent) of the plantation area is owned by 510 individuals, partnerships or family trusts. The data illustrates that commercial plantations cover about 0.97 percent of the Republic's land surface area of 122.1 million hectares, a marked decrease from the 1.0 percent reported in 2016. The total plantation stands at 1 194 663 ha (2019) with the ownership pattern shown in the figure from forestry.



The plantation forests area has been steadily declining over the years. A total of 54 000 ha has been lost from 2008 to 2018, equivalent to (-4.3 percent). However, it appears that all the main commodity land uses (maize, wheat and sugar) followed the same downward trend over the period.

4.8.3 Indigenous forests

Our natural (indigenous) forests constitute the country's smallest biome occupying less than 0.4 percent of South Africa's land surface area (about 492 700 ha). Although they are few and relatively small, indigenous forests, have the highest biodiversity per unit area (418 species/ ha). They are generally multi-layered vegetation units dominated by trees (largely evergreen of semi-deciduous), where combined strata have overlapping crowns (75 percent or more) and where grasses are generally rare. They are restricted to frost-free areas with either high winter or summer rainfall. Together with the woodlands, natural forests provide traditional medicines to billions of the people in the world.

The largest and most famous natural forests in South Africa are the Knysna and Tsitsikamma forests of the Southern Cape. The Knysna forest is the largest forest complex not only in South Africa but in Southern Africa. It covers an area of about 60 500 ha and has survived largely unchanged for centuries.

Most other forests in South Africa are very small and isolated and include dune forests in KwaZulu-Natal and mountain forests, for example, on the slopes of Table Mountain and the Drakensberg, the Eastern Cape, Limpopo and Mpumalanga.

The land ownership of natural forests in South Africa is not known but can be inferred, to some extent, by level of protection. It is assumed forest patches that do not have some form of protection have either communal or private ownership. Almost half of all natural forests in South Africa are found on private property or land under communal tenure. The State, through the Department Forestry, Fisheries and the Environment is managing about 189 696 ha of indigenous forests. The bulk of these are in the Eastern Cape with an area of 132 000 ha (46 percent), followed by KwaZulu-Natal at 32 611 ha (29 percent), Mpumalanga at 15 029 ha (7 percent) and Limpopo at 6000 ha (5 percent).

The natural forests are mainly managed for biodiversity conservation and protection of soil. They also provide recreational outlets for all people to enjoy. The benefits provided by forest ecosystems include goods such as timber, fuel and bio-products; ecological functions such as carbon storage, nutrient cycling, water and air purification and maintenance of wildlife habitat. Social and cultural benefits derived from natural forests include recreational and traditional uses. The use of natural forests as sources of building material, fuelwood, food and medicine is increasing with an estimated 80 percent of South Africa’s population still using medicinal plants most of which are sourced from natural and woodland forests.

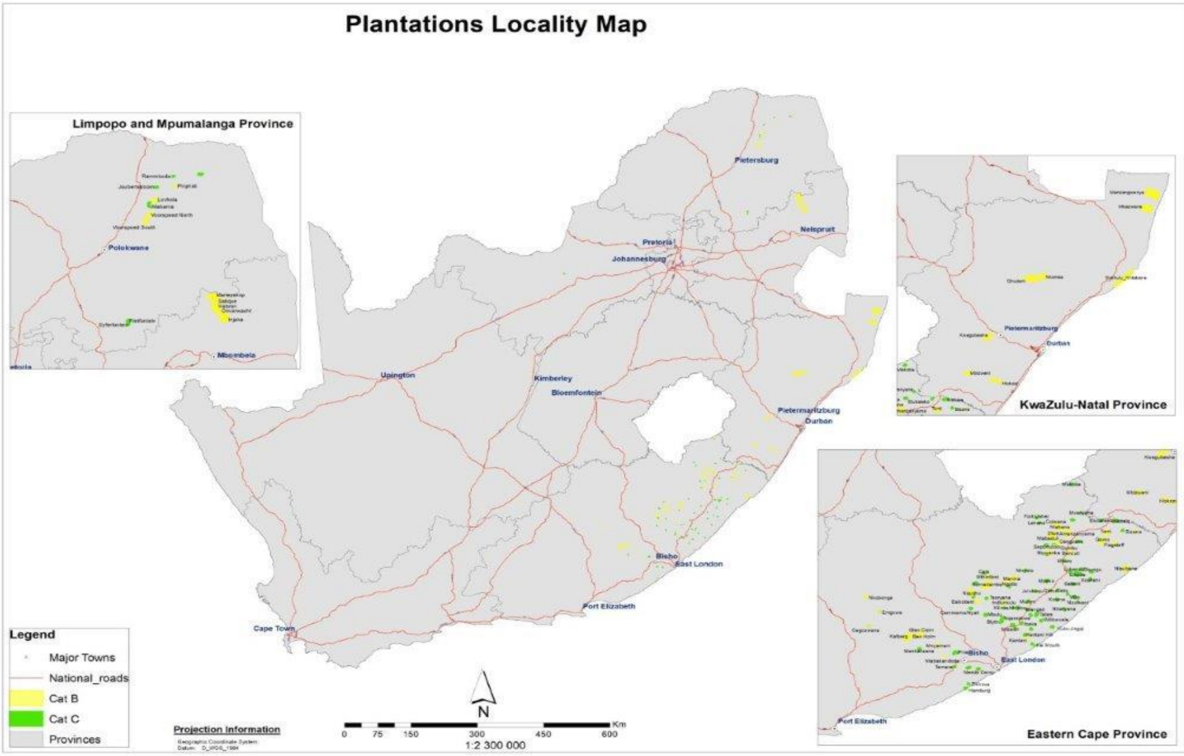
From 2010 to 2015, natural forest decreased by a net 6.6 million ha per year (8.8 million ha of loss and 2.2 million ha of natural forest gain). This is a reduction in net annual natural forest loss from 8.5 million ha per year (1990 to 2000) to 6.6 million ha per year (2010 to 2015). In South Africa, it is unknown how much natural forests are lost per year since no studies were commissioned to establish this in the past years.

In 2015, about 30 percent of the world’s forest was designated as production forest, a slight increase from 1990 (28 percent). Forest designated as multiple use increased from 23 percent of the total forest area to 26 percent between 1990 and 2015. Multiple use forest provides timber, range, Non-Wood Forest Products, water, recreation and wildlife management values. In South Africa, only about 1 percent of the forest is designated for production, which is serviced by plantation forestry.

4.8.4 State plantations

In 2019, the public sector ownership of forestry plantation area in South Africa was 219 394 ha (18 percent) of the total 1 194 663 ha land for commercial forestry production. These commercial forestry plantations are under the management of various public authorities including the South African Forestry Company Limited (SAFCOL), Government Departments and municipalities (local authorities).

The State, through the Department of Forestry, Fisheries and the Environment (DFFE) directly owns and manages about 64 350 ha of plantation forestry occurring in the provinces of Limpopo (3 938 ha), Mpumalanga (4 091 ha), KwaZulu-Natal (29 292 ha), Eastern Cape (27 957 ha) and the North West (206ha). These are plantations which were not leased to third party companies during the restricting of the first batches of plantations in the early 2000’s and are referred to as category B’s and C’s. The map below reflects the distribution of State’s category B and C plantations.



Map: Locality map of state plantation (category B and C)

The intention then was to refurbish them and make them economically viable before devolving them to other management authorities or communities. However, an assessment of these plantations indicates that they are poorly managed and pose a serious liability to the State for various reasons. These include lack of adequate resources (funding) for operations, ageing workforce which is unable to complete their daily tasks, procurement processes and lack of protection of the forest estates due to contracted number of security personnel. It was also reported that the average age of workers in State plantations was 54 years in 2019.

DFFE currently manages about 64 350 ha of category B and C plantations and half of these are located in the Provinces of KwaZulu-Natal and the Eastern Cape. The table below reflects a list of DFFE managed plantations and their stocking statuses:

Table: DFFE commercial (plantation) forestry areas 2018/19

Province	Commercial area (ha)	Non-commercial area (ha)	Total area (ha)	Temporary-unplanted area (ha)
Eastern Cape	27 956.54	22 657.00	50 613.54	6 471.12
KwaZulu-Natal	28 291.72	18 266.97	46 558.69	9 741.87
Mpumalanga	4 090.88	2 408.82	6 499.70	2 937.45
Limpopo	3 937.61	2 629.26	6 567.04	780.12
North West	206.13	261.67	467.80	24.08
TOTAL	**64 349.89**	**46 356.72**	**110 706.77**	**19 954.64**

However, most of these are currently not economically viable due to a variety of challenges, ranging from poor management, inadequate funding, ageing workforce, their locality to markets right through to high levels of Temporary Unplanted Areas (TUPs) which were steady at around 21.3 percent (much higher than the 3 percent industry norm) in the past decade or so. However, the TUP has seen a sharp increase of about 9 percent in the 2019/20 financial year and stood at 30.0 percent, the highest ever experienced in State plantations.

Category C plantations comprised of 78 woodlots, ranging from 5.0 ha to 500 ha were established in the former homelands, primarily to supply rural communities with a local source of fuel wood and building materials. They covered an area of approximately 11 054 ha but these have since been incorporated into the category B plantations and managed as single Farm Management Units.

Several category B plantations and a few category C plantations are subject to land claims in terms of the Restitution of Land Rights Act, 1994 (Act No. 22 of 1994). There are more than 68 land claims lodged on DFFE plantations lodged before the 1998 cut-off date. To date, ten (10) land claims have been settled and the land transferred to the land restitution beneficiaries. See the below table for a summary of land claims by province.

Table: Summary of land claims by Province

Province	No. of claims lodged	No. of claims settled	% claims settled	No. of claims outstanding
Limpopo	7	1	14%	6
Mpumalanga	5	1	20%	4
KwaZulu-Natal	14	-	0%	14
Eastern Cape	42	6	14%	34
TOTAL	**68**	**8**	**15%**	**58**

The land restitution process has some challenges and these include delays in respect of the settlement of restitution claims. This poses a serious threat and has the potential of setting a precedence, which may result in widespread land invasions across the country if the process of land restitution is not expedited and prioritised.

4.8.5 Forest expansion

Feasibility studies conducted throughout the country in the recent years indicated that there were no more areas for potential expansion of the commercial forestry estate except in the Eastern Cape and KwaZulu-Natal. In Limpopo, the areas that were identified as having the potential for afforestation – planting of commercial tree species on a virgin land were found to be very small and in patches which would not be economically viable. New afforestation in South Africa has declined considerably in the recent years due to various factors. These include unavailability of suitable forestry land, the tightening of the procedures for acquiring the necessary water use licences for afforestation, proximity of suitable land to the market and inadequate funding to conduct environmental impact assessments.

From the table below it can be deduced that only 4 500 ha was planted over the 2016 to 2018 period. The industry has over the past years experienced little or no afforestation at all.

Table: Afforestation uptake per species and purpose

Species	Area (ha)			Total area per *spp.* (ha)
	2016	2017	2018	
Softwood *spp.*	526	983	793	2 302
Eucalyptus *spp.*	112	349	289	750
Wattle	464	461	508	1 433
Other hardwoods	5	5	5	15
Total area	**1 107**	**1 798**	**1 595**	**4 500**

Commercial forestry is considered a "Stream-Flow Reduction" activity in South Africa. Land developers are required to apply for a licence, which involves among other issues, conducting an Environmental Impact

Assessment (EIA) to determine, among others, water availability and the impact of the development to the quality and quantity of the water resource. In order to assist small growers in KwaZulu-Natal to establish plantation, the Department conducted and covered the costs for the EIAs for an area of approximately 5 000ha. The result has been positive Records of Decision (RoDs) for an area of approximately 2 400 ha.

4.8.6 Veld and forest fires

Fires play a major role in certain ecosystems such as on grasslands where the majority of plantations have been established. Farmers and foresters also use fires as a management tool, for example, to manage fuel load and for integrated fire management purposes. However, uncontrolled veld and forest fires can also be devastating to the economy, the environment and the lives and livelihoods of communities. They affect the health and vitality of forests posing a risk to sustainable forest management and the development of the resources.

Fire damage may lead to opportunistic agents (pests and diseases) attacking burnt trees and ultimately resulting in catastrophic events where trees die in large numbers. South Africa has seen a number of devastating fires during the period 2016 to 2018, particularly in the Western Cape Province.

The recorded number of fires that occurred in plantations in 2017/18 was 2 306, a bit lower than 2016/17 which were 2 793. In 2018, 17 265 ha of plantations were damaged by fires (16 145 in 2017). The plantation damage by fires and other causes and areas affected for the years 2016, 2017 and 2018 are indicated in table below:

Table: Plantation area damaged by fires and other causes

Causes of fires	2015/16		2016/17		2017/18		Total area (ha)
	Area (ha)	% affected	Area (ha)	% affected	Area (ha)	% affected	
Natural	747	5	5 232	32	4 681	27	10 660
Accidental	4 652	33	3 356	21	4 049	23	12 057
Arson	3 254	23	2 188	14	4 563	26	10 005
Unknown	5 570	39	5 368	33	3 972	23	14 910
TOTAL	**14 223**	**100**	**16 144**	100	17 265	100	47 632

A total of 47 632 ha of plantation area was damaged by fires and other causes during the three-year period. Most damages areas were from unknown causes (14 910 ha), followed by accidental forest fires which accounted for 12 057ha.

The National Veld and Forest Fire Act, 1998 is the legal instrument for managing veld, forest and mountain fires in South Africa. The Act takes an integrated fire management approach which makes provision for the creation of: institutions (fire protection associations and umbrella fire protection associations); systems (the national fire danger rating system); and processes and programmes (such as the Working on Fire Programme) for achieving its objective. The following are some of the provincial Fire Protection Association (FPA), community-based and voluntary organisations, established in accordance with the conditions set out in chapter 2 of the Act:

- Zululand FPA has recorded a total expenditure of R10 173 772 in 2016, 16 158 645 in 2017 and 17 841 778 in 2018. There were four causalities and nine structures were destroyed in 2018. The Association saw a total of 1 974 fires in 2018 of which 1 023 were from forests (timber plantation fires). The area burnt in 2017 was 46 174ha and 852ha of plantation was affected.
- North West FPA recorded the value of losses because of veldfires at R15 000 000, R5 000 000 and R9 701 000 in 2016, 2017 and 2018, respectively.
- The Eastern Cape FPA estimated a damage to the value of R643 899 839 over a three-year period (2016-2018), loss of 210 livestock, 3 vehicles and 82 structures.

4.8.6.1 The 2017 Knysna and Plettenberg Bay Fires

During the 2016/17 fire season, the Western Cape Province saw 17 000 fires, resulting in 142 fatalities. Of the 17 000 fires, 2 000 were reported in informal settlements affecting 5 900 people.

Amongst these tragedies, one particular event was particularly devastating – the Knysna and Plettenberg Bay Fires.

On 7 June 2017, a fire erupted in the Knysna area of Western Cape and caused devastation and destruction on a scale that had never been experienced within a local municipality in this country before. The Knysna fire sadly led to loss of life and the destruction of properties and bulk service infrastructure worth millions of rands.

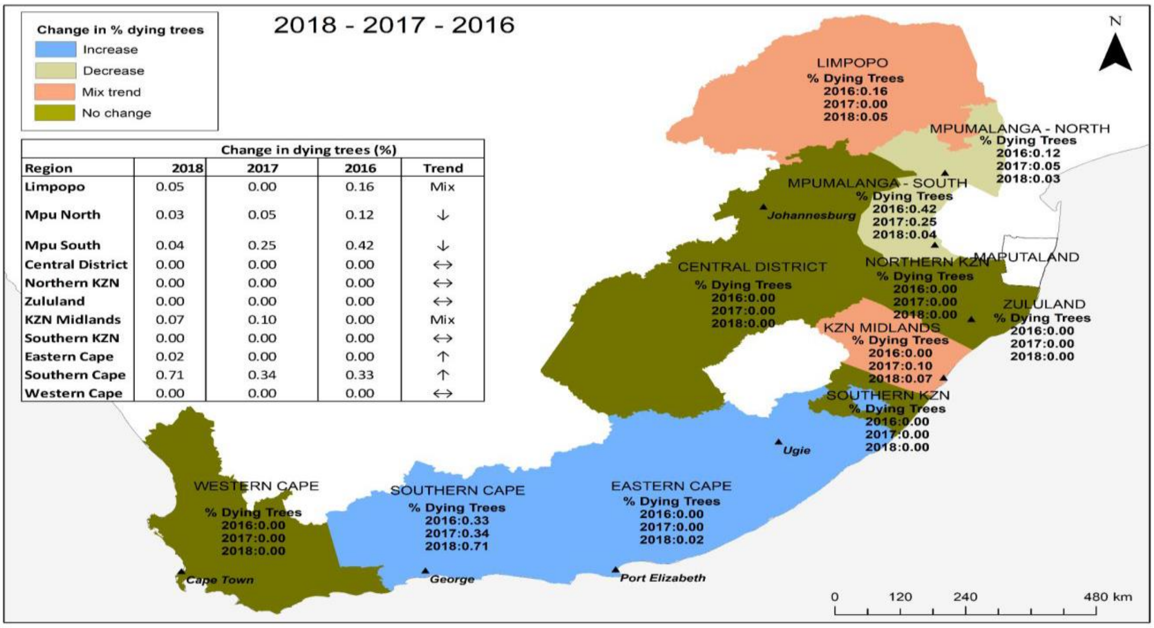
Following the initial deployment of the Working on Fire Riversdale team, Working on Fire had at the peak of the fire, dispatched 485 fire fighter, 12 management, 12 light Delivery Vehicles, 11 Fire Trucks, six Crew busses, four Huey Helicopters, four fixed Wing Spotter Planes and two 802 AT water bombers to provide firefighting services to the Knysna and Plettenberg Bay fires. This deployment of Working on Fire resources together with Local, District and Provincial firefighting resources and volunteers became the largest deployment to a single fire incident in South African history.

One of the properties damaged during the June 2017 Knysna and Plettenberg Bay fires, Western Cape fires.

Between June 6 and June 10, fires destroyed more than 600 structures in Knysna and Plettenberg Bay when gale force winds exceeding 90 km/h made firefighting extremely difficult. Some 28 fires were reported in the area on June 8, 2017. The devastating Knysna and Plettenberg Bay fire disasters in June destroyed hundreds of properties, claimed seven lives and burnt through thousands of hectares of land. Preliminary assessments estimated roughly R136 million worth of infrastructure damage. However, insurers estimated the damage to private property to be between R4bn and R5bn. Communication trough mobile gadgets was near impossible during the fire occurrence because the fires destroyed communication towers resulting in disrupted cellular communication for more than 20 hours.

4.8.7 Pests and diseases

Pests and diseases continue to threaten the vitally and health of forests and trees across the globe including in South Africa. New pests and diseases continue to threaten forestry in South Africa and established pests continue to present challenges. As an example, the *Sirex* wasp was first detected in Cape Town, South Africa in 1994. Over the past two decades, the *Sirex* wasp has spread across all pine plantation areas from Cape Town to the Louis Trichardt area in the Limpopo province. In 2007, Forestry South Africa made an assessment of the damage caused by the *Sirex* wasp and estimated the risk to pine plantation loss at R153m. The figure below indicates the spread of and changes in % dying trees between 2016 and 2018 because of the *Sirex noctilio* from Cape Town right through to Louis Trichardt.



Map: Changes in *sirex noctilio* damage, 2016 – 2018

The Polyphagous shot hole borer (PSHB) is one of the recent tree pests to be detected in South Africa. In 2017, the Polyphagous shot hole borer was detected on London Plane trees in the KwaZulu-Natal National Botanical Gardens in Pietermaritzburg for the first time. The beetle is native to Southeast Asia and Carlifornia, is about 2mm in size and it has a symbiotic relationship with the fungus *Fusarium euwallaceae* which serves as a food source for the adults and their larvae. The beetles can attack a wide range of living exotic and indigenous trees including avocado, macadamia nut, peach, orange, grapevine and pecan trees. The pest was again detected in early 2018 in Gauteng Province near Sandton, Johannesburg. The adult female pest bores the stem creating tunnels beyond the cambium of the tree where it inoculates the living wood with the fungus. The fungus then spreads along these tunnels and becomes a food source for the larvae and the beetles. In susceptible trees, the fungus slowly kills through the failure of the tree's vascular system; leaves begin to thin on the ends of the branches, eventually turning brown leading to the branch, and eventually the tree, dying. The PSHB infestation in South Africa has reached Johannesburg, Durban, Richard's Bay, George, Knysna and Hartswater with Johannesburg being hit particularly hard as a result of its dense urban forests.

4.9 State of waste management

The 2022 SAWIS Annual Diversion Report provides a detailed breakdown of quantities of waste reported in the SAWIS and the relevant provincial waste information systems in 2022 per waste category/stream and activity. Both general and hazardous waste quantities are combined in the table below, as some waste streams are reported in both categories. Furthermore, the report provides granular details of the waste recovered, recycled, treated, exported and disposed of in 2022.

The waste generation is not a reported figure on the SAWIS but a calculated figure based on the total waste quantities reported for the period under review (2022). The data in the table below calculates the tonnages and percentage of waste diverted per waste stream as reported to the SAWIS in 2022. The total waste diversion rate reported for 2022 is 22%. It must be noted that there is a significant difference between the diversion rate for general waste compared to hazardous waste. The diversion rate for general waste for 2022 is 35.17%, while the diversion rate for hazardous waste is 11.73%, resulting in the overall 22% diversion for all waste streams combined.

Table: 2022 Annual SAWIS Waste Diversion Report/per stream

	GENERATED TONNES*	*EXPORTED TONNES*	*DIVERTED TONNES*	*RECOVERY TONNES*	*RECYCLED TONNES*	*TREATED TONNES*	*DISPOSAL TONNES*	*% DIVERTED*
Municipal	4 959 998,83	-	914 246,85	904 460,75	9 448,21	337,90	4 045 751,97	18,43
Commercial	1697203,45	-	611822,98	20523,86	565556,48	25742,64	1085380,47	36,05
Brine	757,50	-	-	-	-	-	757,50	0,00
Fly Ash	61181,52	-	836,16	526,54	-	309,62	60345,36	1,37
Bottom Ash	3848782,56	-	39516,61	30007,69	1529,65	7979,27	3809265,95	1,03
Slag	2768466,41	-	226562,22	52084,02	174478,20	-	2541904,19	8,18
Mineral	922052,06	-	17147,91	9038,52	1336,24	6773,15	904904,15	1,86
Organic	1727665,62	-	1342616,69	730525,79	279548,12	332542,79	385048,93	77,71
Sewage sludge	21820,98	-	12532,75	8362,75	-	4170,00	9288,23	57,43
Construction	1626340,56	-	506378,96	389456,50	116922,46	-	1119961,60	31,14
Paper	1 869 546,90	1 417,56	1 393 003,08	305 191,42	928 859,63	157 534,47	476 543,82	74,51
Plastic	549 628,38	-	191 811,51	68 532,52	123 275,99	3,00	357 816,87	34,90
Glass	309 881,35	-	73 530,57	26 186,36	47 344,21	-	236 350,79	23,73
WEEE	38 011,84	-	17 958,37	442,65	17 468,33	47,40	20 053,47	47,24
Metal	4 071 196,65	-	3 288 876,17	490 896,91	2 742 851,50	55 127,77	782 320,48	80,78
Other	331432,95	-	87083,53	43448,18	8081,95	35553,40	244349,42	26,27
Gaseous waste	187,81	-	37,49	-	-	37,49	150,32	19,96
Mercury containing waste	161,23	-	157,45	117,28	-	40,17	3,78	97,66
Batteries	62603,30	-	59186,37	10325,69	48858,82	1,87	3416,93	94,54
POP Waste	205,71	-	199,21	-	-	199,21	6,50	96,84

	GENERATED* TONNES	EXPORTED TONNES	DIVERTED TONNES	RECOVERY TONNES	RECYCLED TONNES	TREATED TONNES	DISPOSAL TONNES	% DIVERTED
Inorganic waste	843131,68	-	25154,55	1337,72	309,02	23507,81	817977,13	2,98
Asbestos waste	126502,72	-	0,24	-	-	0,24	126502,48	0,00
Waste Oils	135477,28	-	113135,06	43729,36	38022,98	31382,73	22342,23	83,51
Organic halogenated and /or sulphur containing solvents	7680,28	-	7674,48	-	285,46	7389,02	5,80	99,92
Organic halogenated and/or sulphur containing waste	41105,38	-	20394,85	-	33,00	20361,85	20710,53	49,62
Organic solvents without halogens and sulphur	33099,94	-	32584,90	471,16	31505,77	607,97	515,04	98,44
Other organic waste without halogen or sulphur	1425749,05	-	1290137,57	3925,14	1102001,31	184211,12	135611,48	90,49
Tarry and bituminous waste	29238,60	-	9141,50	-	-	9141,50	20097,10	31,27
Brine	9936,29	-	-	-	-	-	9936,29	0,00
Fly Ash and dust	1260415,14	-	1230029,80	1003878,92	226150,88	-	30385,34	97,59
Bottom Ash	22450551,42	-	98,90	-	98,90	-	22450452,52	0,00
Slag	2085425,03	-	22773,91	18624,49	1711,00	2438,42	2062651,12	1,09
Mineral waste	1044391,99	-	72121,08	-	-	72121,08	972270,91	6,91
WEEE	1180,78	52,67	1180,78	233,86	888,25	6,00	-	100,00
HCRW	570069,78	-	556612,93	41,18	-	556571,75	13456,85	97,64
Sewerage sludge	84748,75	1124,93	1634,73	-	-	509,80	83114,02	1,93
Miscellaneous	413434,58	1177,60	149182,14	1354,68	8464,60	138185,27	264252,44	36,08

	GENERATED* TONNES	EXPORTED TONNES	DIVERTED TONNES	RECOVERY TONNES	RECYCLED TONNES	TREATED TONNES	DISPOSAL TONNES	% DIVERTED
Total	**55429264,30**	**3772,76**	**12315362,30**	**4163723,91**	**6475030,94**	**1672834,70**	**43113902,00**	**22,22**

4.9.1 Analysis of 2022 general waste quantities

Of the 25 million tonnes of general waste generated in 2022, just over 35% were diverted from going into landfills, saving airspace at the waste disposal facilities where such waste would have ended up being disposed of. As depicted in the table below, a significant amount of the general waste streams are recyclable. There are waste streams with a diversion rate above 90%, especially from the mainline recyclable streams such as paper, plastic, glass, e-waste and metals. This may be attributed to only the recovery and recycling facilities' reporting on these materials and fewer disposal quantities reported by the disposal facilities. Hence, the quantities are reported in the table to exclude the disposal factor applied in extracting the landfill figures from the municipal waste category (applied in EPR prioritised schemes). This poses significant reporting and calculation challenges. For diversion to be appropriately calculated, disposal quantities are necessary. Overall, the diversion rate for general waste is encouraging and applauded as it contributes to the circularity of the recovered and recycled materials instead of disposing them at landfills. Other waste streams have high diversion rates.

Table: ***2022 General Waste Annual SAWIS Waste Diversion Report***

	GENERATED* TONNES	EXPORTED TONNES	DIVETRED** TONNES	RECOVERY TONNES	RECYCLED TONNES	TREATED TONNES	DISPOSAL TONNES	% DIVERTED
Municipal	4 959 998,83	-	914 246,85	904 460,75	9 448,21	337,90	4 045 751,97	18,43
Commercial	1 697 203,45	-	611 822,98	20 523,86	565 556,48	25 742,64	1 085 380,47	36,05
Brine	757,50	-	-	-	-	-	757,50	0,00
Fly Ash	61 181,52	-	836,16	526,54	-	309,62	60 345,36	1,37
Bottom Ash	3 848 782,56	-	39 516,61	30 007,69	1 529,65	7 979,27	3 809 265,95	1,03
Slag	2 768 466,41	-	226 562,22	52 084,02	174 478,20	-	2 541 904,19	8,18
Mineral	922 052,06	-	17 147,91	9 038,52	1 336,24	6 773,15	904 904,15	1,86
Organic	1 727 665,62	-	1 342 616,69	730 525,79	279 548,12	332 542,79	385 048,93	77,71
Sewage	21 820,98	-	12 532,75	8 362,75	-	4 170,00	9 288,23	57,43
Construction	1 626 340,56	-	506 378,96	389 456,50	116 922,46	-	1 119 961,60	31,14
Paper	1 869 546,90	1 417,56	1 393 003,08	305 191,42	928 859,63	157 534,47	476 543,82	74,51
Plastic	549 628,38	-	191 811,51	68 532,52	123 275,99	3,00	357 816,87	34,90

	GENERATED* TONNES	EXPORTED TONNES	DIVETRED** TONNES	RECOVERY TONNES	RECYCLED TONNES	TREATED TONNES	DISPOSAL TONNES	% DIVERTED
Glass	309 881,35	-	73 530,57	26 186,36	47 344,21	-	236 350,79	23,73
WEEE	38 011,84	-	17 958,37	442,65	17 468,33	47,40	20 053,47	47,24
Metal	4 071 196,65	-	3 288 876,17	490 896,91	2 742 851,50	55 127,77	782 320,48	80,78
Other	331 432,95		87 083,53	43 448,18	8 081,95	35 553,40	244 349,42	26,27
Total	**24 803 967,56**	**1 417,56**	**8 723 924,36**	**3 079 684,44**	**5 016 700,96**	**626 121,40**	**16 080 043,20**	**35,17**

4.9.2 Analysis of 2022 hazardous waste quantities

Of the 30,6 million tonnes of hazardous waste generated, 24,5 million are made of Slag and Bottom Ash, accounting for 81% of the total hazardous waste disposed of in 2022. Hazardous waste diverted from landfills in 2022 accounted for only 12%. Based on the quantities reported, significant waste streams have been disposed of to landfills, resulting in a lower diversion rate. So, the higher diversion percentage is based on the quantities reported by the recovery, recycling treatment and export figures reported to the system. Some waste streams such as Batteries, Mercury-containing waste, Fly-Ash and dust have reported high diversion rates above 80% on average, possibly due to lower disposal quantities reported to the SAWIS. The Department must prioritise appropriate measures or interventions to divert hazardous waste streams generated in large quantities from landfills.

Table: 2022 Hazardous *Waste Annual SAWIS Waste Diversion Report*

	GENERATED* TONNES	EXPORTED TONNES	DIVERTED* TONNES	RECOVERY TONNES	RECYCLED TONNES	TREATED TONNES	DISPOSED TONNES	% DIVERTED
Gaseous waste	187,81	-	37,49	-	-	37,49	150,32	19,96
Mercury containing waste	161,23	-	157,45	117,28	-	40,17	3,78	97,66
Batteries	62603,30	-	59186,37	10325,69	48858,82	1,87	3416,93	94,54
POP Waste	205,71	-	199,21	-	-	199,21	6,50	96,84
Inorganic waste	843131,68	-	25154,55	1337,72	309,02	23507,81	817977,13	2,98
Asbestos waste	126502,72	-	0,24	-	-	0,24	126502,48	0,00
Waste Oils	135477,28	-	113135,06	43729,36	38022,98	31382,73	22342,23	83,51
Organic halogenated and /or sulphur containing solvents	7680,28	-	7674,48	-	285,46	7389,02	5,80	99,92

	GENERATED TONNES*	*EXPORTED TONNES*	*DIVERTED* TONNES*	*RECOVERY TONNES*	*RECYCLED TONNES*	*TREATED TONNES*	*DISPOSED TONNES*	*% DIVERTED*
Organic halogenated and/or sulphur containing waste	41105,38	-	20394,85	-	33,00	20361,85	20710,53	49,62
Organic solvents without halogens and sulphur	33099,94	-	32584,90	471,16	31505,77	607,97	515,04	98,44
Other organic waste without halogen or sulphur	1425749,05	-	1290137,57	3925,14	1102001,31	184211,12	135611,48	90,49
Tarry and bituminous waste	29238,60	-	9141,50	-	-	9141,50	20097,10	31,27
Brine	9936,29	-	-		-	-	9936,29	0,00
Fly Ash and dust	1260415,14	-	1230029,80	1003878,92	226150,88	-	30385,34	97,59
Bottom Ash	22450551,42	-	98,90	-	98,90	-	22450452,52	0,00
Slag	2085425,03	-	22773,91	18624,49	1711,00	2438,42	2062651,12	1,09
Mineral waste	1044391,99	-	72121,08	-	-	72121,08	972270,91	6,91
WEEE	1180,78	52,67	1180,78	233,86	888,25	6,00	-	100,00
HCRW	570069,78	-	556612,93	41,18	-	556571,75	1 3456,85	97,64
Sewerage sludge	84748,75	-	1634,73	-	-	509,80	83114,02	1,93
Miscellaneous	413434,58	1124,93	149182,14	1354,68	8464,60	138185,27	264252,44	36,08
Total	**30 625 109**	**1178**	**3 591 400**	**1 084 039**	**1 458 329,98**	**1 046 675,81**	**27 033 708,48**	**11,73**

4.9.3 Extended producer responsibility

The Department, in terms of the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (the Waste Act), published the Extended Producer Responsibility (EPR) Regulations, 2020 (as amended) and the relevant Notices for the identified waste streams. The purpose of the EPR Regulations is to provide the framework for the development, implementation, monitoring and evaluation of extended producer responsibility schemes by producers in terms of section 18 of the Act to ensure the effective and efficient management of the identified products at the end of its life and to encourage and enable the implementation of the circular economy initiatives.

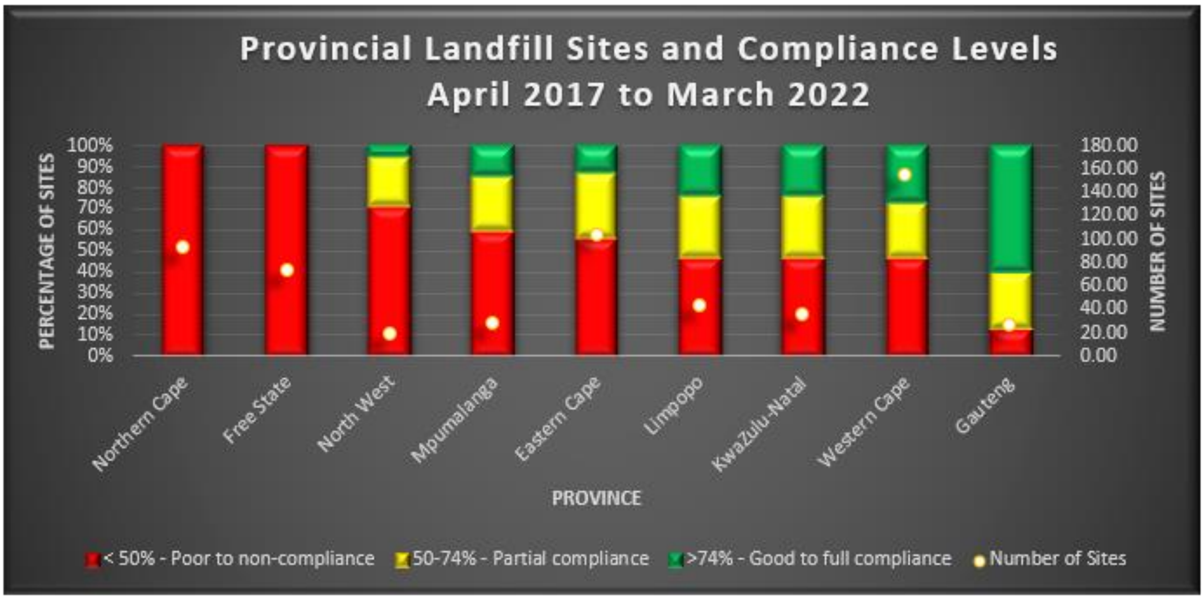
The table below shows the total number of Producers or Producer Responsibility Organisations (PROs) registered within each sector at the time of compiling this report. It must be noted that the Department has received additional EPR applications through the EPR online portal for the Portable battery sector, the Lubricant oil sector, and the Pesticides Sector, which are currently pending review on the system. There is also a list of 600 applications currently pending on the system, 458 of which were returned to be updated by the producer or producer responsibility organisation. The first batch of 126 EPR Condonation letters was prepared, and a submission for approval by the Director-General was uploaded on EDMS. The DG approved and signed the condonation letters on 14 September 2022, which were sent to the companies to process their registration on the EPR system.

Table: Extended Producer Responsibility registrations

Sector	*producer*	*Product responsibility organisation*	*Grand total*
Electrical and Electronic Equipment Sector	157	6	163
Lighting Sector	60	5	65
Paper and Packaging Sector	951	26	977
Grand Total	**1 168**	**37**	**1 205**

4.9.4 Provincial landfill sites and compliance levels

The following graphics provide a summary of the main findings of the Environmental Management Inspectorate Draft Municipal Landfill Site Compliance Report of August 2022, and readers are encouraged to read this report for more, in-depth, fully referenced information. The report, compiled by the National Environmental Management Inspectorate, presents the key findings of the general municipal landfill-sector compliance inspections performed by provincial Environmental Management Inspectors (EMIs) in all provinces 1 April 2017.



The generally poor performance of disposal sites reflected in the graphics above and below is believed to be a result of various complex challenges including, amongst others:

- legacy issues such as the authorising of dumpsites which are not constructed and adequately equipped to meet disposal standards and requirements;
- technical, complex and costly requirements brought about by new legal requirements e.g., liner requirements in terms of the Waste Classification Regulations and the Norms and Standards for Landfill Disposal;
- administrative instability in municipalities which affects the quality and management of services provided;
- difficulties faced by municipalities in addressing problems such as the low levels of waste minimisation as a result of poor historical and current practices; and
- the low level of priority given to environmental compliance e.g., allocation of funds for operations, equipment (purchase and maintenance), human resources (staff complement and technical capacity); etc.

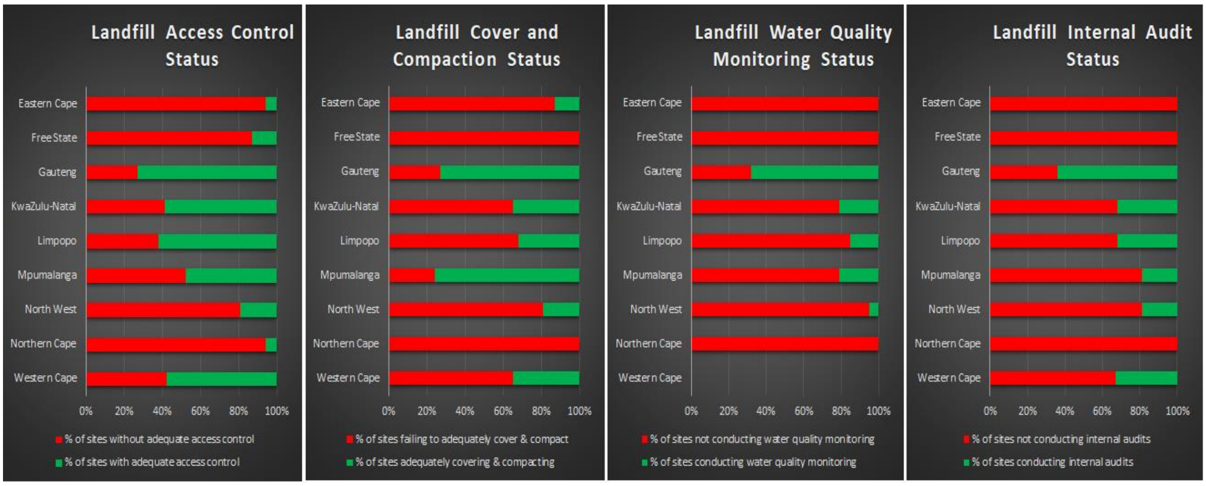


Figure: The performance of provincial landfill sites in respect of various performance monitoring criteria, April 2017 to March 2022

4.10 Provincial state of the environment

4.10.1 Free State province

The information was extracted from the Free State Province Environmental Outlook report of 2019 as well as the Free State Province Biodiversity Plan report and readers are encouraged to read these reports for more, in-depth, fully referenced, information on the Free State Province air quality; biodiversity management; climate change; environmental empowerment services; and waste management related issues.

4.10.1.1 Air quality

The Vaal Triangle Air-shed Priority Area (VTAPA) was formally identified as an air pollution hotspot on 21 April 2006 (Gazette Number 20732, Notice Number: 3344591) in terms of the National Environmental Management: Air Quality Act 2004. The bulk of atmospheric emissions within the Free State portion of the priority area emanate from the petrochemical industry. The province has not yet developed an Air Quality Management Plan. The National Ambient Air Quality Standards for common pollutants have been set as air quality objectives for the VTAPA.

Climate models have indicated that if there is a continued increase in global greenhouse gas concentrations, conditions within the central regions of South Africa may experience increased ambient air temperatures, reduced annual precipitation and frost occurrences and a change in the frequency, severity, duration and spatial extent of droughts. South Africa's biomes are predicted to shrink to about 38 - 55% of their current area by 2050. These predicted changes are expected to impact negatively on the agricultural sector and tourism due to a loss of biodiversity.

Ambient air quality monitoring is a legal requirement in terms of S8(b)(i) and S8(c)(ii) of the [National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004], the "NEM: AQA". This is done to determine the level of contaminants in an area to compare with standards and guidelines. The Priority contaminants which are monitored in the province are: $PM_{2.5}$, PM_{10}, SO_2, CO, NO, NO_2, NOx. For the reporting cycle the province monitored and reported on the following air quality management indicators:

Number of air quality management plans developed

The Free State Province Air Quality Management Plan (AQMP) is in the process of being revived in the 2021/21 Financial year. However, the various Municipalities in the Free State Province are in the process of developing AQMPs trough the assistance of the Department of Forestry, Fisheries and Environment's Local Government Support officials in the respective Municipalities.

Number of transition plans developed/adopted for high carbon emitting sectors

Provincial Transition Plans for high carbon emitting sectors will be developed during 2021/22 financial year. This will involve the determination of key environment sectors under climate change threat to be targeted for mitigation and adaptation measures. Currently, 18 facilities are registered on the National Atmospheric Emission Information System (NAEIS).

Number of government owned ambient monitoring stations meeting minimum data requirement and reporting to the SAAQIS

The province has seven (7) stationery air quality monitoring stations. This indicator is included in the national Medium-Term Strategic Framework indicator set. It is assumed that scientific and technical capacity will be available within the department and sector departments including municipalities.

4.10.1.2 Biodiversity management

There are 40 vegetation (ecosystem) types in the Free State (excluding forests) of which 1 is classified as Endangered (Vaal-vet Sandy Grassland) and 6 are classified as Vulnerable (Bloemfontein Dry Grassland, Eastern Free State Clay Grassland, Eastern Temperate Freshwater Wetlands, Rand Highveld Grassland, Soweto Highveld Grassland, and Vredefort Dome Granite Grassland). Three vegetation types are endemic to the Free State, these being the Bloemfontein Dry Grassland (VU, 4 914 km^2), the Western Free State Clay Grassland (6 667 km^2) and the Winburg Grassy Shrubland (1 570 km^2); together comprising 10 percent of the Free State surface area.)

The pattern of threats to natural ecosystems in the Free State Province is similar to the threat patterns observed in the country as a whole. In the Free State Province, over 70 percent of inland wetland and river ecosystem types listed as threatened. Just under 17 percent of terrestrial ecosystem types are listed as threatened. This shows that generally, the ecological condition of inland aquatic ecosystems is poor which is as a result of compounding pressures. SANBI assesses this ecosystem threat status and the information is updated on a regular basis.

Biomes

The Grassland Biome, second only to the Fynbos Biome in terms of biodiversity, covers about a third of South Africa and is represented in seven of the country's provinces. It extends from the interior of the Eastern Cape and KwaZulu-Natal provinces, over the escarpment and onto the central plateau containing the provinces of Free State, Gauteng, North West, Mpumalanga and Limpopo. Grasslands are dominated by a single layer of grass species, with frost, fire and grazing being the main inhibitors preventing colonisation by trees.

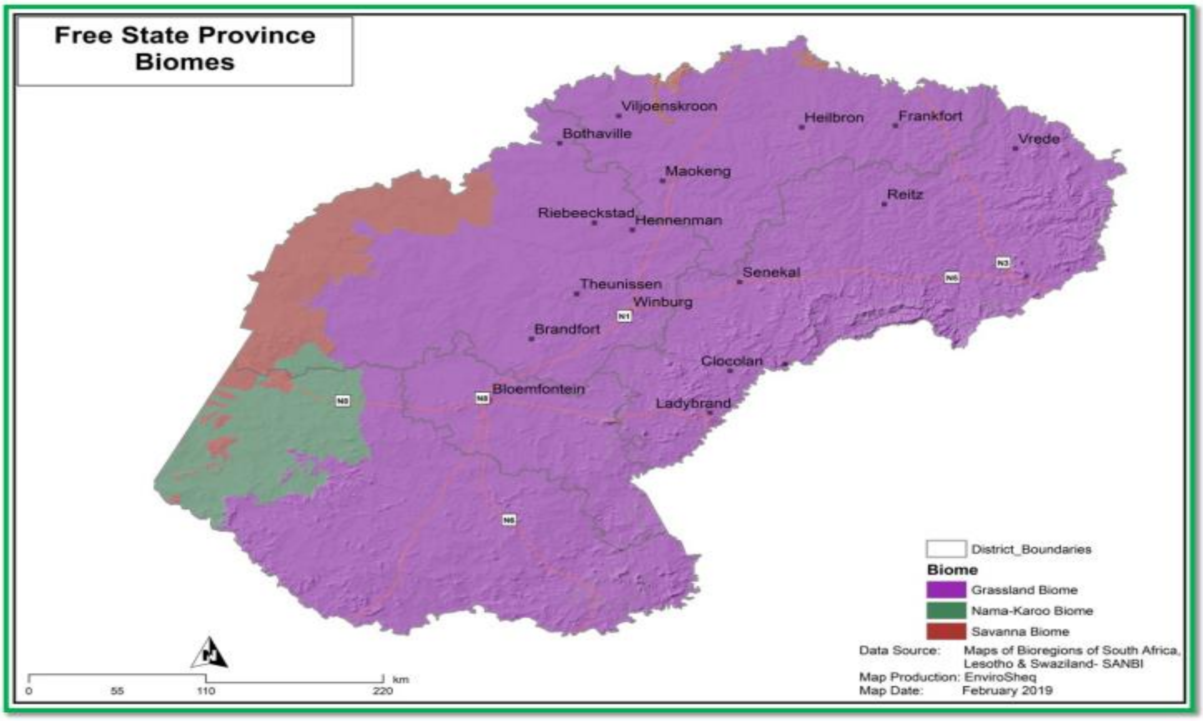


Figure 1 : Biome Analysis

Occurring on the central plateau of the western half of South Africa, from altitudes of 500 to 2 000 metres above sea level, the Nama Karoo Biome is the second largest biome in the region. Limited summer rainfall, which varies between 100 - 520 mm per year, is one of the main drivers of this biome type. Only 1 percent of the Nama Karoo Biome receives any form of protection while 20 percent has been destroyed. Invasive alien plants, such as Prickly

Pear (*Opuntia aurantiaca*) and Mesquite (*Prosopis glandulosa*), have had a severe negative impact on this biome, as has overgrazing by livestock. Climate change is predicted to have a major detrimental effect on the Nama Karoo, with large portions of its current area likely to be replaced by savannah and desert in future.

The Savannah Biome occupies just under one third of South Africa, extending into neighbouring Botswana, Zimbabwe and Mozambique. This biome is characterised by a grassy ground layer and a distinct upper layer of woody plants. A major factor delimiting the biome is the lack of sufficient rainfall, which prevents the upper tree layer from dominating, coupled with fire and grazing, which keeps the grass layer dominant.

Savannah vegetation types are used predominantly for grazing, mainly by cattle or game. Despite 43 percent of this biome being irreparably damaged or destroyed, the conservation status of savannah is comparatively good, with 11.9 percent conserved. Under different climatic models, the Savannah Biome is projected to expand within its geographic range, partly replacing grassland, although an increase in woody cover could shift parts of this biome towards woodland or even forest.

Vegetation

Within the above biomes, a total of 37 vegetation units can be found in the Free State (25 in the grassland biome, 5 in the savanna biome, 1 in the Nama Karoo biome, 1 in the forest biome as well as 2 azonal alluvial and 3 inland wetland vegetation types). Eight grassland vegetation units are restricted to the Free State, namely Xhariep Karroid Grassland, Bloemfontein Dry Grassland, Central Free State Grassland, Winburg Grassy Shrubland, Western Free State Clay Grassland, Eastern Free State Clay Grassland, Frankfort Highveld Grassland and Northern Free State Shrubland Of the 37 vegetation units, 7 are categorised as “Endangered (E)”, according to the conservation categories proposed by Mucina and Rutherford 1 , 6 as “Vulnerable (V)” and 24 as “Least Threatened (LT)”.

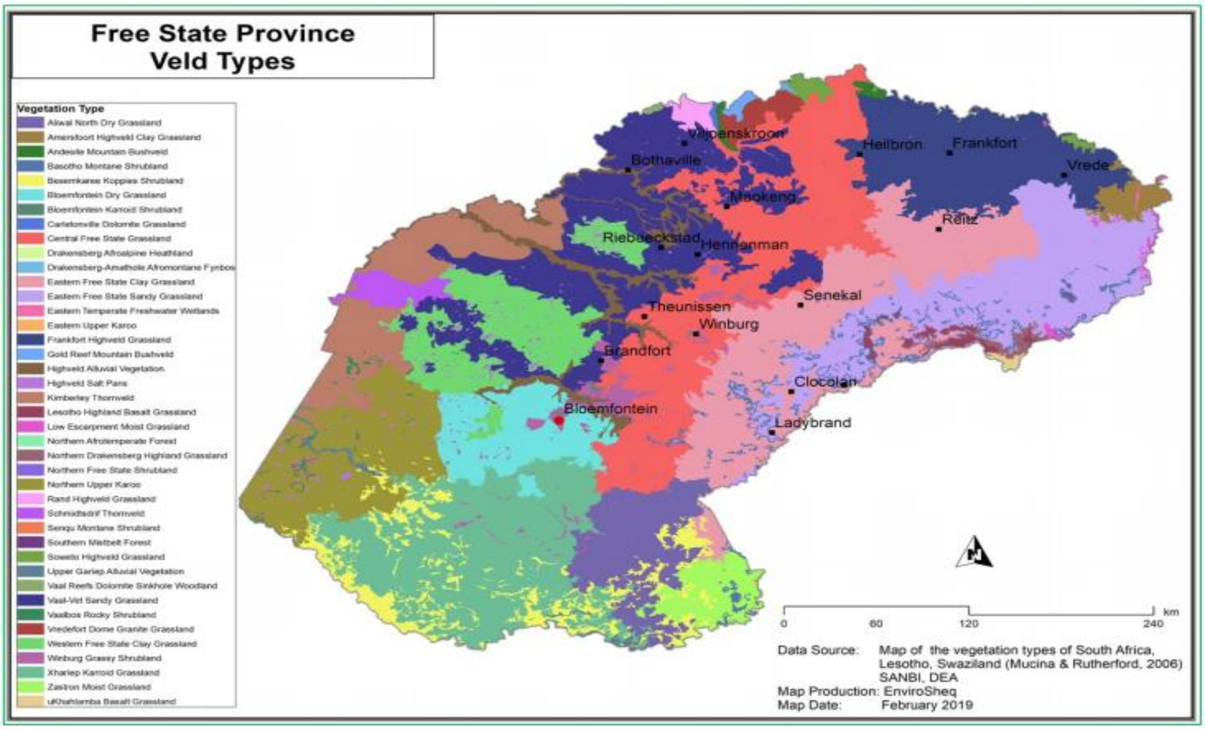


Figure 3 : Veld Types

Table: Biodiversity units in the Biomes (Critical Biodiversity)

Vegetation Units	Total	Endangered	Vulnerable	Least Threatened
Grassland vegetation units	25	7 (28%)	5 (20%)	13 (52%)
Dry Highveld Grassveld Bioregion	10	3 (30%)	1 (10%)	6 (60%)
Mesic Highveld Grassland Bioregion	10	4 (40%)	4 (40%)	2 (20%)
Drakensberg Grassland Bioregion	4			4 (100%)
Sub-escarpment Grassland Bioregion	1			1 (100%)
Savanna vegetation units	5			5 (100%)
Central Bushveld Bioregion	2			2 (100%)
Eastern Kalahari Bushveld Bioregion	3			3 (100%)
Nama Karoo Bioregion	1			1 (100%)
Forest	1			1 (100%)
Azonal Alluvial Vegetation	2		1 (50%)	1 (50%)
Inland Wetlands	3			3 (100%)

A spectacular area of the north-eastern Free State around the village of Memel has become the first in the province to be declared a "protected environment" – for its exceptional natural beauty, diversity of species and significance as a water source area. The 17 456 hectare protected area, known as the Sneeuwberg Protected Environment (SPE), was gazetted on Friday 29 July 2016. A "protected environment" is a class of protection under the National Environmental Management: Protected Areas Act (NEMPAA), which offers the next most secure form of protection after a nature reserve. Protected environments require a management plan encompassing issues like veld management and wetland protection, while still allowing residents to make a living off the land through activities such as livestock farming and tourism.

Biodiversity Priority Areas

A key output of the biodiversity planning process is the Critical Biodiversity Area (CBA) map. Categories included in the CBA map are:

- ***CBA Irreplaceable*** – A site that is irreplaceable or near-irreplaceable for meeting biodiversity targets. There are no or very few other options for meeting biodiversity targets for the features associated with the site. Such sites are therefore critical and they need to be maintained to ensure that features targets are achieved and that such features persist.
- ***CBA Optimal*** – A site that has been selected based on its complementarity for meeting biodiversity targets. CBA Optimal sites are therefore important but their maintenance is not critical to ensure that features targets are achieved and that such features persist.
- ***Ecological Support Areas (ESAs)*** – An area that plays an important role in supporting the ecological functioning of a protected area or Critical Biodiversity Area, or in delivering ecosystem services. In most cases ESAs are currently in at least fair ecological condition, and should remain in at least fair functioning condition.
- ***ESA1*** – ESA1 sites are those with minimal degradation.
- ***ESA2*** – ESA2 sites are those with degradation, i.e. they can be totally degraded, but not totally transformed.

- ***Other (Other Natural Areas)*** – An area of natural habitat not required to meet biodiversity

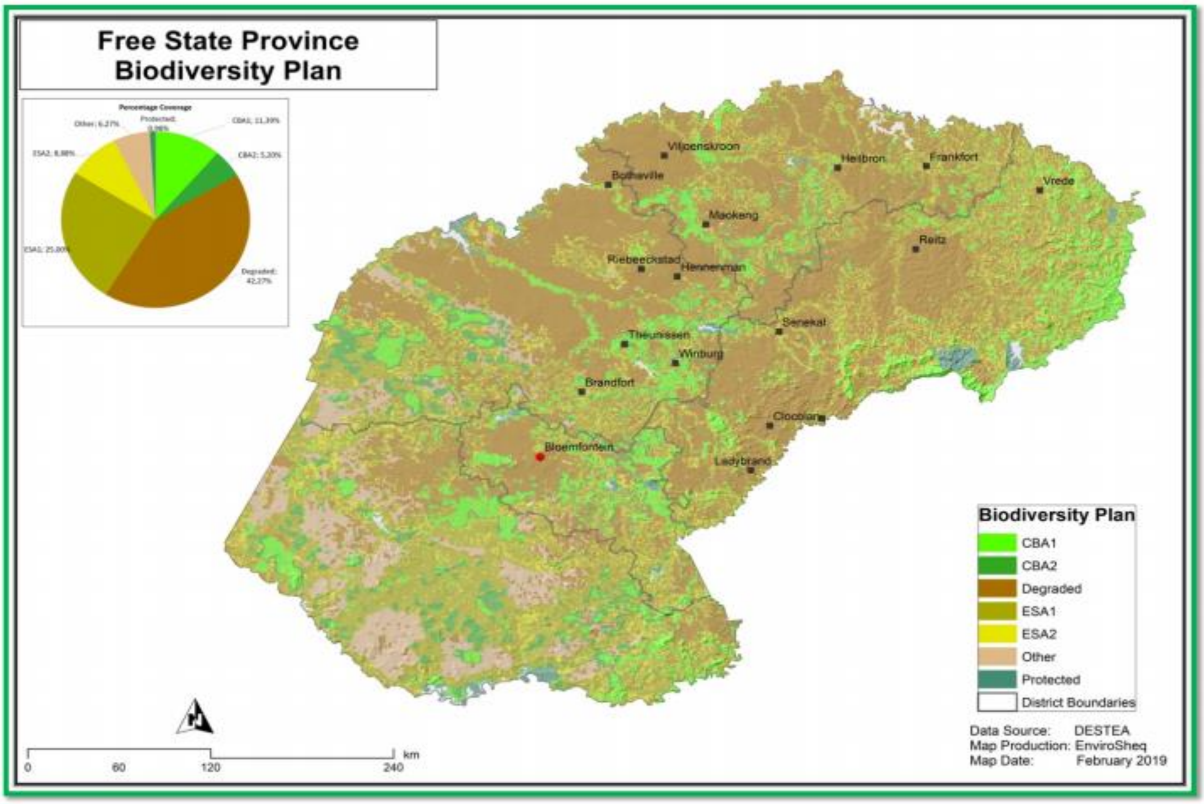


Figure 6 : Biodiversity Plan

The composition of the CBAs provides a summary of the number and percentage of planning units (PUs) per CBA map category. The total and percentage area occupied by the different categories is also provided in the table below.

Table: Total and percentage Critical Biodiversity Area (CBA) categories

Category	nPUs	%PUs	Area (Km^2)	%Area
Protected	2 054	0.97	1 266	1.0
CBA 1 Irreplaceable	17 855	8.5	14 684	11.4
CBA 1 Optional	7 599	3.6	6 707	5.2
ESA 1	46 567	22.2	32 226	25.0
ESA 2	18 899	9.0	11 442	8.9
Degraded	107 796	4.3	8 087	6.3

4.10.1.3 Climate change

Climate includes processes such as precipitation or rainfall, evaporation and temperature that are variable, and can have important implications on runoff, dam storage levels, and supply of water for domestic purposes, rain-fed agriculture, groundwater recharge, forestry, and biodiversity, as well as for maintaining or changing sea levels.

Some quick statistics:
- **2 climate change programs in the province**
- **5 climate adaptation intervention implemented**
- **3 crosscutting projects implemented**

A reduction in rainfall or its variability and an increase in evaporation due to higher temperatures have impacts on the country's scarce water resources. The climate varies from desert to semi-desert in the west to sub-humid along the eastern coastal areas. A number of climate data sets in the province have been used to provide a brief understanding of spatial and temporal variations of some of the most fundamental climate parameters. A total of 13 weather stations were selected and used for data extraction namely Bethlehem WO, Bloemfontein WO, Bloemhof WO, Bothaville-Balkfontein, Fauresmith, Ficksburg, Kimberley, Knellpoortdam, Kroonstad, Vrede, Warden, Welkom, and Wepener.

Rainfall patterns

Rainfall is essential to understanding climatic variability in a catchment and is influenced by temperature and evapotranspiration. The more rainfall experienced in an area, the more runoff is observed. However, not all rainfall translates into runoff as there are other factors that come into play. Spatial distribution of rainfall over the Free State province varies with the eastern part significantly wetter compared to the west. While the latter provides a good perspective on the spatial distribution of rainfall, it is also useful to have an understanding of temporal rainfall variations for each station. Such information is useful in identifying rainfall patterns over a specified period which can be useful in critical future planning decision making.

Examples of some of the observed rainfall patterns –

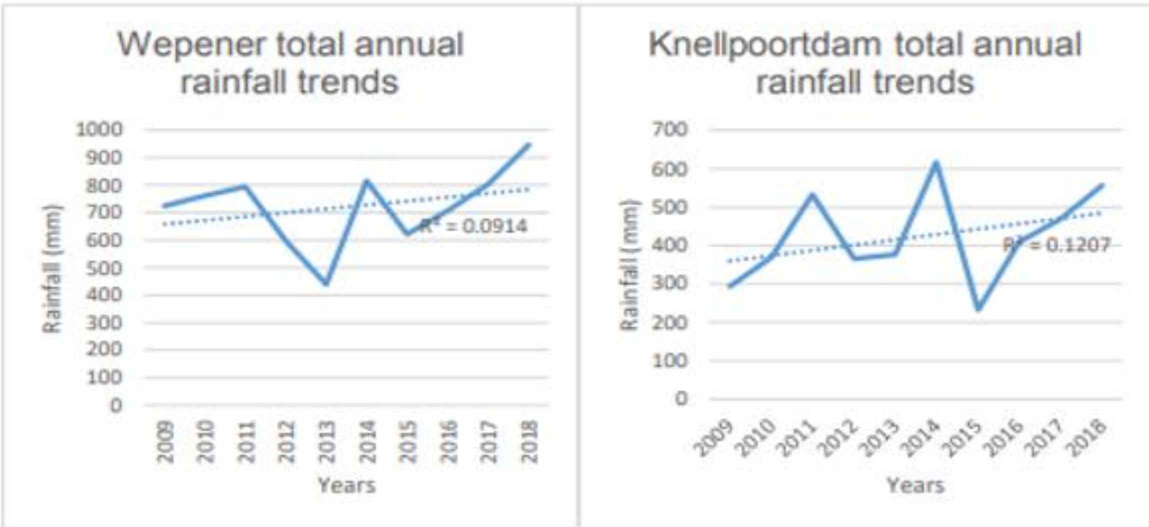


Figure: Weperner & Knellpoortdam annual rainfall trends 2009 – 2018

Increased temperatures could increase the risk of extinction of sensitive species. It will also increase the decomposition rate of organic matter resulting in a decrease in oxygen levels. Higher temperatures can alter stratification and water mixing in reservoirs thus affecting the nutrient balance in the reservoir. This could increase plant biomass and the frequency of algal blooms.

South Africa has been experiencing a warming trend in the past 40 years with the western, northern and the northern eastern parts of the country showing an increase in temperatures. Temperature variations, on different time-scales, play a critical role in most if not all sectors of life. It is therefore important to understand temperature patterns from diurnal, monthly, seasonal, annual timescales and beyond

Examples of some of the observed temperature patterns –

temperatures for each station, for the period 2009-2018.

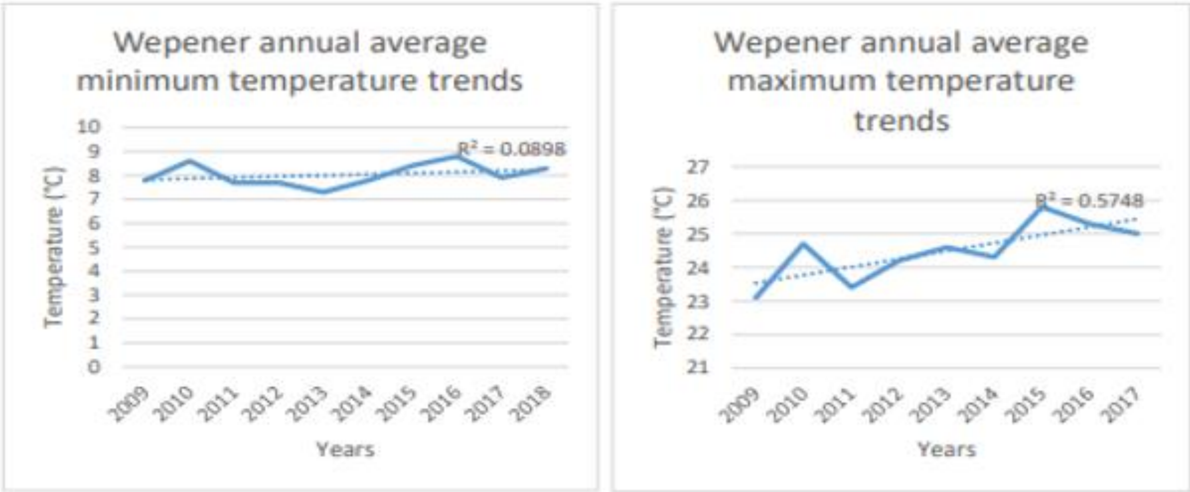


Figure: Wepener annual max and min average temperature trends 2009 - 2018

4.10.1.4 Waste management

The province has seen an overall increase in the volumes of waste managed and reported to the South African Waste Information System from the period of 2015 to the 2019. However, improvements have been made in the volumes of waste collection and recovery.

> **Some quick statistics:**
> - **1 Waste Management program in the province**
> - **1 Waste Management Initiative implemented**

Refuse removal and management is one of the most critical issues in municipal service delivery and can have seriously adverse implications for the environment if refuse is not collected and disposed of properly. Refuse removal and management entails the collection of household and industrial refuse and the management thereof to such a standard that no negative environmental impacts occur. Legislation, defined waste types (e.g. hazardous and non-hazardous) and their management, the selection criteria for establishing waste disposal sites, site registration, etc., needs to be strictly adhered to. Refuse not disposed of at a recognised (registered) waste disposal site is considered illegal dumping. According to the 2011 Census, approximately 62.1 percent of households in South Africa have refuse removed by a local authority or private company.

The provincial profile showed that 4 percent of households have no refuse removal. Looking at variations at district level, Thabo Mofutsanyana district showed the highest proportions of households with no refuse removal facilities (7 percent), while Mangaung district had the lowest proportion of households with no refuse removal (2,5 percent).

The Free State Province has 75 landfill sites. Of these sites, 28 (37%) have old Environmental Conservation Act (ECA) permits, 39 (52%) sites have National Environmental Management: Waste Act licenses and 8 (11%) landfill sites are not permitted nor licensed. 25 landfill sites have been environmentally audited in the 2020/2021 financial year. The information reflected in the table below illustrates the status of the Landfill sites that were environmentally audited in the 2020/2021 financial year in the province.

Summary of landfill status in the Free State province based on the 2020/21 environmental audit		
Name of landfill site	**Status of compliance**	**Challenges**
Allanridge Landfill Site	NEM: WA compliant	• No fence • No gate • No security • No daily covering of waste • No weighbridge
Odendaalrus Landfill Site	ECA Permit	• No fence • No gate • No security • No daily covering of waste • No weighbridge
Reddesburg Landfill Site		• No security or municipal personnel on site • No daily covering or compacting of waste • No weighbridge
Springfontein Landfill Site	NEM: WA compliant	• No security or municipal personnel on site • No daily covering or compacting of waste
Trompsburg Landfill Site	NEM: WA compliant	• No security or municipal personnel on site • No daily covering or compacting of waste • No weighbridge
Ventersburg Landfill Site	ECA Permit	• No security or municipal personnel on site • No daily covering or compacting of waste • No weighbridge
Winburg Landfill Site	ECA Permit	• No security or municipal personnel on site • No daily covering or compacting of waste • No weighbridge

4.10.2 Mpumalanga Province

State of Environment Reporting (SOER) / Environment Outlook Reporting (EOR) provides information on the state of the environment at a specific time as well as trends (i.e. an indication whether environmental conditions are improving or deteriorating). Furthermore, SOER / EOR also highlights the relationship between socio-economic activities and the environment and human well-being. So SOER / EOR reports tell us the state of the environment at a particular time, the factors that are driving environmental changes, the resultant social, economic or environmental impacts of those pressures and impacts, and how we should respond to these. In 2003, the first State of Environment Report for the Mpumalanga province was published by the Mpumalanga Department of Agriculture, Conservation and Environment. The second edition of this report was compiled in 2008, but due to the lack of some critical information, the report was not published. In 2020, the third edition (2018/19) Environment Outlook Report for Mpumalanga Province was published and, although it is not reflected here due to SAE information currency rules, it is available in the archive.

Sustaining the natural environment is essential for sustainable development of the Mpumalanga province. Social and economic human needs and demands are seen as the major drivers of economic and social development activities. These demands contribute to pressures that lead to environmental change. These are referred to as the drivers of change in the natural environment; and are broadly categorised as social and economic drivers. Human activities (driven by socio-economic and cultural needs and demands) often result in unsustainable consumption rates of resources, which exert pressures on the natural environment. A complex relationship exists between the demand for quality resources, resource availability, and the financial and physical constraints of obtaining and managing resources. The natural mineral resources upon which much of Mpumalanga province's economy was built, coupled with socio-economic developments, have resulted in pressure upon the natural resources upon which the province's people and biodiversity depend. Pressures include consumption and extraction of environmental resources (used in the development and delivery of goods and services) and it results in the generation of by-products and waste streams. Extraction and consumption of resources alter the quantity or availability of resources, and the generation of by-products and waste streams affect the quality of such resources, as well as the availability of useable resources, through the discharge, disposal, or treatment of waste. These changes in quality and quantity of resources affect the state of the environment and the environmental resources in the province.

4.10.3 Gauteng province

The following section is an edited extract of the Annual Gauteng Environment Sustainability Report, 2022, and readers are encouraged to read the report for more, in-depth, fully referenced, information on Gauteng's state of the environment.

The section covers the following topics: (i) Air quality management; (ii) Waste management; (iii) Biodiversity management;

4.10.3.1 Air quality management

It is a legal requirement to monitor ambient air quality to assess compliance with ambient air quality standards. Compliance with ambient air quality standards upholds the constitutional right to an environment that is not harmful to health and well-being.

The following air quality management indicators were monitored during the 2022 reporting year:

Number of exceedances per pollutant

The province has prioritised four criteria pollutants that are monitored in most stations and are perceived to be problematic due to a variety of sources in the province that lead to increased concentrations. Below is a snapshot of the legal threshold exceedances on the 4 criteria pollutants monitored.

Table: Exceedances from January to December 2022

Parameter	Averaging period	Maximum Concentration	Allowed Frequency of exceedances	Exceedances recorded
SO_2	24 hour	48 ppb	4	0
O_3	8 hours	61 ppb	11	2551
PM_{10}	24 hours	75 µg/m^3	4	482
$PM_{2.5}$	24 hours	40 µg/m^3	4	473

4.10.3.2 Number of atmospheric emission licences issued

The issuance of Atmospheric Emission Licenses (AELs) is required in terms of the National Air Quality Management Act (NEM–AQA) Section 21 and seeks to control point source emissions from the listed processes/activities through licensing. The Atmospheric Emission License acts as a tool for emission reduction through license conditions and to monitor the trends of stack emission concentration rates. Stack emission sampling results should not exceed the Minimum Emission Standards. Municipalities issue AELs through the web-based System for National Atmospheric Emission Licensing (SNAEL). The figures received from the atmospheric emission licensing authorities indicates that the total AELs issued during 2022 was 109, and the breakdown is as follows: City of Johannesburg issued 9 AELs, City of Ekurhuleni issued 50, the West Rand District Municipality issued 12, City of Tshwane issued 24, Gauteng Department of Agriculture, Rural Development and Environment (GDARDE) issued 4, while Sedibeng District Municipality issued 10. It is important for the Gauteng Department of Agriculture, Rural Development and Environment (GDARDE) to understand the rate at which AELs are issued per municipality as it enables the department to plan for the controls and resources that needs to be put in place to respond to the potential impacts of such industrial development activities in a specific area.

4.10.3.3 Waste management

The Gauteng Waste Information System (GWIS) is a platform where registered and licensed facilities report their waste quantities per the Gauteng Waste Information Regulations (GWIR). The Gauteng Department of Agriculture, Rural Development and Environment (GDARDE) has over the years relied on the facilities registered on GWIS to report accurate data to maintain integrity of the reports. The department undertakes data verification randomly for facilities that are required to confirm accuracy of the numbers reported on the system.

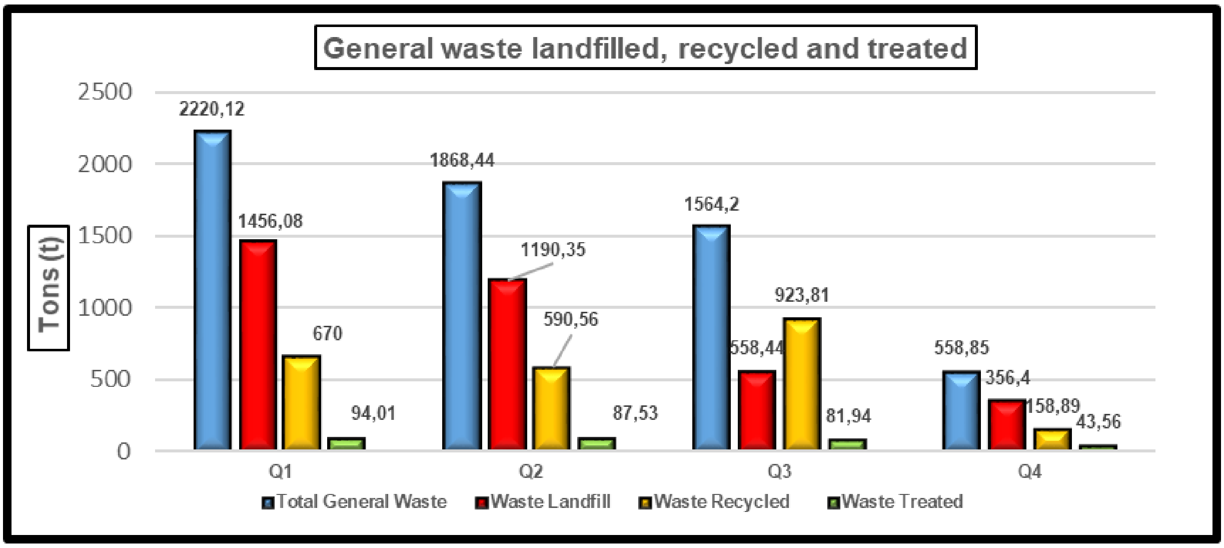


Figure: General waste generated, disposed, diverted, and treated in 2022

Quantity of general waste disposed: During the 2022 reporting period, a total of 6211.61 tons of waste was generated. Out of that, 3561.27 tons of waste was disposed of in landfill sites while a total of 2,343 tons of waste was recycled. It should be noted that the numbers reported above exclude those of the City of Johannesburg which has not been reporting to the GWIS.

General waste diverted from landfill: A total of 2,343 tons of waste was diverted from landfill sites during this reporting period.

General waste treated: A total of 307.04 tons of general waste quantities were treated during the reporting period.

Hazardous waste landfilled: Hazardous waste generated from the province can either be disposed of at Vlakfontein or Holfontein Landfill Sites. Amongst the hazardous waste types reported is the electronic waste which is the most recycled. Others are not reusable but can be treated and recycled/recovered before disposal.

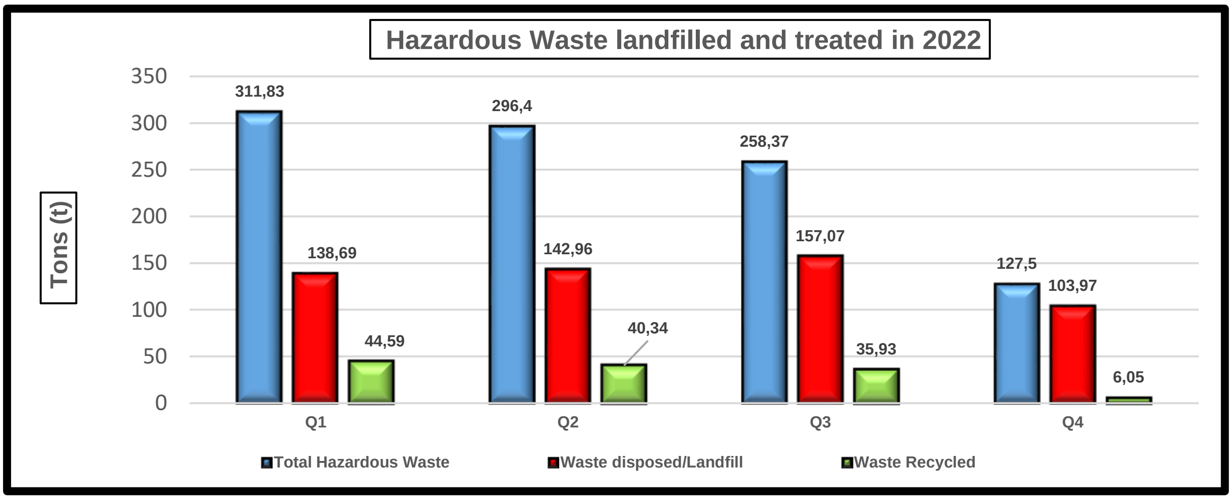


Figure: Hazardous waste generated, disposed and diverted

During the reporting period, the GWIS data reflects that the total hazardous waste quantities generated is 994.1 tons, from which, 542.69 tons of hazardous waste were landfilled.

Hazardous waste recycled: During the 2022 reporting period, the GWIS data reflects that the total hazardous waste quantities diverted from landfill sites is 126.91 tons.

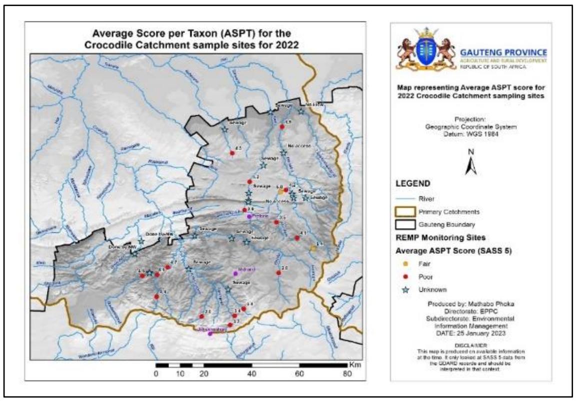
4.10.3.4 Biodiversity management

The following biodiversity management indicators were monitored during the 2022 reporting year.

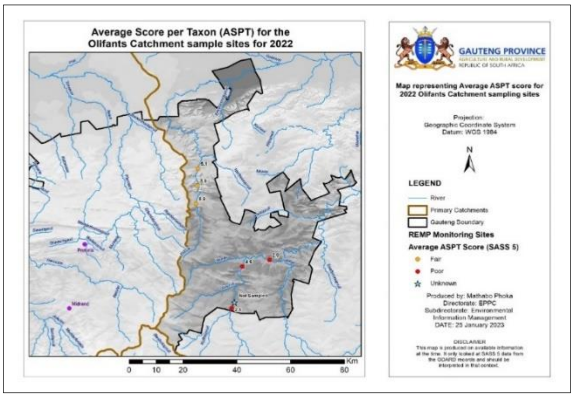
River Eco-Status Monitoring Programme

The River Eco-Status Monitoring Programme (REMP) uses biological indicators such as fish communities, riparian vegetation, and aquatic invertebrate fauna to assess the condition or health of river systems. The rationale for using biological monitoring is that the integrity of biota inhabiting river ecosystems provides a direct, holistic, and integrated measure of the integrity or health of the river.

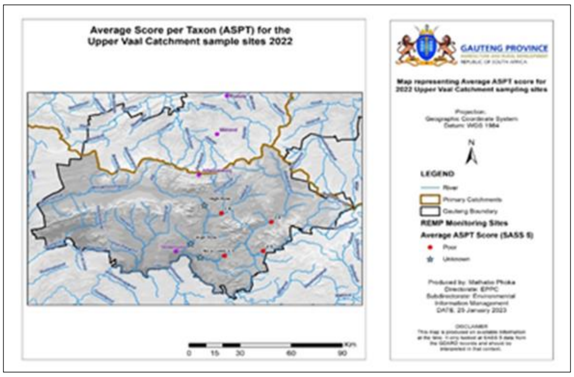
The main rivers monitored are part of the following three catchments –



- **Crocodile (West) catchment:** there are 37 sampling points in this catchment, with 22 points not sampled at all during the 2022/2023 period for various reasons stated below while two are sampled by North-West province. The catchment is highly developed with industrial, mining, and agricultural sectors highly dependent on water resources within the WMA. The results below are an indication of a generally poor state of rivers in the catchment, almost all sampling sites in all sampling seasons produced results that are below 5 which is of poor river health except for the Pienaars - A2Pien-Tiege which depicted an improved river health during the spring, summer, winter and autumn sampling periods. On the fish monitoring, a variety of fish species such as Straightfin Barb, Largescale Yellowfish and Sharptooth Catfish were found.



- **Upper Olifants catchment:** is the eastern Part of Gauteng rivers and some of its tributaries, notably Elands River, Wilge River and Bronkhorstspruit, rise in the Highveld grasslands. The upper reaches of the Olifants River Catchment are characterised mainly by mining, agricultural and conservation activities. Over-grazing and highly erodable soils result in such severe erosion in the middle section that, after heavy rains, the Olifants River has a red brown colour from all the suspended sediments. Out of a total of seven sampling points, only one sampling point was not sampled throughout the sampling period. Three sampling points in Doorn River had a fair and good average score above 5 while the other one in Klipe had a poor average score below 5 and Sprin rivers had a fair average score. On the fish monitoring programme, a variety of fish species such as Shortspine suckermouth, Banded Tilapia and Southern mouthbrooder were found.



- **Upper Vaal catchment:** During the 2022/2023 sampling period, data could be collected from four sampling points, no data was collected from three points in C2suik-Zwart, Badfo, Klip-slang. The results from the sampled points indicate a deteriorating health of the river with the ASPT score of below 5. On the fish monitoring programme, a variety of fish species such as Moggel, Mosquito Fish, Banded Tilapia as well as the Small mouth Yellowfish, Largemouth Bass and Sharptooth Catfish were found. No red data fish in the catchment were recorded during the surveys, however all other sensitive, rheophillic species were recorded and were widespread from the three catchments. In addition, invasive fish such as Micropterus salmoides and Gambusia affinis were also recorded from the Upper Vaal and Upper Olifants catchments respectively.

Multi-species threats to indigenous fauna in Gauteng

South Africa has an international obligation to conserve waterbirds and their habitat. Coordinated Waterbird Counts (CWAC) were conducted biannually at 49 wetlands (some comprising multiple waterbodies) across the province to assess the health of populations. Threats to habitat and species were noted.

128 indigenous and alien species of water-associated birds from three trophic groups which are vertebrates, invertebrates and mixed feeders with a large vegetable component have been recorded during counts within the Gauteng network to date. Numbers of Red-knobbed Coot, African Darter, Blacksmith Lapwing, Three-banded Plover, Little Grebe, Southern Pochard, Squacco Heron, Cape Wagtail and Yellow-billed Duck declined below long-term (i.e., ≥ 5-year) thresholds of potential concern at some sites. Good rainfall in 2021 and 2022 increased the abundance of small, temporary waterbodies in the region. This, together with high water levels and tall shoreline vegetation at more permanent sites may account for dispersal of some of these species to sites outside of the monitoring network.

Numbers of Three-banded Plover, African Sacred Ibis, Cape Shoveler, Cape Teal, Black-winged Stilt and Whiskered Tern declined below their respective short-term (i.e., 5-year) provincial thresholds of potential concern across the monitoring network. The declines in numbers of Three-banded Plover at Bronkhorstspruit Dam in the summers of 2021 and 2022 were not compensated for by corresponding increases at other sites within the network. This suggests that regional scale drivers rather than site-specific wetland conditions may be responsible for the decline. The species is a potential indicator of shoreline conditions and generally good rainfall in Gauteng in 2021 and 2022 reduced the extent of shallow open water and mudflats used by this species at Bronkhorstspruit Dam and elsewhere in the monitoring network. Numbers are expected to increase when water levels fall.

Cape Shoveler and Cape Teal are both relatively uncommon within the monitoring network averaging below 350 and 50 respectively in summer and winter over the last five years. There were no consistent patterns amongst sites with some recording influxes while numbers at others declined. Movements are not well understood but in the case of the Cape Shoveler, it may be a response to food availability, though, both species appear to prefer shallow, saline pans and dams and nutrient rich waterbodies.

Black-winged Stilt were also relatively uncommon over the last five years averaging just 106 for summer and 108 for winter across the monitoring network. This species may be found at a wide variety of natural and man-made wetlands including nutrient rich seeps resulting from sewage spills. Movements are poorly known but the species responds to changing water levels moving to areas that have recently flooded and where water levels are subsiding creating good foraging conditions and leaving when water levels get too high.

Whiskered Tern numbers have declined by an order of magnitude since 2018 with fewer than 70 recorded across the monitoring network in summer 2022. Bronkhorstspruit Dam, Bullfrog Pan, Klipdrift Dam, Roodeplaat Dam and Marievale Bird Sanctuary are the only sites that have supported 50 or more individuals during the past five years with a maximum of 190 recorded at Klipdrift Dam in 2019. The reason for the decline is unknown but preliminary data for summer 2023 suggests that numbers within the network may have increased.

The biomass of all three trophic groups was relatively stable between 2021 and 2022 and remained above the respective short-term threshold of potential concern (STPC) for each group in summer and winter. This suggests that any population declines at individual monitoring sites were compensated for by increases in biomass of species in the same trophic groups either at the same site or elsewhere in the network.

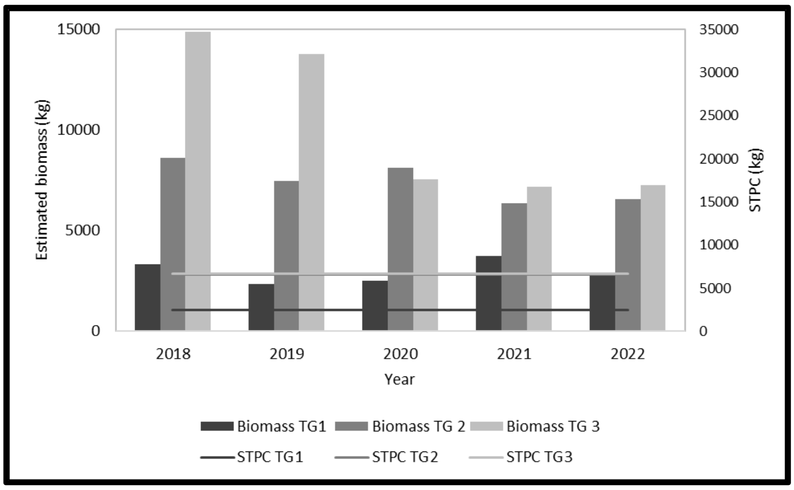


Figure: Summer biomass of waterbird trophic groups at monitoring sites in Gauteng, 2018-2022

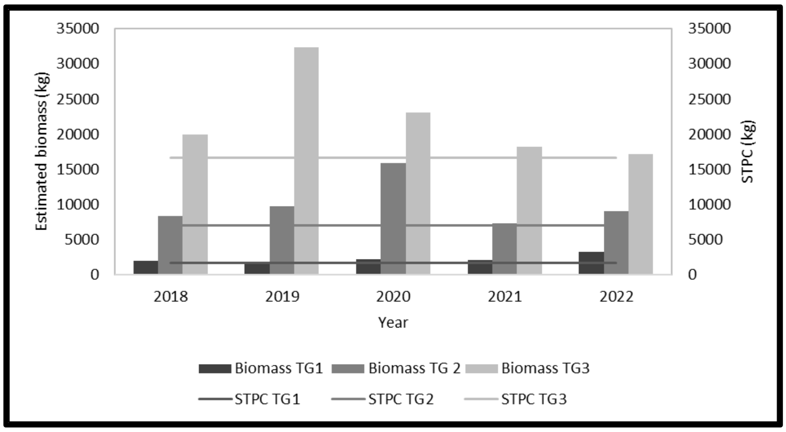


Figure: Winter biomass of waterbird trophic groups at monitoring sites in Gauteng, 2018-2022

Species change (mammal,plants, birds, species vs population data)

To understand the risk of each species becoming extinct and to prioritise conservation efforts and allocate scarce resources effectively, species are categorised in red lists. This process was established by the International Union for the Conservation of Nature (IUCN) and its purpose is to objectively categorise the probability of extinction for all species on the planet and is obtained through assessments carried out through networks of stakeholders pooling their expert knowledge. Red lists have become the backbone of global species conservation as a unified and standardised protocol to measure biodiversity loss and inform policy decision and development.

- **The Juliana's golden mole (*Neamblysomus julianae*)** is a South African endemic species and is known from only three geographically isolated and range-restricted subpopulations in South Africa, two of which occur within protected areas (Nysvley provincial nature reserve in Mpumalanga and the Kruger National Park in Limpopo) and the third occurring along the Bronberg ridge, east of Pretoria in Gauteng. The Bronberg Ridge subpopulation, is treated as a distinct subpopulation, and has been classified as Critically Endangered, due to no evidence of gene flow between the other two subpopulation. Golden moles are fossorial species, which means they have adapted to primarily living underground. Unlike other fossorial species, they do not have powerful tunnelling abilities and are consequently restricted to the softer sand soil types and subsequently are not evenly distributed throughout their geographical range and occupy very specific smaller components of their available habitat.

- **Oribi (*Ourebia ourebi ourebi*)** is a near-endemic species with a patchy distribution throughout the southern part of its African range. It is globally listed as Least Concern while in the southern African sub-region it is listed as Endangered. The South African population is estimated to have declined by approximately 13% over three generations. Within Gauteng, Oribi is found in several formally protected areas and also on private land within the grassland biome. Due to its elusive nature and low-density occurrence, there has been no targeted monitoring of the species in recent years. Information on the presence, absence and distribution of the species within the Suikerbosrand nature reserve is obtained from incidental sightings of the species during other biodiversity monitoring activities (e.g., game counts, nocturnal counts, co-ordinated Ungulate Distribution Assessments (CUDA)). This allows for the mapping of distribution and habitat preferences for the species within the reserve. Oribi at Suikerbosrand nature reserve occurs at very low densities of 0.1 – 0.4 animals/ km^2 and the current population is stable.
- **The Southern Mountain Reedbuck/ Mountain reedbuck (*Redunca fulvorufula*)** is the only species of Mountain reedbuck found in the Southern African subregion and is globally listed as Least Concern (while in the southern African subregion, it is listed as Endangered). The species is near endemic to the southern African subregion and is patchily distributed and restricted to rocky and grassy hillsides. In Gauteng, the

extent of the population is not known but is known to occur in the provincially managed Suikerbosrand nature reserve and has been sighted in other private properties. At Suikerbosrand, the species distribution is derived from data collected during nocturnal mammal surveys, CUDA and aerial game counts. Species specific monitoring has been initiated and this will allow for close estimates of the population size.

- **Black rhinoceros, *Diceros spp.*** are one the most charismatic large mammals in the world and are part of the tourists' Big Five. The species is endemic to Africa and the Southern-central black rhinoceros sub-species, *Diceros bicornis minor* (hereafter black rhino) has South Africa as its stronghold, after being extirpated in other African countries within its natural habitat range. In Gauteng, the species is found in a few municipal and private nature reserves and as a high value species, owners provide high protection for the species.
- **Spotted-necked otter (*Hydrictis/Lutra maculicollis*) and Cape clawless otter (*Aonyx capensis*):** The two species of Otter confirmed to occur in Gauteng are listed under different red list categories, with the Spotted-necked otter (*Hydrictis maculicollis*) listed as Vulnerable and the Cape clawless otter (*Aonyx capensis*) listed as Near Threatened. The two species are predominantly aquatic and seldom found far from permanent water, with the Spotted-necked otter more aquatic than its counterpart. They have a generic preference of fresh water with an abundance of fish and crabs, which make up the bulk of their diet.
- **The White-tailed rat (*Mystromys albicaudatus*)** is a small mammal that is endemic to South Africa and Lesotho. The species is a grassland specialist and is listed as Vulnerable in the Mammal Red list. Its distribution is extremely patchy and fragmented due to its preference for microhabitats within the grassland biome. No empirical population estimates or trends are available as the species is one of the rarest species encountered and infrequent capture rates during surveys indicate that population size is low.

4.10.4 KwaZulu-Natal province

The following section is an edited extract of the KwaZulu-Natal State of Coasts Report 2022, and readers are encouraged to read the report for more, in-depth, fully referenced information on the state of KwaZulu-Natal state of coasts.

4.10.4.1 KwaZulu-Natal state of coasts

Worldwide, coasts are regarded as an important environment for human settlement, recreational activities, and access to numerous resources. It is estimated that the average population density in coastal areas is approximately 80 persons per square kilometre, twice that of the world's average population density. Predictions indicate that coastal populations will continue to grow, driven by natural population increase, as well as in-migration to coastal areas. A growing population puts the coastal environment under pressure from urban encroachment, pollution, water extraction and over-exploitation of resources. KwaZulu-Natal's (KZN's) coastal zone is no exception, being sought after for tourism, recreation, residential and industrial development. As such, it is important to understand the drivers of change and manage potential impacts on the KZN coastal environment.

The KZN province, situated on the east coast of South Africa, is known as the garden province due to its green spaces and abundant plant and animal life. It is home to a cosmopolitan population with a wide mix of cultures. The KZN coast extends some 580 kms from the Mozambique border in the north, to the uMtavuna River bordering the Eastern Cape Province in the south; to the east it is bordered by the warm Indian Ocean. It is intersected by 76 of South Africa's 290 estuaries and is home to the St Lucia system, the largest and one of the most important systems in South Africa.

The coast is regarded as a national asset and legacy for future generations. This makes management measures of the utmost importance for the promotion of its current and future sustainable use. To facilitate this management, the Integrated Coastal Management Act (ICMA), (24 of 2008 and Amendment 36 of 2014) outlines roles and functions for all spheres of government and places the onus on provincial authorities to report on the state of the coastal environment every four years, through the development of a State of the Coast Report (SOCR). The SOCR aims to provide decision-makers with current data and information about the state of the KZN coast. It should identify emerging problems and guide management actions such as conservation, development planning and legislation going forward, in support of sustainable targets for development.

The SOCR is therefore a statutory requirement intended to acquire practical knowledge on the current state of the coastal environment, the condition, trends, and pressures ecosystems are exposed to, with the aim of informing future management decisions. It should identify emerging problems and guide management actions such as conservation, development planning and legislation going forward. A key output of this initial SOCR is to identify data gaps and monitoring needs.

4.10.4.2 Summary of KZN state of coasts

The State of the Coast Report, 2022 presents key findings relating to the state of the KZN coastal zone, according to the following seven main themes: (i) Overarching; (ii) Climate variability; (iii) Coastal environment; (iv) Marine environment; (v) Economic environment; (vi) Human environment; and (vii) Governance. Several cross-cutting issues can be identified which may have the potential to greatly disrupt the normal processes. Examples include climate change, coastal sand winning, oil and gas exploration and changes in human settlements. In addition, possible emerging issues, such as water quality and new diseases relating to mariculture and mining operations may be encountered.

The development of this SOC report allows for the identification and prioritisation of management interventions towards sustainability in the coastal zone. Priority actions are targeted at specific issues so that KZN best meets its obligations in terms of the ICM Act and the Provincial Coastal Management Programme (CMP). These key actions are outlined in tables in the following sections. The actions detailed speak to the impacts and state of the seven spheres and should be considered in the development of coastal management and monitoring programmes going forward.

Overarching drivers

			Outlook		
Sphere	Topic		State	Trend	Key Actions
OVERARCHING DRIVERS	The Blue Economy				• Review of Operation Phakisa: 2014 Ocean's Economy programme. • Introduction of cleaner energy alternatives. • Evaluate viability to desalinate sea water for use on land.
	Human Settlements				• National imperatives are the provision of housing, water and sanitation - these need to be carefully managed to ensure impacts on the receiving natural environment are minimised.
	Pollution				• Improve development and maintenance of sewerage infrastructure. • Re-instituting the Green Drop programme – will ensure systems in place to monitor wastewater treatment works. • Regular, systematic monitoring of receiving waters. • Marine laboratory capability must be improved. • Litter boom projects and litter clean-ups are important. • Paradigm shifts regarding waste: in the way we generate, dispose and accept responsibility for solid waste.

Climate variability

			Outlook		
Sphere	**Topic**		**State**	**Trend**	**Key Actions**
CLIMATE VARIABILITY	Climate Change		Moderate	Stable	• Determine a preliminary risk assessment of sea-level rise related impacts for KZN. • The risk lines associated with scenarios of sea-level rise, that inform the CMLs, are important.
	Extreme Events		Moderate	Stable	• Monitoring system for early warning of weather / storm events. • Stricter development controls: reduce the number and value of buildings and non-essential infrastructure. • Shoreline management plans (reports) implemented by all municipalities. • Investigate sand replenishment methods.
	Oceanographic Events		Moderate	Stable	• Long term in-situ observations of the Agulhas Current are needed to better understand its behaviour and its response to anthropogenic climate change (This could be a student project).

Estuarine environment

			Outlook		
Sphere	**Topic**		**State**	**Trend**	**Key Actions**
ESTUARINE ENVIRONMENT	Estuaries		Poor	Declining	• Compliance is inadequate and enforcement with legislation is poor. • The Ecological Water Requirements (EWR) and estuarine flow requirements for KZN estuaries are a priority. • All existing discharges to estuaries should comply with the provisions of the ICM and the National Water Acts. • Estuary Working Group to be established to provide scientific and technical support to committees that report to national structures. • Seventy percent of KZN estuaries do not have plans for formal management – authorities need to act. • "Protocol for Requests to Breach Estuary Mouths in KZN: Mouth Maintenance Management Plans" needs to be implemented effectively. • New developments should be set well back from the EFZ, also to mitigate against the climate change risks of flooding and sea level rise and should consider the CMLs. • Water quality monitoring under the National Estuarine Monitoring Programme (NEsMP) of the Department of Water and Sanitation established in 2008 must be re-initiated.
	Mangroves		Poor	Declining	• Protection of existing stands of mangroves – regular reporting on status, diversity, blue carbon. • Research is needed to quantify the importance of our mangrove ecosystems as blue carbon sinks. • Specific local conservation actions - e.g., mouth management plan and freshwater baseflow allocation to Mlalazi Estuary. • All mangrove habitats in KZN should be considered critically endangered ecosystems and managed accordingly.
	Submerged Macrophytes		Poor	Declining	• Status of submerged macrophytes documented - track the health and survival of submerged macrophytes (Kosi, St Lucia, uMhlathuze and uMgobezeleni estuaries). • Restoration efforts must focus on establishing riparian buffer zones, maintaining normal marine connectivity and control nutrient input (plans to be approved by EDTEA).

Coastal environment

			Outlook		
Sphere	Topic		State	Trend	Key Actions
COASTAL ENVIRONMENT	Sandy Shores		Moderate	Declining	• Municipalities need to restore and maintain coastal ecological infrastructure. • Re-establish natural sand supplies to the coast to replenish sand-starved beaches (where possible). • Identify ecological or biological indicators that monitor beach health in addition to the physical metric of coastal development and other landcover change.
	Swamp Forests		Poor	Declining	• A report on Swamp Forest cover should be tracked through focused monitoring that quantifies change in habitat area and species composition. • A report on factors driving change, such as those related to human activities, should be incorporated to identify cause-effect relationships. • Education and awareness can be improved: signboards at all sites and citizen science participation to ensure ownership and protection (possibly through a student project).
	Rocky Shores		Moderate	Declining	• Improved management of rocky shore subsistence fisheries is needed. • Management interventions are needed at Isipingo: wastewater effluent and increased plastic pollution are affecting rocky shore communities. • Long-term monitoring at rocky shore sites is required – report on status, use, compliance annually. • Biomonitoring is required to monitor indicator species for water quality and heavy metal pollution.
	Coastal Lakes		Poor	Declining	• A strategic conservation plan for coastal lakes needs to be developed and adopted. • A protocol for developing Lake Management Plans (comparable with EMPs) must be established. • Identify and protect buffer areas around lakes (such as the EFZ and CMLs). • Address compliance and enforcement, which at present is weak. • Environmental water requirement studies for coastal lakes. • Systematic monitoring of lakes needed to consider a wide range of factors.
	Wetlands		Poor	Declining	• The 500 m buffer needs firm enforcement and extension where needed – status report and compliance needed. • Reports on groundwater are required to better map groundwater compartments and determine accurate water budgets.
	Coastal Vegetation		Poor	Declining	• The CBD targets should be implemented, particularly target 5 (by 2025), which requires extensive governmental interaction across all sectors and stakeholders. • CBD targets adopted, remaining vegetation types identified and documented. • Protected Area expansion should occur in vegetation types that are not adequately protected.

Marine environment

Sphere	Topic		Outlook: State	Outlook: Trend	Key Actions
MARINE ENVIRONMENT	Coral Reefs		Moderate	Declining	• Monitoring of proposed indicator organisms and trends in the levels of the OCPs to arrive at sensible responses to and mitigation of this pollution. • Greater enforcement and compliance and an improved system of closed sanctuaries. • International adherence to IPCC recommendations to mitigate climate change. • Report on overall management plan including OCP, DDTT, compliance and IPCC recommendations.
MARINE ENVIRONMENT	Rocky Reefs		Moderate	Stable	• Ongoing invertebrate catch statistics monitoring - provides background information on trends and informs management recommendations to ensure their sustainable harvest. • Research needed for long-term monitoring of the marine invertebrate resources.
MARINE ENVIRONMENT	Soft Sediments		Moderate	Declining	• Improving foundational biodiversity knowledge of smaller invertebrates. • Detailed mapping of physical features, sediment distribution and soft-sediment habitats to inform Critical Biodiversity Area (CBA) maps. • Support new generations of marine taxonomists. • Fluvially-dependent marine sediment ecosystems must receive vital quantities and good quality of freshwater. • Cross-sector and cross-realm plans need to be developed and consider the coast-marine connectivity. • Fisheries management plans for fishing in soft-sediment habitats. • Climate change impacts: strategy for detecting and monitoring change. • Awareness campaigns to communicate KZN's soft sediment biological assets and value are needed.
MARINE ENVIRONMENT	Pelagic Environment		Moderate	Stable	• Annual detailed report on pelagic landings, marine mammal monitoring, turtle nesting and other vulnerable species. • Research into the understanding of the Agulhas Current. • Long-term in situ monitoring, remote sensing and improved ocean models.

Human environment

Sphere	Topic		Outlook: State	Outlook: Trend	Key Actions
	Coastal Access		Moderate	Stable	• Municipalities to report on status of coastal access. • Provincial government to assist local municipalities with monitoring and regulating coastal access.
HUMAN ENVIRONMENT	Small-scale Fisheries		Poor	Declining	• Government needs to provide sufficient management capacity to effectively support and manage the SSF. • Effective monitoring programme to understand impact of harvesting by SSF communities on targeted resources.
HUMAN ENVIRONMENT	Recreational Fishing		Moderate	Stable	• Ensure the health of fish and invertebrate populations by protecting key habitats. • Improve angler awareness and compliance – marketing strategy developed and implemented. • KZN-MPAs need to have proper management plans. • A well-designed angler awareness programme is required to ensure that anglers understand the rationale behind fishing regulations and to ensure improved compliance.
HUMAN ENVIRONMENT	Boat-based Activities		Moderate	Stable	• The KZN BLSMS should be maintained. • The number of scuba diving operators permitted within MPAs should be managed based on the capacity of diving reefs. • Permit fees from both the diving operators and diving information documented – annual report.

Economic environment

Sphere	Topic		Outlook: State	Outlook: Trend	Key Actions
ECONOMIC ENVIRONMENT	Commercial Fishing		Poor	Declining	• The recent promulgation of MPAs provides reasonable protection for several marine ecosystems. • Inadequate compliance and monitoring of commercial fisheries generally – requires an annual report.
	Coastal Dune Mining		Moderate	Stable	• Monitoring and enforcement of this legislation remains key. • To unlock the post-extraction, downstream value chain of titanium, there needs to be significant investment into research and development facilities (Review and prospects).
	Sand Mining		Poor	Declining	• Clarity over management of environmental best practice, responsibility and enforcement of remediation of sites. • Environmental best practice should be adopted and after mining, remediation of the site should be enforced. • Consistent environmental monitoring is required. • Detailed quantitative investigations are required on the biophysical effect of sand mining in the local context.Increased public awareness - develop media campaigns. • Detailed mining inventories are required - to inform the scale of mining pressure on aquatic coastal systems. • Technical report on sustainable alternative materials for use in industry and construction.
	Offshore Mining		Moderate	Declining	• National protocols and procedures finalised (Green Paper).
	Oil & Gas Exploration		Moderate	Declining	• Ongoing efforts to improve legislation and regulations pertaining to offshore hydrocarbon minimisation and green products are required. • Needs to be a phase-out of all fossil fuel usage. In keeping with the Paris Agreement, to limit warming to 1.5-2°C. • There should be no new developments aimed at hydrocarbon extraction; to negate the knock-on effects of extraction.
ECONOMIC ENVIRONMENT	Ports & Shipping		Moderate	Improving	• Environmental management plan for ports is available and should be supported. • Issues related to pollution are being addressed through the ICCMSBW and the South African drafted Ballast Water Management Bill (2013).
	Tourism		Moderate	Improving	• A achievable target for KZN tourism is keeping the number of KZN's Blue Flag beaches (Blue flag inventory). What requires careful management is the provision of additional services such as ablution and parking facilities. • Coastal tourism strategy report and public awareness campaigns are needed.
	Aquaculture		Moderate	Stable	• South Africa's current environmental legislation is sufficient to manage the aquaculture sector. • Provision must be made to incorporate better management practices as pressure increases to develop the sector in KZN. • Effective monitoring of operations will be key to growing the KZN aquaculture sector in an environmentally sustainable manner (Review and update past reports).
	Agriculture		Moderate	Stable	• Future growth of the Agri-business sector needs to be managed to ensure long-term sustainability and reduced impacts on the natural environment. • Land reform is a key factor to be addressed in terms of agricultural lands. • Diversification in farming is critical. • A broader approach to agriculture by fostering the small-scale farming sector through strengthened technical support is needed. • A report on small scale farming supported as a viable alternative needed.
	Manufacturing & Industry		Moderate	Improving	• The department responsible for Economic Development has endeavoured to develop industry-oriented interventions to stimulate the local economy. Report on developing IEH as a way of driving industrial development throughout KZN – this needs to consider the needs of the receiving environment.

Governance environment

			Outlook		
Sphere	Topic		State	Trend	Key Actions
GOVERNANCE ENVIRONMENT	Coastal Management				• Improved coastal management for KZN is critical – this requires additional human and financial resources. • Develop a marketing plan to ensure stronger advocacy - urgent action is required and improved political will. • Re-establishment of the KZN PCC and technical sub-committees is imperative.
	Marine Protected Areas				• The focus must be on developing and implementing effective management plans. • Monitoring programmes to determine MPA effectiveness.

4.10.4.3 Actions and way forward

The following section is an edited extract of the KwaZulu-Natal State of Coasts Report, 2022 and readers are encouraged to read the report for more, in-depth, fully referenced information on the state of KwaZulu-Natal state of coasts.

Governance

Human and financial resources are critically needed to improve coastal management and the management of critical ecosystems within KwaZulu-Natal (KZN). Funds need to be made available for building capacity for critically under resourced and under skilled areas such as marine laboratory personal and training for the next generation of marine scientists and managers.

Current governance frameworks are under resourced. Greater enforcement of legislation is important in improving overall governance and compliance. Additionally, governance frameworks need to be clear: Who is responsible for management, inspection, and enforcement. National protocols and procedures must be put in place to ensure that due process and international best practice is followed. Provision must be made to incorporate better management practices as pressure increases to develop the sector in KZN. Management plans need to be developed in accordance with the Integrated Coastal Management Act, however greater attention and funding needs to be given to compliance and enforcement of these plans. Of critical importance is the that the KZN Provincial Coastal Committees (PCC) and sub-working groups need to be re-established, these bodies can guide, advice on and province scientific support for the implementation of such plans for the KZN province.

Awareness and education

Awareness, education, and knowledge sharing are critically important to improving the overall understanding as to the value of the coastal environment, its ecosystems, and resources. There are several ways, such as signage at key sites, training on topics relating to legislation and policy, but importantly we need to instil change in the thinking around our coastal environment, its recourses, and our impact on this environment. There needs to be a paradigm shift as to the way we generate, dispose, and accept responsibility for solid waste. Awareness campaigns also need to highlight specific coastal ecosystems and their value, such as coastal lakes, estuaries, soft-sediments, mangroves, sandy shores etc.

Planning

Climate change projections highlight increased risk for coastal areas, thus planning for future risk through the determination and enforcement of Coastal Management Lines (CMLs) for the coast and estuaries is imperative in reducing risk to infrastructure and properties. The implementation and enforcement of this, while challenging, is critical and any new developments need to comply with CMLs and buffer zones. Additionally, new developments need to consider process linkages and biological connectivity of coastal and marine ecosystems. Many coastal ecosystems require detailed mapping to ensure better long-term management and spatial planning. Measures to replenish sand need to be critically assessed and implemented, both coastal and marine ecosystems are being adversity affected by the quantities and quality of sediment. Where possible, natural sand supplies should be reinstated and better maintained, while in their absence alternatives need to be considered, planned and budgeted for. Importantly, authorities need to take urgent action against illegal sand mining operations.

Maintenance of infrastructure

Coastal areas are being adversity affected by poorly managed infrastructure daily. Examples include failing sewage infrastructure and collapsing shore defence measures. It is therefore imperative that resources be allocated to the development and maintenance infrastructure. Importantly, waste removal services to coastal community need to be improved and existing discharges to estuaries need to be improved to comply with the provisions of the Integrated Coastal Management and the National Water Acts.

Long-term monitoring

Long-term monitoring is critical for better understanding the state of, and changes to coastal ecosystems and resources. It is important that authorities allow financial resources for long-term monitoring. Core monitoring highlighted in the SOCR, 2022, but not limited to, include:

- Monitoring at rocky shores to identify status and trends;
- Monitoring key estuaries to track the health of submerged macrophytes;
- Monitoring of levels of Organochlorine Pesticides (OCPs) pollution;
- Monitoring of indicator species for water quality and heavy metal pollution;
- Monitoring to determine Marine Protected Area (MPA) effectiveness;
- Monitoring of harvesting by Small Scale Fishery (SSF) communities to manage targeted resources;
- Monitoring invertebrate catch statistics;
- Monitoring of swamp forest cover to quantify change in habitat area and species composition;
- Monitoring of commercial fisheries compliance needs to be increased;
- Monitoring and regulating coastal access is needed;
- Monitoring of estuaries – health status, extent and distribution of habitats, alien species, indigenous species, resource species;
- Monitoring wastewater treatment works, especially the critical reinstitution of the Green Drop programme, and regular, systematic monitoring of receiving waters;
- Long-term in-situ observations, remote sensing, and improved ocean models of the Agulhas Current is needed;
- Systematic monitoring of lakes is required and needs to consider a wide range of factors; and
- The KZN Boat Launch Site Monitoring System (BLSMS) should be maintained to ensure ongoing monitoring of boat launching activities.

4.10.5 North West province

This section is an edited extract of the North West Climate Change Risk and Vulnerability Report, 2021; and the North West GHG Emission Inventory, 2020 reports and readers are encouraged to read these reports for more, in-depth and fully referenced information.

4.10.5.1 Provincial overview

The North West Province is known as the “platinum province”, a name derived from the abundance of the metal found there with approximately 50 percent of the world’s platinum mined in the province. The North West is landlocked and located along the northern border of South Africa, neighbouring Botswana to the north, and the South African provinces of Limpopo to the north-east, Gauteng to the east, Free State to the south, and Northern Cape to the south-west. The province covers an area of approximately 110,000 square kilometres and its capital city is Mahikeng. Major towns include Brits, Klerksdorp, Lichtenburg, Potchefstroom, Rustenburg and Vryburg.

4.10.5.2 Climate risk and vulnerability assessment

The North West Climate Change Risk and Vulnerability Report, 2021 identifies the four key climate change hazards that threaten the province; and analyses the province’s core economic, social, and environmental sectors to better understand how climate change will impact on the families, communities and people of the North West province. Drawing on evidence, the report identifies rising temperatures, increasing rainfall variability, increasing periods of drought, and increasing storms and flooding events as the key climate change hazards facing the North West.

To appreciate how these hazards will affect different sectors, the report documents the exposure to climate change of each sector; the impacts on sectors as a result of climate change; the sensitivity of each sector to climate change and finally the capacity of each sector to adapt to climate change.

Summary of North West Province's climate risk and vulnerability assessment

Sector	Level of Concern	Sensitivity	Adaptive Capacity
Ecosystems	High Concern	high sensitivity	low to medium adaptive capacity
Rural Livelihoods	High Concern	high sensitivity	low adaptive capacity
Urban Livelihoods	Medium Concern	medium sensitivity	low to medium adaptive capacity
Agriculture	Medium Concern	high sensitivity	medium adaptive capacity
Tourism	Medium Concern	high sensitivity	medium adaptive capacity
Mining	Medium Concern	high sensitivity	medium adaptive capacity
Water supply	High Concern	high sensitivity	low adaptive capacity
Energy supply	Medium Concern	high sensitivity	medium to high adaptive capacity
Transport	High Concern	high sensitivity	medium adaptive capacity
Waste management	High Concern	high sensitivity	low adaptive capacity
Human health	High Concern	medium sensitivity	medium adaptive capacity
Disasters resulting from extreme weather	High Concern	high sensitivity	medium adaptive capacity

Ecosystems

Ecosystems consist of terrestrial (land-based) ecosystems such as forests, grasslands and deserts, and aquatic (freshwater) ecosystems such as rivers, lakes and wetlands. The Ecosystems sector is of High Concern due to the following reasons:

Exposure: The Savanna Biome covers about 70 percent of the North West's terrestrial area, and the Grassland Biome covers the rest. The North West includes the Barberspan wetland, the Kgaswane Mountain Reserve and part of the Griqualand West Centre of Endemism.

Impacts: Ecosystems are expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Increased average temperatures may lead to land degradation and affect biodiversity;
- Increased rainfall variability can lead to severe periods of drought and increased number of fire-danger days; and
- Deterioration of water quality may threaten aquatic ecosystems.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's ecosystems as having high sensitivity to climate change. Key sensitivity factors include:

- Impacts of environmental degradation on biodiversity;
- The poor state of wastewater treatment works and aged water infrastructure; and
- Unsustainable use of natural resources.

Adaptive capacity: The majority of stakeholders viewed the province's ecosystems as having low to medium adaptive capacity to respond to climate change. In particular, it was noted that while there are existing plans in place, there are limited human and financial resources to implement these plans.

Rural Livelihoods

The Rural Livelihoods sector is of High Concern due to the following reasons:

Exposure: Around 60 percent of the population in the North West live in rural areas. The rural population mainly depends on agriculture for their livelihoods.

Impacts: Rural livelihoods are expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Increased temperatures disrupt natural resources leading to increased levels of food insecurity;
- Decreased quality and quantity of water resources, which affects the health of rural communities; and
- Increased prevalence of extreme weather events leading to loss of life and livelihoods.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's rural livelihoods as having high sensitivity to climate change. Key sensitivity factors include:

- Existing land degradation in rural areas;
- Heavy reliance on natural resources for livelihoods; and
- Poverty and higher proportion of vulnerable persons.

Adaptive capacity: The majority of stakeholders viewed the province's rural livelihoods as having low adaptive capacity to respond to climate change. In particular, it was noted that rural communities do not have access to resources, such as knowledge and finances to respond to the effects of climate change.

Urban Livelihoods

The Urban Livelihoods sector is of Medium Concern due to the following reasons:

Exposure: The Madibeng, Rustenburg, Mahikeng, and City of Matlosana local municipalities together account for about half of the North West's population, about 58 percent of its workforce, and about 63 percent of the total economic activity in the province.

Impacts: Urban livelihoods are expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Decreased water supply leading to disruption to urban livelihoods;
- Decreased quality and quantity of water resources, which affects the health of urban communities; and
- Increased prevalence of disasters from extreme weather leading to loss of life.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's urban livelihoods as having medium sensitivity to climate change. Key sensitivity factors include:

- Increased heat stress and health issues;
- Increased rural to urban migration, which will put pressure on urban service delivery; and
- Access to basic services and resources to respond to climate change.

Adaptive capacity: The majority of stakeholders viewed the province's urban livelihoods as having low to medium adaptive capacity to respond to climate change. In particular, it was noted that urban livelihoods have access to basic services, however, water scarcity and poor management within municipalities compromises this access.

Agriculture

The agriculture sector is of Medium Concern due to the following reasons:

Exposure: The North West Province has approximately 6.3 million hectares of land that is being used for commercial agriculture. In the North West, the agriculture, forestry and fisheries sectors contributed 2.6 percent to the provincial gross domestic product in 2017.

Impacts: Agriculture is expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Changes in temperature leading to decreased water supply for irrigation;
- Changes in temperature and rainfall affect crop production; and
- Increased temperatures can lead to heat stress on livestock.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's agriculture and farming as having high sensitivity to climate change. Key sensitivity factors include:

- Increased temperatures affect water availability for irrigation;
- Increased runoff and erosion; and
- Effect of extreme weather on crops and livestock.

Adaptive capacity: The majority of stakeholders viewed the province's agriculture as having medium adaptive capacity to respond to climate change. In particular, it was noted that agriculture is a water intensive activity, however, farmers that have access to resources will be able to implement farming practices to respond to climate change.

Tourism

The Tourism sector is of Medium Concern due to the following reasons:

Exposure: The total tourism spend as a percentage of the North West's GDP was 4.1 percent in 2019. The formal tourism sector in the North West employed over 33,000 people prior to the COVID-19 pandemic.

Impacts: Tourism is expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Changes in temperature and rainfall patterns have significant effects on the biodiversity and natural attractions;
- Increased temperatures discourage activity-based tourism; and
- Changes in temperature and rainfall patterns lead to decreased water availability for tourism.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's tourism as having high sensitivity to climate change. Key sensitivity factors include:

- Tourism requires water availability for activities;
- Increased temperatures may deter tourists; and
- Sensitivity of nature to increased temperatures.

Adaptive capacity: The majority of stakeholders viewed the province's tourism as having medium adaptive capacity to respond to climate change. In particular, it was noted that while the tourism sector has been significantly impacted by COVID-19, it has some institutional capacity to respond to climate change.

Mining

The Mining sector is of Medium Concern due to the following reasons:

Exposure: The North West has a large mining industry. The main commodities mined in the North West are diamonds, gold and platinum-group metals. The mining industry contributes approximately 33.8 percent to the total industrial GVA of the province and 14.5 percent of formal employment.

Impacts: Mining is expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Changes in temperature and rainfall patterns affect water availability for mining operations; and
- Increases in temperature lead to increases in the number of very hot days and disrupts mining operations because of poor working conditions.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's mining sector as having high sensitivity to climate change. Key sensitivity factors include reliance on water supply for operations and the impact of extreme weather events.

Adaptive capacity: The majority of stakeholders viewed the province's mining as having medium adaptive capacity to respond to climate change. In particular, it was noted that the technological and financial resources are available to respond to climate change impacts.

Water supply

The Water Supply sector is of High Concern due to the following reasons:

Exposure: Important river systems in the North West include the Crocodile West, Groot Marico, and Vaal River systems. Water from these river systems is used for agriculture (including irrigation), domestic, mining, and industrial purposes.

Impacts: Water supply is expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Changes in rainfall patterns result in changes in spatial/geographic distribution of water;
- Increasing temperatures and rainfall variability reduces water availability and results in many households experiencing a high degree of water stress;
- Warmer temperatures result in changes in water quality such as a decline in biochemical oxygen demand (BoD) or slight decreases in pH levels, salinisation and sedimentation; and
- Disruption of water infrastructure by climate change-related extreme weather events.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's water supply as having high sensitivity to climate change. Key sensitivity factors include:

- North West is a water scarce province; and
- Increased temperatures reduce water quality and quantity.

Adaptive capacity: The majority of stakeholders viewed the province's water supply as having low adaptive capacity to respond to climate change. In particular, it was noted that the North West is a water scarce province and there is poor management of water resources in the province.

Energy supply

The Energy Supply sector is of Medium Concern due to the following reasons:

Exposure: The North West uses an estimated 12 percent of South Africa's available electricity. The number of households with access to electricity in the province increased from 73 percent in 2011 to 81 percent in 2016.

Impacts: Energy supply is expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Disruptions in energy supply as a result of damage to energy supply infrastructure during climate change-related extreme weather events;
- Increase in demand for air conditioning in warmer temperatures; and
- Changes in water availability for cooling in power plants.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's energy supply as having high sensitivity to climate change. Key sensitivity factors include:

- Reliance on water supply for activities;
- Reliance of fossil fuels for energy generation; and
- Poor infrastructure and maintenance.

Adaptive capacity: The majority of stakeholders viewed the province's energy supply as having a medium to high adaptive capacity to respond to climate change. In particular, it was noted that while fossil fuels are still being used in electricity generation, there is a slow movement toward clean energy production.

Transport

The Transport sector is of High Concern due to the following reasons:

Exposure: The North West's Road network is relatively well developed with key highways and an increasing number of paved roads. As a largely rural province, much of the road network remains unpaved.

Impacts: Transportation is expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Increases in heavy rainfall can cause erosion of dirt roads and landslides causing road blockages;
- Roads and bridges buckling and cracking in warmer temperatures; and
- Disruption of transportation infrastructure by climate change-related extreme weather events.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's transportation as having high sensitivity to climate change. Key sensitivity factors include:

- Poor quality of existing infrastructure; and
- Effects of disaster events on transport infrastructure.

Adaptive capacity: The majority of stakeholders viewed the province's transportation as having medium adaptive capacity to respond to climate change. In particular, it was noted that there was little consideration of climate change effects in the design and construction, and poor maintenance of infrastructure.

Waste management

The Waste Management sector is of High Concern due to the following reasons:

Exposure: There are 68 waste disposal sites in the North West (as of July 2021), 53 of which are municipal owned, while the other 15 are privately owned (Moselakgomo 2021). Of the 53 municipal waste disposal sites in the province, 25 are operational and 28 have been earmarked for closure or are closed (Moselakgomo 2021). Of the 15 privately owned waste disposal sites, 5 are operational and 10 have been earmarked for closure or are closed.

Impacts: Waste management is expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Intense rainfall events wash waste into streams, rivers and stormwater systems, increasing blockages in these systems and distributing waste into the aquatic environment; and
- Damage to waste management facilities and disruption of waste management services as a result of extreme weather events.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's waste management as having high sensitivity to climate change. Key sensitivity factors include:

- Non-compliance with waste legislation; and
- Unsustainable disposal of waste at landfills.

Adaptive capacity: The majority of stakeholders viewed the province's waste management as having low adaptive capacity to respond to climate change. In particular, it was noted that there is a lack of financial and human resources to adequately manage waste in the province.

Human health

The Human Health sector is of High Concern due to the following reasons:

Exposure: The North West has a population of approximate 4,108,816 people. Women have an average life expectancy of 65 years and men an average life expectancy of 58.6 years.

Impacts: Human health is expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Drought could lead to dehydration, lowered food security (due to less access to adequate nutrition), and an increase in water-borne disease (from more users using limited water supplies, increasing the risk of contamination);
- Flood events can cause effluent overflow which in turn can cause an increase in water-borne diseases;
- Increases in temperature can result in heat stress which can exacerbate existing chronic health conditions, cause dehydration, result in heat strokes and increase the presence of pests; and
- The pattern of increasing extreme rainfall events and rising temperatures favour the geographical expansion of the borders of vector-borne diseases such as malaria, dengue fever and yellow fever.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's public health as having medium sensitivity to climate change. Key sensitivity factors include:

- Insufficient basic services and primary health care; and
- Increased deaths as a result of disaster events.

Adaptive capacity: The majority of stakeholders viewed the province's human health as having medium adaptive capacity to respond to climate change. In particular, it was noted that vulnerable members of communities will be more susceptible to climate changes affects, especially in rural areas.

Disasters resulting from extreme weather

The Disasters Resulting from Extreme Weather events are of High Concern due to the following reasons:

Exposure: Climate change is likely to lead to increased disaster situations in the province.

Impacts: Disasters resulting from extreme weather are expected to experience a number of climate change impacts, in particular, stakeholders highlighted, *via* an online survey, the following impacts as being of most concern:

- Floods;
- Droughts; and
- Wildfires.

Sensitivity: The majority of stakeholders who participated in an online consultation event for this report viewed the province's disasters resulting from extreme weather as having high sensitivity to climate change. Key sensitivity factors include:

- Increased temperatures will lead to increased fire risk;
- Lack of disaster management in rural areas; and
- Poor infrastructure development to protect from disaster events.

Adaptive capacity: The stakeholders viewed the province's disasters resulting from extreme weather as having medium adaptive capacity to respond to climate change. In particular, it was noted that there are disaster management plans in place, however, there is a lack of coordination from the relevant departments to respond to disaster events.

Conclusion

The report records high levels of concern for the future of important sectors in the face of a changing climate. Ecosystems, rural livelihoods, water supply, waste management, human health, transport and disaster management are all sectors of high concern in the North West. Urban livelihoods, agriculture, tourism, mining and energy supply are all sectors of medium concern.

Despite its relatively small population of approximately 3,75 million people, or 7 percent of the national population, North West plays an important role in the national and global economy. Its large mining industry provides 50 percent of the world's platinum, and the province welcomes South African and international guests to its world-class provincial parks and world heritage sites. Its significant agricultural sector makes an important contribution to national food security, the export sector and rural livelihoods. The province's ability to respond and adapt to climate change in these and other sectors is of national and international significance.

This report identifies the major risks to the province in the face of climate change and its key vulnerabilities. Safeguarding the unique and important cultural, environmental and economic assets of the province for future generations is a collective responsibility. While responding to climate change is by no means the only challenge that faces the province, the threat it presents will undoubtedly magnify many others.

4.10.5.3 Greenhouse gas emission

North West Greenhouse Gas (GHG) Emissions Inventory uses the Greenhouse Gas Protocol - Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities, which was developed by the World Resources Institute (WRI 2021). The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories is designed for use by "any geographically discernible subnational entity, such as a community, town, city, or province, and covers all levels of subnational jurisdiction as well as local government as legal entities of public administration".

The Greenhouse Gas Protocol - Global Protocol for Community-Scale Greenhouse Gas Emission Inventories divides GHG emissions into three categories: i.e.

- Scope 1 - emission that physically occur within the boundary of the province. An example is the burning of coal in a particular industry located within the province.
- Scope 2 - emissions that are imported into the province by grid supplied electricity or heating.
- Scope 3 - emissions that occur outside the provincial boundary but are as the result of activities within the province. An example of scope 3 emissions are flights that could take place in other provinces but are for people of organisations from the province.

For the purpose of the North West GHG Emission Inventory, only Scope 1 and Scope 2 GHG emissions were considered.

Summary results of North West's Greenhouse Gas (GHG) Emissions Inventory

The compilation of the North West GHG Emission Inventory 2020 is an important step in documenting GHG emissions in North West Province that are contributing to human-induced climate change. The total GHG emissions for the province (excluding forestry and other land use (FOLU)) for 2020 were estimated to be 29,578.99 Gigagrams of carbon dioxide equivalent (Gg CO_2e). By comparison, the estimated total emissions for South Africa (excluding FOLU) in the National GHG Inventory Report South Africa 2017 were 512,660.6 Gg CO_2e.

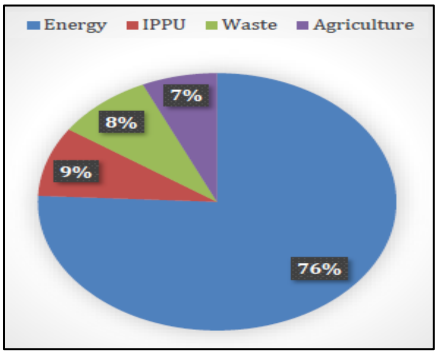


Figure: NW GHG Emissions Inventory - 2020 by IPCC Category (excl. FOLU)

Of the four IPCC GHG emissions categories (Energy, Waste, IPPU, and Agriculture) that were assessed in the North West GHG Emission Inventory 2020, the Energy category was by far the largest contributor to the GHG emissions profile of North West, as it was estimated to account for 76 percent of all GHG emissions in North West. The IPPU category was estimated to account for 9 percent, the Waste category for 8 percent, and agriculture accounted for 7 percent of GHG emissions in the North West.

There are no earlier GHG emissions inventories for North West against which the data in the North West GHG Emission Inventory 2020 could be compared. It is intended that going forward, the North West GHG Emission Inventory will be updated annually. It is also intended that future GHG emissions inventories for North West will be able to be compared against the data in this GHG emissions inventory, to determine if annual GHG emissions in the province are increasing or decreasing.

North West Province Greenhouse Gas (GHG) Emissions Inventory - 2020 by IPCC Category (excluding FOLU)

IPCC GHG emissions categories	GHG emissions in Gg CO_2e
Energy	22 406.18
IPPU	2 592.96
Waste	2 575.44
Agriculture	2 004.41
Grand Total (excl. FOLU)	**29 578.99**

4.10.5.4 Dr Ruth Segomotsi Mompati District Municipality

Government's District Development Model builds on the White Paper on Local Government (1998), which seeks to ensure that "local government is capacitated and transformed to play a developmental role". The White Paper says developmental local government "is local government committed to working with citizens and groups within the community to find sustainable ways to meet their social, economic and material needs and improve the quality of their lives".

The model is a practical Intergovernmental Relations (IGR) mechanism to enable all three spheres of government to work together, with communities and stakeholders, to plan, budget and implement in unison. In so doing the vexing service delivery challenges can also be turned into local level development opportunities, through localised procurement and job creation which promotes and supports local businesses, and that involves communities.

The objectives of the District Development Model are to –

- Coordinate a government response to challenges of poverty, unemployment and inequality particularly amongst women, youth and people living with disabilities;
- Ensure inclusivity by gender budgeting based on the needs and aspirations of our people and communities at a local level. Narrow the distance between people and government by strengthening the coordination role and capacities at the District and City levels;
- Foster a practical intergovernmental relations mechanism to plan, budget and implement jointly in order to provide a coherent government for the people in the Republic; (solve silo's, duplication and fragmentation) maximise impact and align plans and resources at our disposal through the development of "One District, One Plan and One Budget";
- Build government capacity to support municipalities. Strengthen monitoring and evaluation at district and local levels. Implement a balanced approach towards development between urban and rural areas; and
- Exercise oversight over budgets and projects in an accountable and transparent manner.

The following sections provide a brief summary of the state of environment-related information that has been captured in the Profile of Dr Ruth Segomotsi Mompati District Municipality (DRSMDM) compiled to inform the rollout of the District Development Model in the area.

Air quality management

The National Environmental Management Air Quality Act, Act 39 of 2004 (NEM: AQA) (Section 15(2)) requires Municipalities to introduce Air Quality Management Plans (AQMP) that seeks to improve air quality, identifies and addresses emissions that have a negative effect on human health. Municipalities are required to include an AQMP as part of their Integrated Development Plans (IDP). The Dr Ruth Segomotsi Mompati District Municipality's Air Quality Management Plan was developed in 2017. The current AQMP was never approved by the Council. The Dr Ruth Segomotsi Mompati District Municipality (DRSMDM) and its local municipalities have not established any air quality management by-laws. The national Department of Forestry, Fisheries and Environment has developed a generic Air Pollution Control By-Law for municipalities which aims to assist municipalities in the development of their own air quality management by-law within their jurisdictions. There is only one registered Atmospheric Emission Licence (AEL) in the District; the operation/facility is located in the Naledi Local Municipality. The function of AEL is performed by the NW-READ Air Quality Officer for the entire District and its local municipalities. This is due to the District and local municipalities not having Air Quality Officers.

There is no existing emissions inventory database for the DRSMDM. However, the following sectors contribute to pollutant emissions within DRSMDM: agricultural activities; biomass burning (veld fires); domestic fuel burning; denuded land; mining; landfills; vehicle tailpipe emissions; waste treatment and disposal; and some industrial operations.

Currently there is no continuous ambient air quality monitoring in the DRSMDM. An assessment of the current ambient air quality in the DRSMDM is undertaken through analysing emission data, and through dispersion modelling using an emissions inventory.

Biodiversity and conservation

The municipal area is dominated by the Savanna biome (94.8 percent), with Grassland (3.6 percent) and Azonal Vegetation (1.6 percent) found in smaller areas. Vegetation in the District is characterised by turf thorn-veld and mixed bushveld areas, which is good for cattle, goats and wild animals. A list of threatened terrestrial ecosystems was published in 2011 under the National Environmental Management: Biodiversity Act (Act 10 of 2004). The primary purpose of listing threatened ecosystems is to reduce the rate of ecosystem and species extinction. Least Threatened ecosystems cover a total area of 331 858km (73 percent) of the District, whilst Vulnerable accounts for 24 percent and Critically Endangered accounts for 4 percent. In order to preserve and protect the biodiversity, development of the biodiversity framework and bioregional plans is required.

The DRSMDM has a number of natural attractions, monuments, reserves and heritage sites that can be better utilised for this purpose, including the Molopo Game Reserve, the Leon Taljaard Nature Reserve and the Taung Heritage Route. The District Municipality is also home to a great variety of game species including lion, buffalo and rhino. The Molopo Game Reserve offers game, birding, game drives as well as its special feature, namely, the fossilised Phepane riverbed which is many millions of years old.

DRSMDM has three Type 1 formal protected areas – (1) Bloemhof Dam Nature Reserve, (2) Molopo Nature Reserve and (3) S.A. Lombaard Nature Reserve – and one Type 2 formal protected area – the Leon Taljaart Nature Reserve.

The Bloemhof Nature Reserve has pressure on the endemic yellow-fish due to extensive tourism and fishing activities. S.A. Lombard Nature Reserve has pressure from agricultural activities on surrounding farms.

The DRSMDM houses three Biodiversity Nodes situated in the north-western part in the vicinity of Pomfret–Molopo / Kagisano Local Municipality; the south-western part in the vicinity of Reivilo and Pudimoe in Greater Taung Local Municipality and in the south-eastern part between Christiana and Bloemhof towns in Lekwa-Teemane Local Municipality.

Climate change

The District has over the years experienced shortage of water supply for human consumption, with the Wentzel Dam in Mamusa having dried up twice over a period of three years. Numerous water supply schemes are currently underway in each of the five local municipalities. The District is characterised by large surface water bodies and climate change would therefore have an impact on water resources in the area. The District Municipality is prone to flooding incidences and this will need to be taken into consideration for rural development planning purposes. Research indicates that increasing frequency and intensity of extreme rainfall will result in a higher risk of flooding episodes in urban areas (which has already happened, but will increase further).

The Climate Change Vulnerability Assessment and Response Plan developed in 2016 by the national Department of Forestry, Fisheries and Environment is currently not being implemented by the municipality due to human resource capacity challenge.

Chemicals and waste management

The provision of waste management services (refuse collection services, management of landfill sites etc.) is typically a local municipality function; however, in 2008 these powers were transferred to the District Municipality by the North West Provincial Government for four of the five local municipalities. The only local municipality which currently still holds responsibility for provision of waste management services in the District is the Naledi Local Municipality.

The first-generation Integrated Waste Management Plan was written in 2004 and focussed on waste management collection services and disposal facilities in the five local municipalities within the District Municipality. All the local municipalities with the district have IWMPs. The current IWMPs for the district and local municipalities were developed in 2016 and they are due for review. There are unskilled personnel in waste sections of local municipalities. The current IWMPs for the district and local municipalities are still due for council approval and they are not being implemented. There are no peace officers at any of the Local Municipality's to monitor illegal dumping and enforce by-laws.

Approximately 83 percent of households receive weekly waste collection while 27 percent of the households in the DRSMDM do not receive a weekly waste collection service. Waste is collected once a week from the industrial area, three times a week from businesses and seven times a week from food outlets within the district.

There are a number of existing and proposed landfill sites in the District; and these are –

- Two licenced landfill sites (Vryburg and Schweizer-Reneke) and one licenced transfer station (Huhudi);
- One regional landfill site that has not been constructed to completion (Pudimoe Regional Landfill Site);
- Six landfill sites in the District are licenced for closure, but remain operational (Stella, Taung, Pudimoe, Christiana, Bloemhof and Amalia). Environmental authorisation and engineering designs for two proposed landfill sites that were not constructed (Bloemhof and Christiana); and
- Seven unlicensed landfill sites (Reivilo, Bray, Pomfret, Morokweng, Piet Plessis, Tosca, and Ganyesa).

There are several landfill sites within the DRSMDM that are not being managed and operated according to their permit requirements and that are not meeting minimum standards for the operation of landfill sites. Improper waste disposal and management of landfill sites is the main concern at all the landfill sites in the DRSMDM except for the

Vryburg landfill site. With the exception of Vryburg landfill site the management of landfill sites is poor. Waste type and quantity entering sites is not recorded and waste is regularly burnt to create more space.

There is only one transfer station in the DRSMDM in Huhudi. In addition, a transfer station in Vryburg has been closed due to lack of finances to appoint staff to manage the transfer station. A lack of financial capital prevents the construction of transfer stations in the DRSMDM and the purchasing of vehicles to transport waste from transfer stations to landfill sites within each Local Municipality.

Environmental authorisation, compliance and enforcement

The following integrated environmental sector plans have been prepared and adopted by the District to manage the state of the environment and the associated planning parameters –

- Air Quality Management Plan, 2017;
- Climate Change Vulnerability Assessment and Response Plan, 2016;
- Integrated Waste Management Plans (for all local municipalities; 2016);
- Spatial Development Framework, 2012;
- Growth and Development Strategy, 2017; and
- Disaster and Management Framework, 2011.

Environmental governance

Environmental Management within the District falls under the Community Services Department and comprises of the following Sections: Solid Waste Management Services, Fire and Disaster Management Services, and Environmental Health Services (Municipal Health).

The following are the environmental governance structures municipalities find it challenging to participate in due to lack of budget as well as lack of human capacity –

Provincial forums	District forums
• Provincial Air Quality Forum (NW-DEDECT) • Provincial Waste Forum (NW-DEDECT) • Provincial Environmental Implementation Plan forum (NW-DEDECT) • Provincial EPWP Forum (NW-DEDECT)	• Waste Management Forum

Environmental Programmes

During the 2016/2017 financial year, 337 employment opportunities were created within the District and the highest population employed (283) was within Naledi Local Municipality through Environmental Protection and Infrastructure Programmes (EPIPs) as well as Natural Resources Management (NRM) Programmes. Working on Waste is the dominant EPIP and is only implemented in one local municipality. Alien Plant Clearing, People and Parks and a Land User Incentive programme are also within the District. It should be noted that there may have been other environmental programmes funded by government agencies, the data provided here is limited to those programmes funded by Department of Forestry, Fisheries and Environment. The challenge is limited implementation of other EPIPs across the District, and only one local municipality has implemented the waste management programme.

4.10.6 Western Cape province

The following section comprises edited extracts of the 2022 Western Cape State of Conservation Report and the 2018 Western Cape 2050 Emission Pathway Analysis Report, and readers are encouraged to read the reports for more, in-depth, fully referenced information.

4.10.6.1 Climate change

Projected change to climate patterns

The Western Cape is perceived to be highly vulnerable to climate change, due to reliance on winter rainfall (which is likely to be affected by a changing climate). The Western Cape has experienced gradual warming of ca. 1°C over the last five decades, but changes in rainfall have been less distinct over this period. There have been numerous locally significant climate-induced disasters, but, until the 2015-2017 drought, nothing at the scale experienced by many other winter rainfall climate regions.

Extreme weather events

The Western Cape is prone to the effects of climate-related hazards, which pose a significant risk to the Western Cape's economy, ecosystems and population. Between 2003 and 2008 alone, the direct costs of climate related extreme events in the Western Cape amounted to approximately R3.161 billion. The 2009/10 Eden District drought damage was estimated at R300 million, the 2011 Eden District floods at R350 million and the 2012 floods at R500 million. The recent 2015/16 drought and concomitant fires are together estimated to have cost the agriculture sector up to R4 billion in losses.

GHG emission profile

A GHG emissions profile can be defined as a measure of the GHG emissions that are directly and indirectly caused by an activity or are accumulated over the life cycle of a product or service. The GHG emissions are typically expressed in carbon dioxide equivalents (CO_2e), which renders all GHG emission values to a common (carbon) denominator.

Total energy consumption and the total energy related GHG emissions in the province have increased since 2013, while GHG emissions per capita remained the same. Electricity is the largest contributor to the province's energy emissions. Electricity contributes disproportionately to emissions due to the high carbon content of Eskom supplied coal-based electricity generation.

By sector, industry contributed the most to the provincial emissions profile in both 2013 and 2016 as it utilises coal-derived electricity as well as in situ coal and diesel. The transport and residential sectors are the next highest contributors. Emissions in the industrial, transport, commercial and residential sectors increased between 2013 and 2016, but declined in the agricultural and local government sectors.

The City of Cape Town is the largest contributor of emissions at 57 percent with the West Coast District the second largest contributor at 19 percent. The Central Karoo District contributes the least (1percent) to the Province's total emissions. The West Coast, Overberg and Eden Districts all increased their contribution to the Province's emissions between 2013 and 2016, whereas the City of Cape Town and the Cape Winelands District reduced their contributions.

GHG emissions profile

The Greenhouse Gas (GHG) Inventory for the Western Cape Province forms part of the completion of a 2050 Emissions Pathway exercise modelling a net-zero emissions future for the Western Cape.

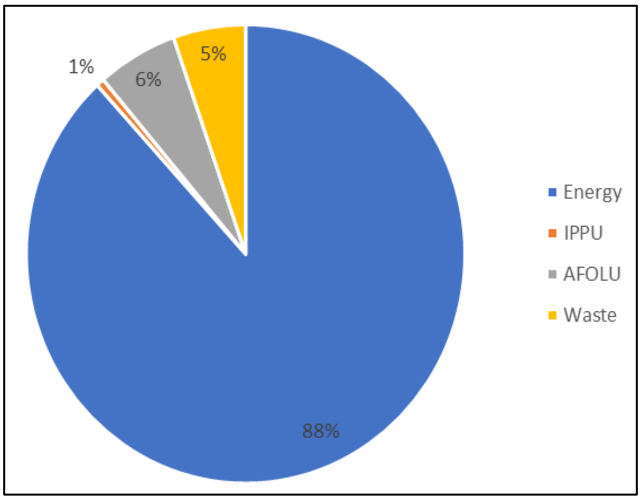


Figure: Breakdown of GHG Emissions by Sector for the Western Cape 2018 (tCO_2e)

The Western Cape Government has maintained and Energy Consumption and CO_2e Emissions Database for the Western Cape for the last decade, continuously improving on the coverage and accurate of the emissions data. This work is now being expanded to a full GHG inventory include the development of a baseline emissions profile using 2018 data. The sectors covered in this profile are Energy (including Transport, Waste (including wastewater treatment), Industrial Process and Product Use (IPPU) as well as Agriculture, Forestry and Other Land Use (AFOLU).

The 2018 Western Cape 2050 Emission Pathway Analysis Report contains a high-level GHG emissions breakdown for the Western Cape based on the emissions for each of the four sectors as well as highlighting key actions required to improve the emissions data going forward. For each sector a specific report has been drafted including an introduction, a brief description of the methodology used in calculating the GHG emissions for that sector as well as the latest information and statistics on GHG emissions.

The Western Cape's emission profile is dominated by the Energy sector, which also includes transport related activities.

It should be noted that the IPPU sector, in particular, has some significant data gaps and does not provide a true reflection of the sector's emissions for the Western Cape. The waste sector has also been identified as a sector experiencing some data challenges, with wastewater treatment data being extremely difficult to capture and not available in a central data repository.

Source	GHG emitted (tonnes)			
	CO_2	CH_4	N_20	CO_2e
Energy Sector	34 950 183			34 950 183
IPPU Sector	231 369			231 369
Waste Sector		104 895	232	2 346 161
AFOLU Sector	- 1 566 601*	91 815	4 185	2 113 372
TOTAL	33 614 951	20 210	4 417	39 641 085
***Note that the CO_2 component of the AFOLU sector constitutes a nett carbon sink, hence a negative sign**				

4.10.6.2 Western Cape state of conservation

The following section is an edited extract of the 2022 Western Cape State of Conservation Report and readers are encouraged to read the report for more, in-depth, fully referenced, information on the Western Cape state of conservation.

The Western Cape State of Conservation Report (WC SoCR) is released on an annual basis and provides succinct summaries of the status of indigenous species and ecosystems. The latest in this series of reports is the WC SoCR 2022. In addition to providing a status summary the report showcases achievements such as delivery on the expansion of the conservation estate and an overview of action to address threats to biodiversity such as climate change, alien invasive species, fire and biodiversity crime.

Status of Western Cape ecosystems

The report starts with an overview of the status of all the 349 ecosystem types in the Western Cape, which covers the realms of Marine, Freshwater, Terrestrial and Estuarine. 191 of the 349 ecosystem types are threatened. The 191 threatened ecosystems are made up of 109 listed as Critically Endangered, 54 Endangered and 28 listed as Vulnerable.

Indigenous biodiversity

A profile of the rich indigenous biodiversity of the Western Cape is provided, noting that 16% of extant taxa are threatened. The status of freshwater fish is of concern as 24 of a total of 44 taxa of freshwater fish are listed as threatened. The 2022 report indicates a recent change in the number of freshwater fish: the 2021 report reflected a total of 42 freshwater fish taxa however taxonomic revision resulted in the description of two new species of chubbyhead barb (*Enteromius anoplus*), namely *E. cernuus*, which is near endemic to the Western Cape, and *E. mandelai* which has a limited distribution the Western Cape.

Freshwater ecosystems

There are 138 freshwater ecosystems in the Western Cape, comprised of 64 river types and 74 wetland types. Of these, 101 are threatened (73 Critically Endangered, 18 Endangered and 10 Vulnerable). Strategic Water Source Areas (SWSA) are important areas to safeguard to support ongoing supply of freshwater and 6 of South Africa's 22 surface water SWSAs are entirely located in the province and 2 are partly located in the province.

Western Cape conservation estate

CapeNature manages 16 Nature Reserve complexes, comprising a total of 828 970 ha. The CapeNature protected area estate totals 1 030 429 ha which includes CapeNature managed Protected Areas and formal Stewardship sites support by CapeNature. Gains during the reporting period of 2021/22 are comprised of 19 854 ha of sites declared via partnership with WWF while seven new Stewardship agreements added an additional 14 060 ha to the conservation estate.

Partnerships

The value of collaborations and partnerships is stressed, particularly in relation to protected area expansion via stewardship as well as in addressing the threats to biodiversity such as fire, alien invasive species and biodiversity crime. Formal partner organisations, where a current MOU or MOA is in place, are listed. Informal collaborations are equally valued. The SoCR 2020, SoCR 2021 and the SoCR 2022 can be accessed on the CapeNature website on: www.capenature.co.za

4.10.6.3 Waste management

Population growth and migration into the Western Cape is a driver that influences the amount of waste that is generated and the demand for waste and sanitation services. It is estimated that 88 percent of projected population growth will be in the Greater Cape Metropolitan Region. Between 2018 and 2020, the total amount of waste generated within the Western Cape averaged 3 million tonnes. Waste diversion will be driven to reduce waste going to landfill and be made available for reuse, recycling, repurposing and beneficiation. The availability of waste as a secondary resource will promote the waste economy and create jobs.

Waste service levels vary between municipalities and there has been some improvement compared to the previous years and despite a high population growth and rapid urbanization. However, the increasing cost of providing waste management services, shortages in the air space available for waste disposal facilities and the increasing amount of waste being generated are all concerns that need to be addressed by the province and municipalities.

The Western Cape Province has a shortage of landfill airspace and securing available land for new waste management facilities is difficult, as there is increasing competition for land. Other challenges include the prohibitive cost containment barriers for waste management facilities, as prescribed by the National Norms and Standards for Disposal of Waste to Landfill (2013). Integrated waste management infrastructure is not recognised as bulk infrastructure and, therefore, limited funds have been allocated for new developments, resulting in service delivery backlogs and limited landfill airspace. In addition, very little Municipal Infrastructure Grant (MIG) funding is allocated for integrated waste management infrastructure.

Integrated waste management is only effective if it's viewed as in integrated activity and involves the planning and development of Integrated Waste Management Plans (IWMPs), thereby implementing the waste hierarchy. The review and effective monitoring of municipal IWMPs to ensure implementation must be done in alignment with the actions and targets as outlined in the Western Cape Integrated Waste Management Plan. The Western Cape Integrated Waste Management Plan (2017 -2022) guides waste management in the province and the Department will review the plan in 2021 and municipalities are encouraged to partake in the process.

Regional cooperation initiatives are considered as potential solutions to airspace shortages, as these are important for municipalities to work towards sharing infrastructure and waste services, which reduces individual responsibility to comply with waste management licences. Therefore, regional waste disposal facilities have been planned, licenced and are in various stages of being established, due to financial resources and models.

The province has made progress in moving up the waste management hierarchy with respect to general waste and can be attributed to the recent changes in waste legislation, policies and plans; more waste facilities looking at waste beneficiation and the value of waste as a resource; awareness raising campaigns and conscious consumerism, as well as the active and growing informal sector. The reduction of the environmental impacts of waste managed through diversion and the utilisation of waste as secondary resource will ensure a cleaner and healthier environment for communities and will stimulate the waste economy and create jobs. The interaction with municipalities in the Western Cape is crucial for the success of the interventions, which include technical assistance and active municipal support. Waste diversion will reduce waste going to landfill, and waste can be made available for reuse, recycling and beneficiation, which can reduce the impact of waste management on the environment. However, there is still a long way to go to improve compliance at municipal waste management facilities, to divert more waste streams, to improve waste collection services, and to increase enforcement in order to protect human health and the environment.

5 WHY IS THE ENVIRONMENT IN THE STATE IT IS IN?

5.1 Welcome to the Anthropocene

Geologists have divided Earth's history into a series of time intervals. These time intervals are not equal in length because the divisions are based on significant events in the history of the Earth. For example, the boundary between the Permian and Triassic is marked by a global extinction in which a large percentage of Earth's plant and animal species were eliminated. These divisions provide us with a common means of identifying the different stages through which the planet has passed since its formation to today.

Although periods like the Cenozoic (the 'Age of Mammals') and the Mesozoic (the 'Age of Reptiles/Conifers' – the time of the dinosaurs) may be quite well known, there is increasing debate around what some scientists are referring to as the Anthropocene – the era in which we now live. The reason for this is that for the last two hundred years humankind has had such a significant and clearly observable impact on every corner of the planet that some scientists are starting to regard this period as a new geological age: the age of human impact on Earth or the Anthropocene.

Support for naming our current period of Earth's history the Anthropocene is increasing as more people realise that since the pre-industrial era, and especially since the second half of the last century, the degradation of the natural environment and human-induced climate change has increased at an unprecedented rate.

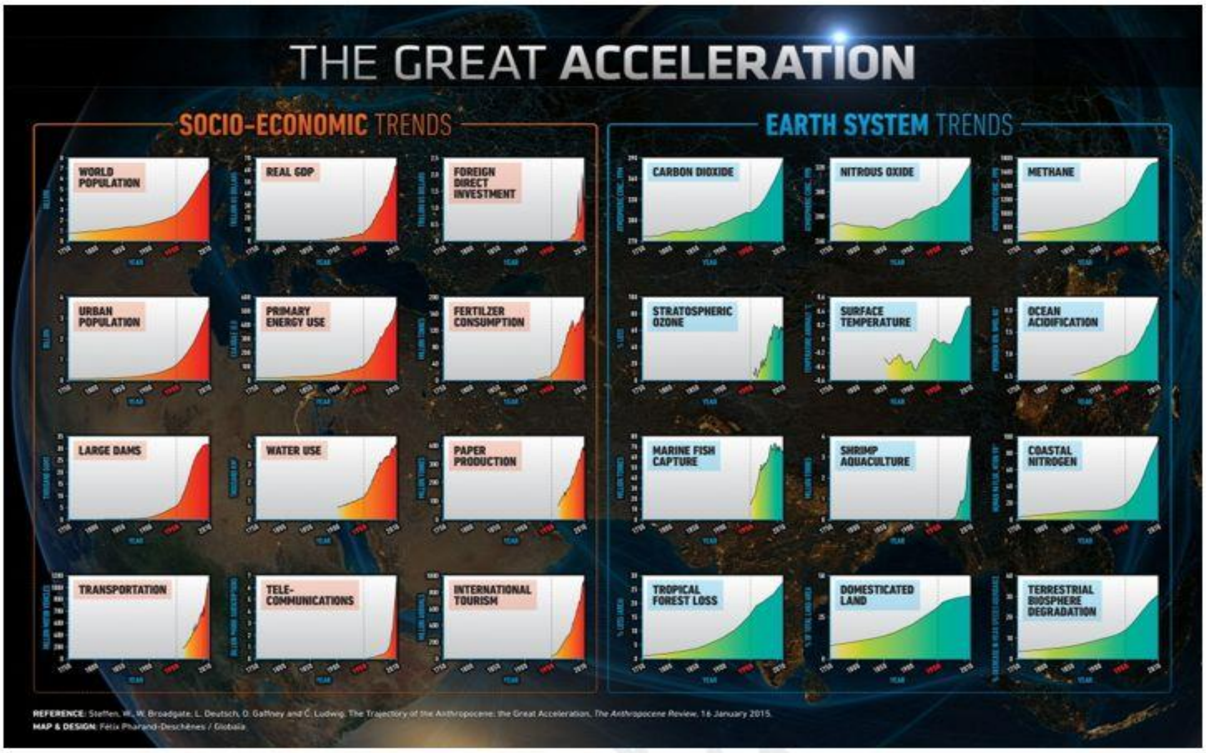
5.2 The great acceleration

In trying to explain the unprecedented rate of environmental degradation and human-induced climate change, initiatives like the International Geosphere-Biosphere Programme, a research programme that ran from 1987 to 2015, studied the phenomenon of global change. Results of their work were used by others to suggest that the cause of the change marked by the proposed Anthropocene is a phenomenon known as 'The Great Acceleration' – a period of massively accelerating rates of change in all sorts of socioeconomic and earth system indicators. While the proposed start dates for the Anthropocene span the Industrial Revolution and earlier, the Great Acceleration begins in the 20th Century with the acceleration rate dramatically increasing after the Second World War.

To track the effects of human activity upon the Earth, a number of socioeconomic and earth system parameters were used including population, economics, water usage, food production, transportation, technology, greenhouse gases, surface temperature, and natural resource usage. The International Geosphere-Biosphere Programme analysed data from 1750 to 2010 divided into two broad categories which they further divided into 12 subcategories. The first category, socioeconomic trend data, is used to illustrate the impact on the second category, earth system trend data.

The following picture summarises the results and it is clear that there has been explosive growth in: The global human population; Real Gross Domestic Product (GDP); Foreign Direct Investment; Urban population; Primary energy use; Fertiliser consumption; Large dams; Water use; Paper production; Transportation; Telecommunications and International Tourism.

The picture is also clear that this explosive growth over the last 70 years may be linked to equally explosive growth in: Carbon dioxide, Nitrous oxide and Methane emissions; Stratospheric ozone concentrations; Surface temperature; Ocean acidification; Marine fish capture; Shrimp aquaculture; Nitrogen to the coastal zone; Tropical forest loss; Domesticated land; and Terrestrial biosphere degradation.

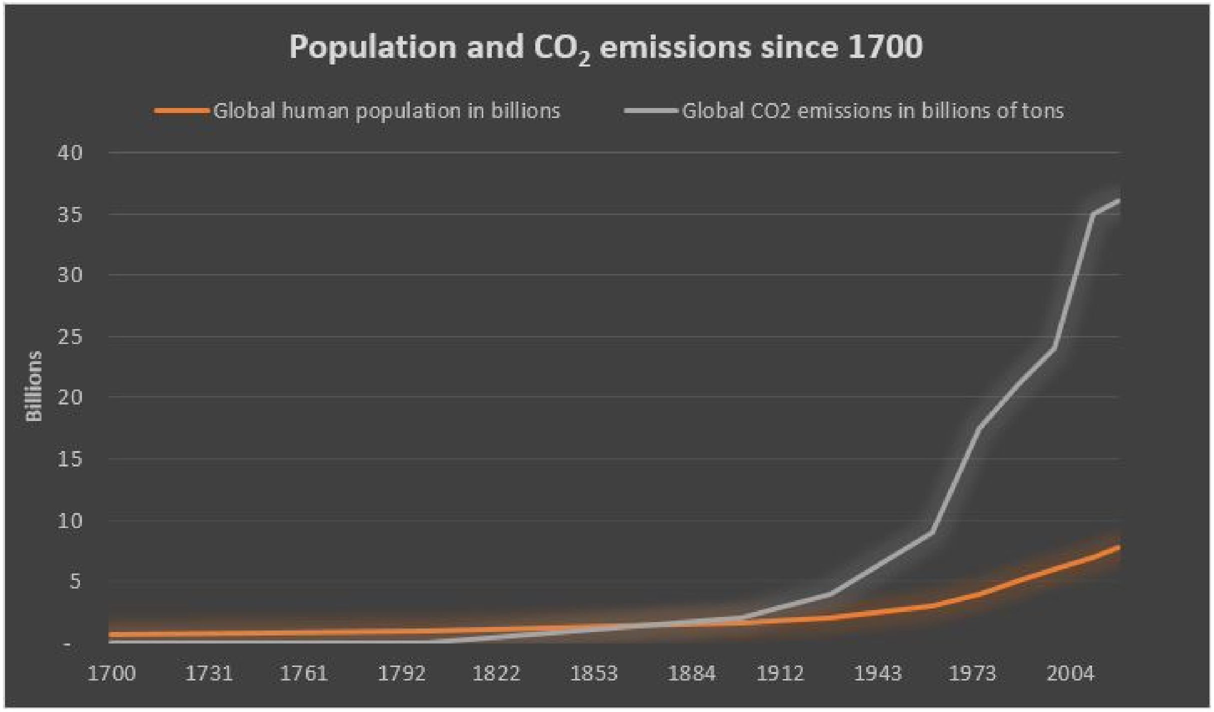


5.3 An uncomfortable truth-it is human activity, not only numbers driving change

Although the information used to illustrate the Great Acceleration is very useful in informing our understanding of what lies behind much of the unprecedented global change, great care must be taken not to draw overly simplified, simplistic or reductionist conclusions. Typical of such simplistic and misleading conclusions is that the unprecedented rate of environmental degradation and human-induced climate change is due to human population growth. Although the growing human population tends to exacerbate the problem, it is human activity not numbers that is driving the change.

The issue of climate change perfectly illustrates this point. Climate change is the ongoing trend of changes in the earth's general weather conditions as a result of an average rise in the temperature of the earth's surface which is due, primarily, to the increased concentration of gases known as greenhouse gases (GHGs), especially carbon dioxide (CO_2), emitted into the atmosphere by human activities. As illustrated in the graph below, although there has been a significant growth in both population and CO_2 emissions since the 1950s, CO_2 emissions grew almost 5 times faster than the human population. Importantly, if humans did not, for example, burn fossil fuels like coal and oil, climate change would not be the problem it is today despite the growing number of humans on the planet.

This realisation leads to a very 'uncomfortable truth' for many of us, namely, we cannot shake our heads, roll our eyes, and point to the growing faceless masses of humanity as the driver of the unprecedented rate of environmental degradation and human-induced climate change – we have to look far closer to home at our own lifestyles and behaviour.



5.4 The drivers of environmental degradation

5.4.1 Production practices

The industrial age's increasingly pervasive one-way global economy of take→make→use→dispose production practices are now regarded as being unsustainable and are considered to be one of the key drivers of environmental change globally. These production processes are those that destroy, deplete or degrade the environment and natural resource base in ways that potentially undermine the health and well-being of current and future generations.

In South Africa, the key production processes responsible for the destruction, depletion or degradation of the environment include: the housing production practices that result in urban sprawl; the fossil fuel-based electricity generation and transportation processes that result in greenhouse gases and other atmospheric emissions; the mining operations that destroy irreplaceable ecological infrastructure and habitat, pollute ground and surface water, pollute the air and/or leave behind a poisonous unproductive and polluting landscape; the agricultural operations that degrade or destroy irreplaceable ecological infrastructure and habitat, and pollute ground and surface water; the waste disposal processes that pollute our air, soil and water; and the exotic forestry operations that destroy irreplaceable ecological infrastructure and habitat.

As these practices have impacts on the 'quality' of our environment and/or the 'quantity' of the natural environment, they are sometimes categorised as processes that pollute or processes that change the use of land. With serious discussions starting to take place around the popularisation of the term 'climate crisis' to replace 'climate change' and 'global heating' to replace 'global warming', perhaps the production practices of greatest concern and urgency are those involving fossil fuels. In this regard, South Africa is an acknowledged significant contributor to global greenhouse gas emissions due, largely, to our continued dependence on electricity generated by coal-fired power stations.

5.4.2 Consumption patterns

Unsustainable production and consumption patterns are a global problem and, hence the United Nations Environment Programme's UNEP 2019 Global Environmental Outlook (GEO 6) provides an up-to-date insight into our current consumption patterns –

The scale and magnitude of global consumption, especially in urban areas, is affecting global resource flows and planetary cycles.

Consumption rates and linear activities (extract-make-use-dispose) have increased resource exploitation beyond the recovery ability of ecological systems, with harmful consequences at all levels from the local to the global. Globally, two out of every five people lack access to controlled waste disposal facilities. Inadequate and sometimes illegal practices include those related to food waste, e-waste, marine litter, waste trafficking and crime. Developed countries have policies in place to promote reduced waste and resource efficiency, while developing countries still face basic management challenges, such as uncontrolled dumping, open burning and inadequate access to services.

Global energy consumption is expected to rise significantly during the period from 2014 to 2040 (by as much as 63 percent, according to one estimate), much of which is attributed to expected consumption in countries that currently depend on fossil energy sources. Equity and gender issues, such as universal access to improved final energy services, are still a problem that is far from being resolved. Despite the fast deployment and cost reduction of renewable energy and improvements in efficiency, without further and effective, ambitious measures, energy-related greenhouse gas emissions will result in the Paris Agreement temperature targets being missed.

Despite the many benefits brought to humanity, in this, the most chemical-intensive era in history, the pollution that is associated with chemicals poses a global problem, because toxic substances can spread to the most remote environments, including to receiving water systems worldwide. Products in everyday use contain toxic compounds that interfere with the health of humans, other species and the environment.

Multilateral environmental agreements and concerted national initiatives have made progress in addressing several of the most concerning chemicals. However, significant gaps in assessing and regulating harmful chemicals continue to exist, due, inter alia, to insufficient national legislation or enforcement to address associated risks and to missed innovation opportunities. Failure to address the risks posed by such chemicals can result in adverse impact on human health and the environment, with estimated costs amounting to hundreds of billions of US dollars. Emerging issues requiring more science-based information, precaution, in accordance with international agreements (where applicable), and risk assessment and management include endocrine disruption, widespread antibiotic resistance and the use of nanotechnology.

The food system, in response to growing and changing consumer demand, is increasing pressure on local ecosystems and the global climate. Agriculture is the largest consumer of water and, when not sustainably managed, food production is a major driver of biodiversity loss and polluter of air, fresh water and oceans, as well as a leading source of soil degradation and greenhouse gas emissions. Changing environmental conditions and consumption patterns are both increasing such pressures and presenting new food security challenges, reflecting malnourishment, including in the form of over-nourishment, as well as undernourishment.

As with the rest of the globe, the dominant aspirational South African lifestyle is not sustainable, and our activities as private individuals and households directly and indirectly account for a large and increasing share of total environmental impacts.

In a water-poor country like South Africa, our water consumption patterns perfectly illustrate this point. At 490 mm, South Africa's annual rainfall is half the world average and South Africa is considered the 39th driest country in the world. Despite this, at 235 litres per person per day, South Africa's average water consumption is almost 30 percent higher than the world average of 185 litres per person per day. South African farmers are the biggest direct users of water using around 60 percent of total water consumption and around 37 percent of water in South Africa's urban piped water systems is lost to leaks or is used illegally. However, Cape Town's response to their 2018 'day zero' crises – the day that the city was predicted to run out of water – clearly showed how consumption patterns can be changed to use scarce resources more efficiently and effectively.

5.4.3 Climate change

Although climate change is an impact of the drivers and pressures described above, it has become a driver in its own right.

South Africa's climate change policy, the 2011 National Climate Change Response White Paper, regards climate change as an existential threat. While weather changes on a daily basis, climate represents the statistical distribution of weather patterns over time, and on a global scale has changed only very slowly in the past – usually over periods of tens of thousands of years or even millions of years which allows time for the earth's bio-physical systems to adapt naturally to the changing climatic conditions. Currently, the global climate is changing much more rapidly as a result of global warming, leading to, among others, the melting of polar and glacier ice, sea-level rise, ocean acidification, changes in rainfall and snowfall patterns, more frequent floods and droughts and increased frequency and intensity of extreme weather events, such as tornadoes, hurricanes and cyclones. The rapid rate of this climate change does not allow the earth's bio-physical systems to adapt to these changes naturally.

Evidence of rapid climate change, including more frequent and intense weather systems and greater climate variability, is now being frequently observed and includes: increases in the average global temperature; with the past decade being the hottest on record; rises in the average global sea level; changes in average rainfall patterns, with some regions experiencing higher rainfall and other areas experiencing drying; increased frequency of heavy rainfall and extreme weather events over most land areas; unprecedented floods and wildfires and more intense and longer droughts. The rate of change to the earth's climate exceeds the ability of all types of ecosystems (marine, coastal, freshwater, and terrestrial) to adapt as well as compromising their ability to function effectively.

South Africa is extremely vulnerable and exposed to the impacts of climate change due to our socio-economic and environmental context. Climate variability, including the increased frequency and intensity of extreme weather events, will disproportionately affect the poor. South Africa is already a water-stressed country, and we face future drying trends and weather variability with cycles of droughts and sudden excessive rains.

The science is clear that action to address the causes and impacts of climate change by a single country or small group of countries will not be successful. This is a global problem requiring a global solution through the concerted and cooperative efforts of all countries. Should multi-lateral international action not effectively limit the average global temperature increase to below 1.5°C, or at most 2°C, above pre-industrial levels, the potential impacts on South Africa in the medium- to long-term are significant and potentially catastrophic. Even under emission scenarios that are more conservative than current international emission trends, it has been predicted that by mid-century the South African coast will warm by around 1 to 2°C and the interior by around 2 to 3°C. By 2100, warming is projected to reach around 3 to 4°C along the coast, and 6 to 7°C in the interior. With such temperature increases, life as we know it will change completely: parts of the country will be much drier and increased evaporation will ensure an overall decrease in water availability.

This will significantly affect human health, agriculture, other water-intensive economic sectors such as the mining and electricity-generation sectors as well as the environment in general. Increased occurrence and severity of veld and forest fires; extreme weather events; and floods and droughts will also have significant impacts. Sea-level rise will negatively impact the coast and coastal infrastructure. Mass extinctions of endemic plant and animal species will greatly reduce South Africa's biodiversity with consequent impacts on ecosystem services.

5.4.4 Imperialism, colonialism, and industrialization biases against grassy ecosystems

Deforestation is a major threat to the Earth's forests and so efforts to reverse this through planting new trees (afforestation) is generally considered to be a very good thing. Furthermore, afforestation is also considered a way of increasing our terrestrial carbon sinks at relatively low cost although planted forests often lack permanence, do not reduce carbon emissions immediately, and can negatively impact previously established ecosystems. Despite this, as international and local pressure to dramatically reduce our greenhouse gases increases, many large emitters of greenhouse gases are banking on massive afforestation carbon offset projects to meet their, often highly publicised, carbon neutrality commitments. Such project involve the planting of trees in areas that have not recently been forested, hoping to increase overall carbon storage capacity and reduce the amount of carbon in our atmosphere. Being perceived as a relatively cheap means of reducing atmospheric greenhouse gas concentrations without actually reducing greenhouse gas emissions, afforestation carbon offset projects are particularly attractive to large fossil fuel companies. However, even in the highly unlikely event that such projects could have a significant impact on reducing atmospheric greenhouse gas concentrations, vast areas of the Earth's surface would have to be forested and Africa's grassy ecosystems are getting a lot of attention in this regard and this increased attention is making African ecologists very nervous.

According to the Annual Review of Environment and Resources Volume 47, 2022, grassy ecosystems are central to the human story, from our initial emergence as hominids to utilizing fire, husbanding livestock, and providing the crops that support the majority of human calories. Yet human activity has become so extensive and intensive that we have entered a new geological epoch, the Anthropocene, where human influence overrides natural processes from local to global scales, with ecosystems being increasingly altered even in the most remote and protected regions.

The evolution and expansion of grassy ecosystems was a long and spatially complex process, occurring synchronously across continents over millions of years. Grass pollen and phytoliths first appeared in the Cretaceous 67 million years ago, and grass pollen was present on all continents by the Eocene. A grassy ecosystem is a dynamic product of climate space and disturbances (fire or herbivory) that help maintain its light-loving lifestyle. As some of these processes disappear from the landscape, low-intensity management by humans from grazing cattle to hay-cutting can replicate natural disturbances. As the Anthropocene advances, the components that maintain grassy ecosystems are changing.

Between the seventeenth and nineteenth centuries, imperialism, colonialism, and industrialization, alongside the burgeoning of the natural sciences in western Europe, initiated a new approach to and understanding of ecosystems that have compounded to produce biases against grassy ecosystems that persist to this day. Against this backdrop, a multitude of indigenous knowledge systems and land stewardship approaches within grassy ecosystems were marginalized, eroded, or eliminated. The marginalization and loss of indigenous knowledge and practices translated to changes in the limits and loss of grassy ecosystems evidenced from Australia to South America to North America. Previous to the Anthropocene, ecology was locally rooted in local and indigenous understanding and experience accumulated over thousands of years. With western exploration, ecology was formulated as a global discipline. The famous German naturalist and explorer Alexander von Humboldt's explorations and influence in the early 1800s set the scene for ecological theory postulating that climate largely determined the distribution of ecosystems, with forests being the natural climax state and grasslands being deforested landscapes associated with people and animals. As global ecology developed, some influential scientists defined a central and founding tenant to ecology – that of succession representing a deterministic relationship between time and vegetation to reach a climax state.

The result of what is now considered an imperialist and colonialist perception of Africa's remarkable and highly biodiverse grasslands as being deforested landscapes associated with people and animals is that these grasslands are being eyed as prime targets for massive afforestation carbon offset projects. The bitter irony of this is that, apart from such projects effectively destroying an invaluable African landscape, healthy thriving grasslands are probably far better carbon sinks than any planted forest.

5.4.5 Human drivers on fire regimes of South African grassland and savanna environments

Another threat to grassland and savannah is what is often considered to be 'natural' bush encroachment. However, this bush encroachment may not be natural at all, but a product of changing veld fire regimes and increasing atmospheric CO_2.

According to the African Journal of Range & Forage Science, *2022, 39(1): 107–123,* human drivers, particularly land transformation and human population density, are important determinants of veld fire regimes. Fire is a key determinant of the global distribution of the grassland, savanna and forest biomes and is an important regulator of tree cover within grasslands and savannas. Fire exclusion in grassland and savanna favours increased woody cover and can result in a switch to closed canopy forest where rainfall is sufficient. In mesic environments, where moisture does not constrain woody seedling recruitment, frequent fire acts as the primary regulator of tree cover by limiting the transition of saplings to adult trees. Although fire is less frequent in arid savannas, owing mainly to moisture constraints on grass fuel loads, even a single fire can result in some (often high) adult tree mortality and high seedling mortality.

The changes in the fire regimes of South Africa's grassy biomes over the past century is in response to widespread human-induced changes. The changes in human drivers were sufficient to conspicuously alter fire regimes across savanna and grassland through reducing burnt area by up to 27% since 1910 and through a shift to fire regimes with lower burnt areas, longer fire return intervals and lower fire intensities. An increase in woody cover at the expense of grassland, termed bush encroachment in South Africa, is a vegetation dynamic impacting grasslands and savannas worldwide and is of global concern owing to its impact on forage production, hydrology, biodiversity, and carbon storage. The cause of such widespread increases in woody cover is often ascribed to increasing atmospheric CO_2 because of its ubiquitous nature in space and time. A broad-scale reductions in the extent, frequency and intensity of fires within the grassy biomes of South Africa over the past century has therefore potentially been an important driver of the observed increases in woody cover over this period, particularly in the mesic eastern region

5.4.6 Case study – what is driving declines in biodiversity

The following section is an edited extract of The National Biodiversity Assessment 2018 report and readers are encouraged to read the report for more in depth, fully referenced, information on the state of South Africa's biodiversity.

Changes in hydrological regime and poor water quality are the major pressures on biodiversity in inland aquatic, estuarine, coastal ecosystems and selected terrestrial ecosystems. The over-abstraction of water and building of dams (primarily for crops, human settlements and mining) results in direct negative impacts on species and ecosystems, and indirect impacts through the disruption of important ecological processes such as sediment supply. Pollution of inland aquatic ecosystems from a combination of acid mine drainage, mining, industrial and urban waste water, and agricultural return flows negatively impact water quality. When combined with flow regime changes, pollution represents a major additional pressure on inland aquatic, estuarine and coastal biodiversity.

In contrast, the primary pressure in the terrestrial realm is habitat loss as a result of land clearing for croplands, plantation forestry, human settlements and mining. Agriculture, which includes cultivation for crops and plantation forestry, significantly impacts on all the terrestrial and freshwater species groups assessed to date. Over-utilisation of rangelands, which results in loss of shrub and herbaceous cover and leads to increased erosion, is a direct pressure to terrestrial species and ecosystems and an indirect pressure on inland aquatic ecosystems. In the estuarine and marine realms, and in coastal areas, the unsustainable use of biological resources (in this case overfishing of key species) is a significant pressure on biodiversity.

Changes to fire regimes linked to management imperatives, climate (drought events and high winds) and an increase in fuel loads from invasive plants are important natural system modifications in the terrestrial realm that have a detrimental impact on biodiversity. Species which have evolved special adaptations to survive fire, such as certain lycaenid butterflies and Fynbos plants, struggle to cope with fires that have increased intensity and occur more frequently than in the past. Biological invasions impact all realms, with predatory alien fishes substantially impacting indigenous fish species in rivers. A wide range of woody invasive plant species impact riverine areas, wetlands and mountain catchments in particular and cause severe declines to South Africa's indigenous plants and amphibians.

Mining typically does not have the same footprint as other pressures in terms of area, but is an intense form of pressure on biodiversity, with long-term direct and indirect impacts on species and ecosystems. South Africa's mineral wealth is comparable to its outstanding biodiversity; to make the most of these resources, careful spatial planning, monitoring and management of mining operations is essential to avoid and mitigate the worst of the impacts.

Climate change is a documented threat across all realms, and also amplifies other pressures such as competition with invasive species, disease, habitat loss and habitat degradation. Though impacts of climate change on biodiversity are best understood in the terrestrial realm, coastal and estuarine ecosystems are particularly at risk from extreme weather events, especially where human settlements limit the natural resilience of these ecosystems by encroaching into dune systems and the estuarine functional zone.

Based on the national land cover, 81percent of South Africa (985 559 km^2) was in a natural state in 1990. By 2014 natural areas were estimated to have declined to 79 percent (961 010 km^2). Habitat loss, as a result of historical (1750-1990) and recent (1990-2014) clearing of natural habitat for field crops, horticultural crops and planted pastures, is the largest pressure on terrestrial ecosystems and biodiversity in South Africa and has affected 16 percent of the land area. Clearing of natural habitat for new croplands between 1990 and 2014 affected 1.4 percent of the country. The relatively mesic eastern portions of South Africa and the Fynbos and Renosterveld of the Cape lowlands were the most impacted by this clearing. Built-up areas (including rural and urban settlements, industrial and commercial areas and large infrastructure) also contribute to natural habitat loss and currently cover over 2.5 percent of the country.

The rate of habitat loss linked to new built-up areas is increasing, especially in Gauteng and along the KwaZulu-Natal coast and adjacent interior. Plantation forestry (including non-native pine, eucalyptus and acacia species) is an important driver of habitat loss, in mesic grassland regions in particular, and cover just under 2 percent of South Africa; although new plantations are being established the rate of habitat loss to this activity may be decreasing. The impact of mining as a direct driver of habitat loss is relatively low (0.3 percent of South Africa), however, the highly uneven distribution of mining areas means that the impacts are focussed on particular ecosystems, and the impacts are often persistent.

5.4.5 South African attitudes to the environment

In May 2021, the Human Sciences Research Council (HSRC) released its South African Social Attitudes Survey (SASAS) - National results: Attitudes towards the Environment, dated May 2021 (SASAS Round 17, 2020/21).

The HSRC's South African Social Attitudes Survey (SASAS) is a nationally representative survey series that was established in 2003, with the aim of monitoring underlying value change in the country. As part of its broader thematic focus on the public relationship with science, the survey fielded modules of questions on attitudes to the environment in 2010 and 2020. The results of the SASAS 2020 Attitudes to the Environment, including a special supplement focused on attitudes towards litter and littering, is the focus of the HSRC's initial short briefing report released in May 2021.

As social awareness, attitude and behaviour is the key driver of environmental change and, hence, the key reason why the environment is in the state it is in. The results of the SASAS 2020 Attitudes to the Environment survey, and other current relevant surveys, will be unpacked in further detail in future editions of the South African Environment (SAE).

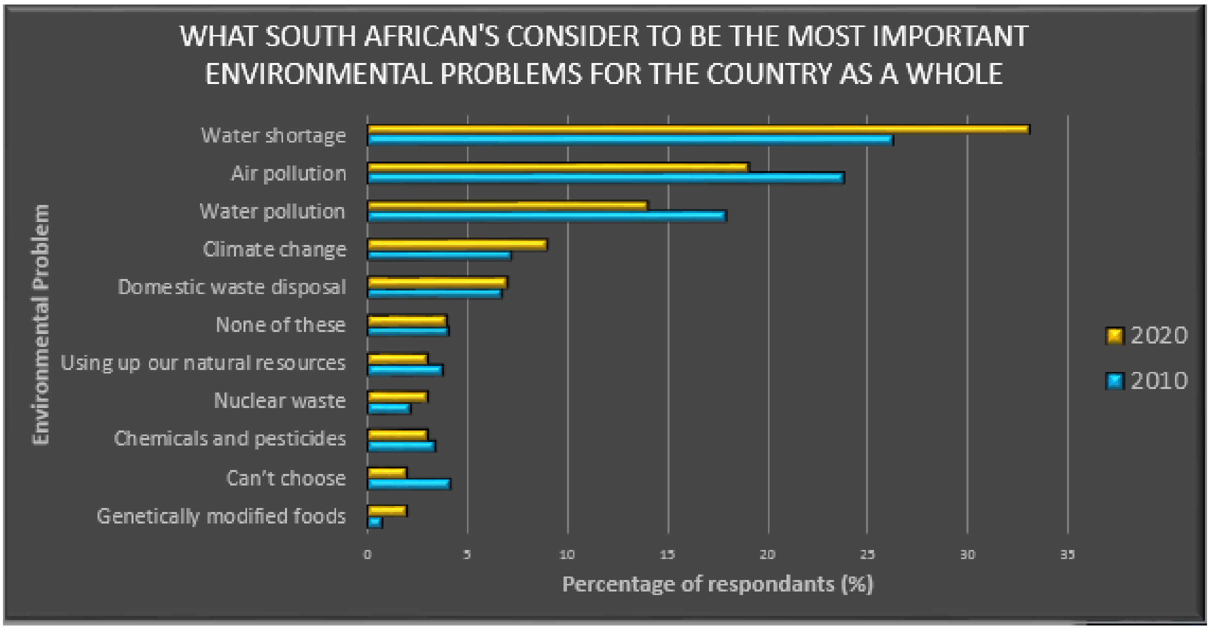
However, for the SAE 2022, the following initial summary may be of interest –

5.4.6.1 The perceived importance of environmental issues

In the public agenda, the environment does not feature as a strong national priority in the country today, relative to other challenges. Only 3 percent of the adult public mentioned it as the most pressing issue in the country, and 5 percent mentioned it as the second most important priority. This is almost unchanged relative to 2010. The top five priorities in 2020 were education, health care, poverty, crime, and the economy. This suggests that basic social needs are given precedence over environmental considerations.

When asked directly about the level of personal concern about environmental issues, 44 percent expressed concern about the environment while 20 percent were unconcerned. The balance was either ambivalent (34 percent) or uncertain (2 percent). Environmental concern is 14 percentage points lower than in 2010 (39 percent in 2010; 20 percent in 2020), with increases in the share unconcerned (+5 percentage points) and ambivalence (+9 percentage points).

The most pressing environmental issues the public was worried about in 2020 were water shortages (33 percent), air pollution (19 percent) and water pollution (14 percent). Climate change was mentioned by 9 percent of adults as the top national environmental concern. The main changes between 2010 and 2020 was an increase in concern over water shortages (+7 percentage points) and decreases in the share mentioning air pollution (-5 percentage points and water pollution (-4 percentage points). Climate change has remained virtually unchanged (+2 percentage points).



5.4.6.2 *Climate change beliefs*

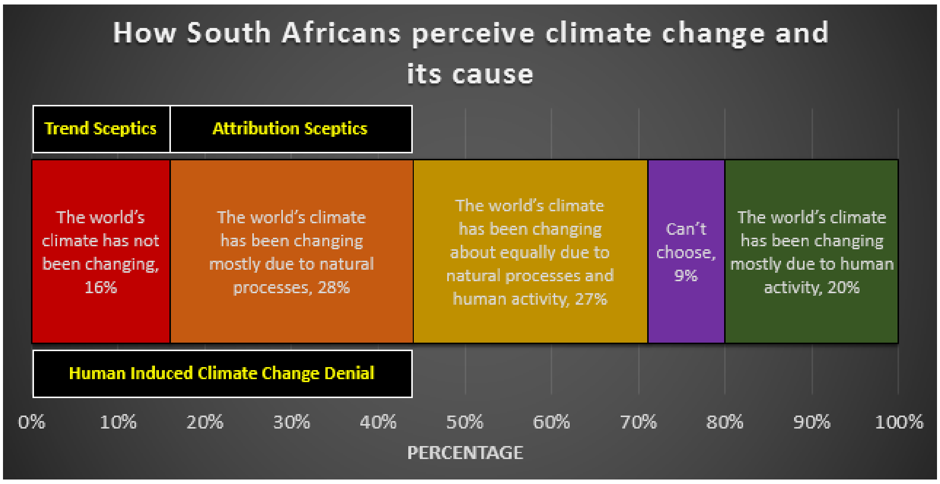
With regard to climate change beliefs, a sizeable share of the public expresses some form of climate scepticism. The survey results show that 16 percent believed that the world's climate is not changing (trend sceptics). A further 28 percent believe that the climate has been changing but mainly due to natural processes (attribution sceptics), while 47 percent acknowledged the contribution of human activity (27 percent equally with natural processes and 20 percent mostly due to human activity).

16%

believe that the world's climate is not changing (trend sceptics)

28%

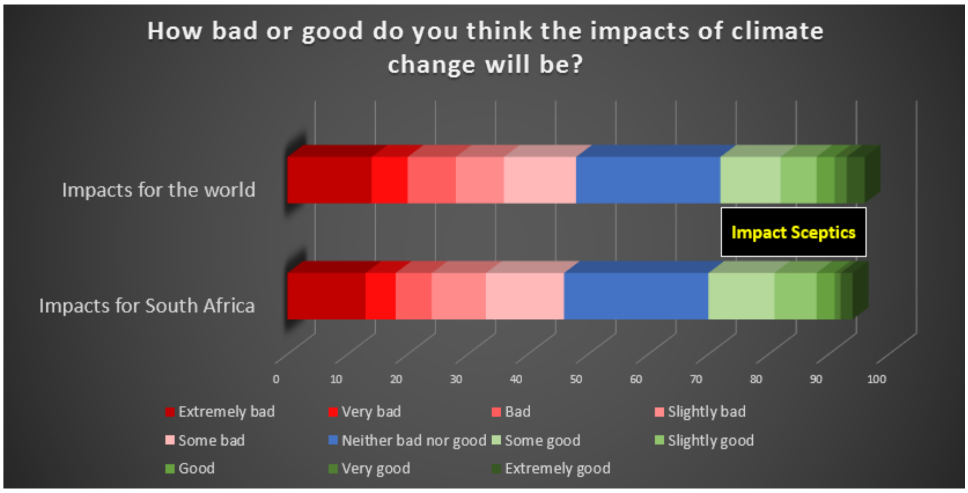
Believe climate has been changing but mainly due to natural processes (attribution sceptics)



The survey also showed that 23 percent of South Africans voice impact scepticism, implying that they do not think climate change will have negative impacts on the world as a whole. By contrast, close to half (48 percent) recognised the negative impact that climate change is likely to have globally, while 28 percent were ambivalent or uncertain. Almost identical findings were found when spatial reference in the impact scepticism question was changing from the impact globally to South Africa specifically (24 percent sceptical, 47 percent convinced of adverse impact, 28 percent ambivalent/uncertain).

23%
South Africans voice impact scepticism

47%
Convinced of the adverse impacts of climate change



5.4.6.3 Attitudes towards environment, science, and nature

A large share (47 percent) of South Africans believe that modern science will solve our environmental problems without having to significantly change our way of life. A far smaller share (18 percent) disagreed with this viewpoint, while 36 percent were ambivalent or uncertain.

South Africans are also more inclined to favour (47 percent) than oppose (23 percent) the view that we worry excessively about the future of the environment and not enough about the basic economic issues of today (prices, jobs).

With regard to the human impact on the environment, 53 percent agreed that ‘almost everything we do in modern life harms the environment’, while only 16 percent disagreed. More worrying is the fact that 50 percent believe that we worry too much about the impact of human progress on the environment.

From an economic perspective, 56 percent believed that economic growth is needed first in order to protect the environment. There was some recognition that the pursuit of economic growth may have adverse environmental consequences, with 41 percent agreeing that ‘economic growth always harms the environment’.

These set of findings point a somewhat concerning (and complex) set of environmental beliefs, that place strong faith in science to overcome pressing environmental challenges, and emphasis on resolving basic economic needs prior to addressing environmental challenges (without necessarily recognising the interconnections between these priorities).

5.4.6.4 Respondent’s (hypothetical) behaviour and environmental protection

The survey included a series of questions about the willingness to engage (hypothetically) in environmental protection behaviours. The results show that only between a quarter and fifth of South Africans would be willing to pay higher prices (31 percent willing), accept cuts in their standard of living (28 percent), or pay much higher taxes in order to protect the environment. By contrast, between 42 percent and 45 percent were unwilling to support such propositions.

A third (35 percent) opposed the suggestion of reducing the size of the country’s protected nature areas in order to open them up for economic development, while 32 percent expressed a willingness to do so, and 27 percent were ambivalent or uncertain.

Only a fifth (21 percent) of South Africans said that they always or often recycled glass, tins, plastic or paper, while 23 percent reported doing this sometimes, and 47 percent never. The remaining 9 percent stated that recycling was not available at their place of residence. A similar share (20 percent) said that they avoid buying certain products for environmental reasons.

In terms of other environmental actions, 12 percent reported that they belonged to a group focused on preserving or protecting the environment, while 6 percent reported having signed an environmental petition, donated money to an environmental group, or protesting about an environmental issue in the last five years (2015-2020 period).

5.4.6.5 Environmental efficacy and scepticism

From a personal efficacy viewpoint, 50 percent agreed that it was too difficult for someone like them to personally do much about the environment, compared to 22 percent who disagreed and 28 percent who were ambivalent/uncertain.

Slightly over two-fifths (43 percent) agreed that they do what is right for the environment, even if costs more in time or money, while 26 percent opposed this view. Yet, 41 percent also held the view that there were more important things in life than protecting the environment, and 38 percent agreed that many claims about environmental threats are exaggerated.

47 percent stated that there was no point in doing what they can for the environment if others do not do the same. This suggests that South Africans believe that individual engagement in pro-environmental actions is likely to be of little effect in addressing environmental problems if it is not accompanied with collective action.

5.4.6.6 Dangers of specific environmental problem

The survey included questions on the perceive dangers associated with seven environmental problems, ranging from air pollution caused by cars to nuclear power stations.

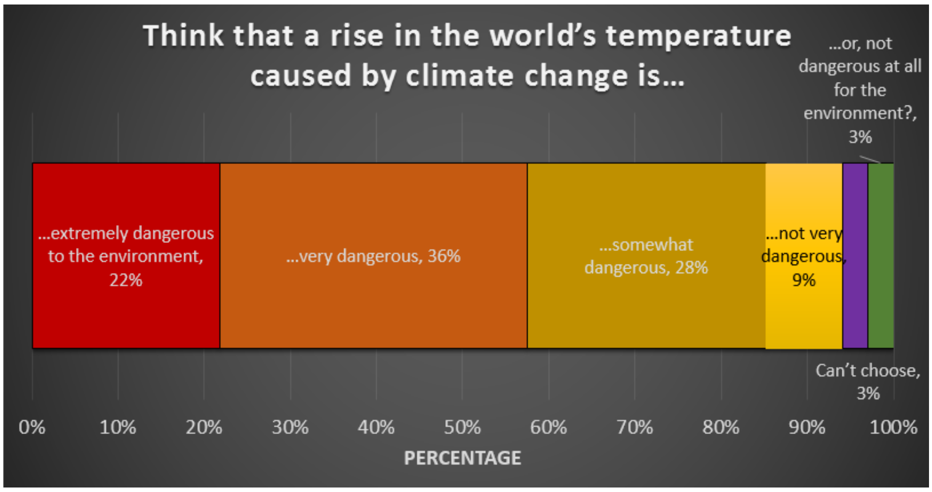
The share reporting these problems as very or extremely dangerous to the environment ranged from 48 percent to 65 percent. In descending order of perceived danger were air pollution caused by industry (65 percent very/extremely dangerous), pollution of the country's rivers, lakes and streams (64 percent), nuclear power stations (59 percent), climate change (58 percent), pesticides and chemicals used in farming (55 percent), air pollution caused by cars (55 percent), and the genetic modification of crops (48 percent).

58%

believe that climate change is dangerous to the environment

11%

Believe that it is not dangerous



Only between 7 and 17 percent reported that these seven problems were ‘not very’ or ‘not at all’ dangerous for the environment. Survey respondents were asked about their preferred approach to getting business and industry, as well as people and their families, to protect the environment.

South Africans’ dominant preference for business and industry is for them to be heavily fined for damaging the environment (39 percent favour this option), followed by usage of the tax system to reward businesses that protect the environment (30 percent), and education and information campaigns about the advantages of environmental protection (26 percent).

With regard to people and their families, there was fairly even support for heavy fines (30 percent), tax rewards (31 percent), and education/information campaigns (34 percent). There was a slightly greater emphasis on the latter option than was the case for business and industry, and lower relative support for heavy fines.

5.4.6.7 Interaction with nature

Just over a third (36 percent) of South Africans enjoy being outside in nature to ‘a great extent’. A further 34 percent say they enjoy interacting with nature ‘to some extent’, while 28 percent responded, ‘not at all’ or ‘to a small extent’. Despite South Africans natural abundance, this finding regarding intentional interaction with nature is quite surprising.

In the year prior to interviewing, 56 percent reported engaging in leisure activities outside in nature on at least one occasion, while 42 percent did not. The survey revealed that 17 percent engaged in such leisure activities several times a week or more. These results will have been influenced by the COVID-19 lockdown during 2020. However, 40 percent of our interviewing was conducted prior to the March 2020 hard lockdown. Comparing the pre- and post-samples based on this question, we found very nominal variation in frequency of leisure activities outside in nature.

5.4.6.8 Exposure to environmental harm

In terms of exposure to neighbourhood-level environmental harm, 14 percent said that that their local neighbourhood was affected to a great extent by air pollution. Similarly, 17 percent reported that their neighbourhood was seriously affected by water pollution and extreme weather events.

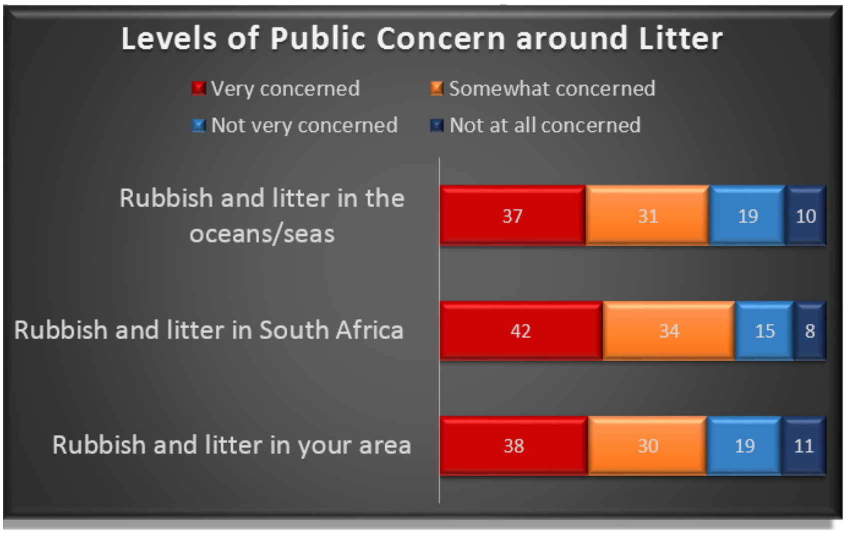
Slightly over half of South Africans (53-54 percent) said that these issues affected their local neighbourhoods to a small extent or not at all.

5.4.6.9 Litter / Littering

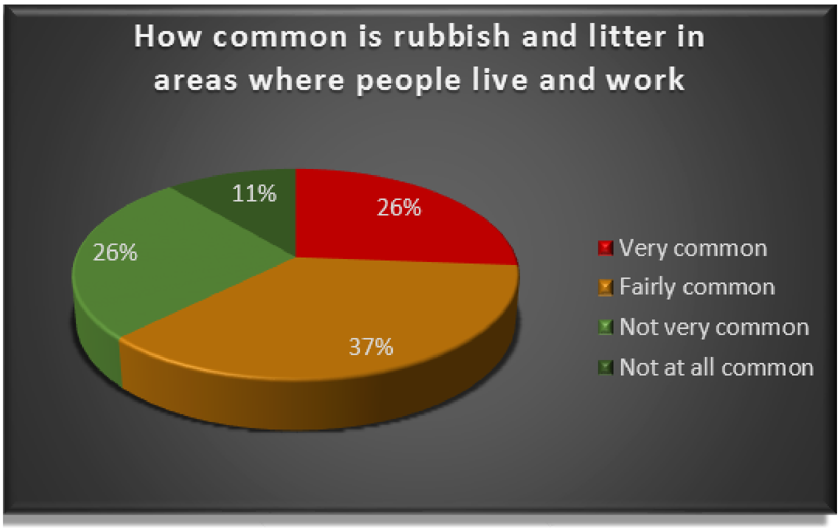
The survey also included a special supplement on attitudes towards litter and littering. Some of the highlights are outlined below:

Litter in one’s areas of residence represents a significant concern for South Africans. Approximately two-thirds (68 percent) voiced concern about rubbish and litter in their area, while 30 percent were not very or not at all concerned about this. South Africans were even more emphatic in their concern when referring to the country as a whole, with 76 percent expressing concern about rubbish and litter in South Africa. Concern over littering in the seas and oceans of the world stood at 69 percent at the time of survey.

Rubbish and litter lying about one’s area of residence is commonly reported, with 63 percent stating it was very or fairly common and 37 percent saying it was not very or not at all common.

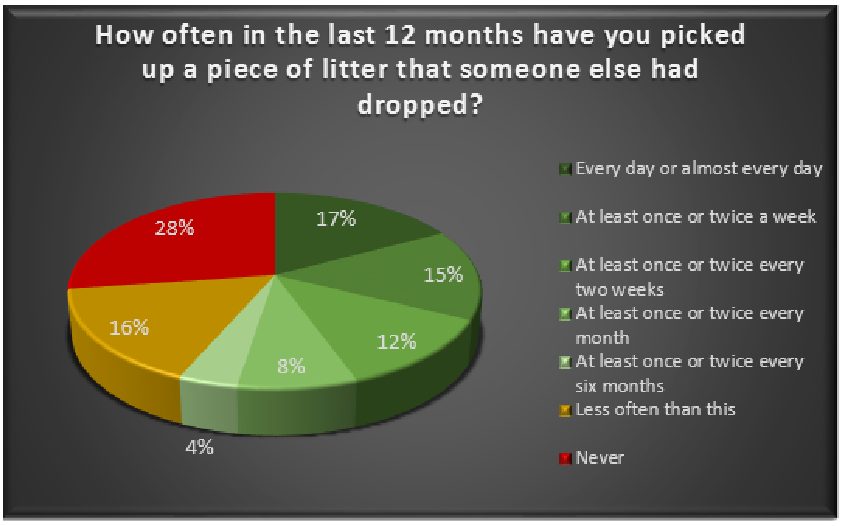


Notwithstanding the possible bias towards what respondents may perceive as being more socially laudable, accepted or expected opinion, **23% of South Africans believe that litter is of little, if any, concern**



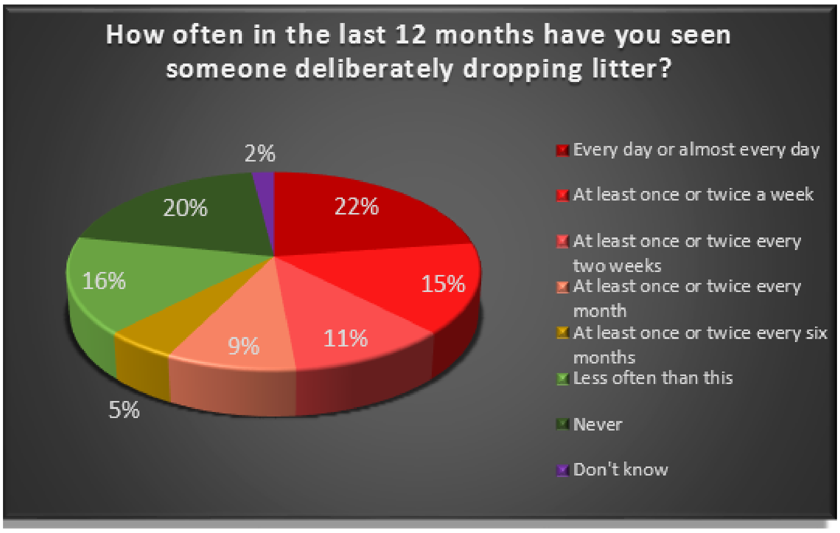
Notwithstanding the possible bias by respondents who may not identify discarded waste as rubbish or litter, **62% of South Africans believe that litter is common where they live or work**

An estimated 71 percent of South Africans reported picking up a piece of litter that someone else dropped in the past year, with 27 percent saying this never happened and 2 percent uncertain. Among those picking up someone else's litter, 17 percent reported doing this daily and a further 15 percent at least once or twice a week.



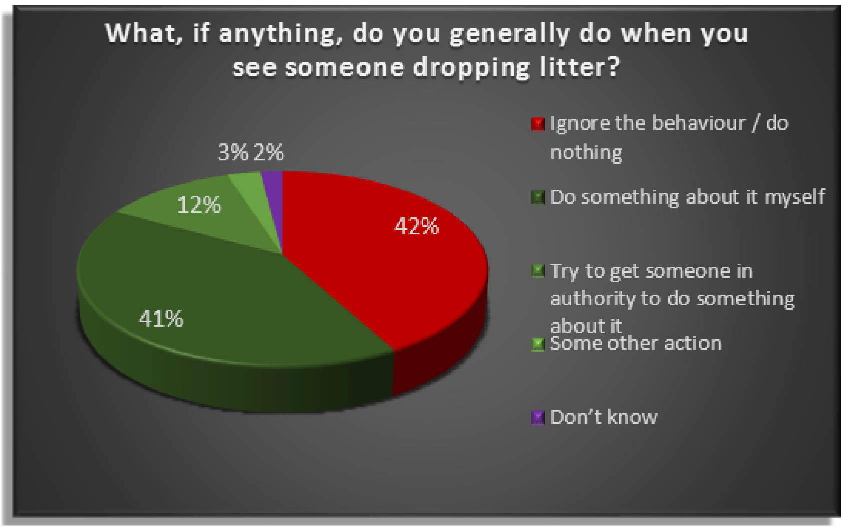
Notwithstanding the possible bias towards what respondents may perceive as more socially laudable behaviour, **72% of South Africans pick up someone else's litter from time to time**

In the last year, 78 percent reported seeing someone deliberately dropping litter, with 23 percent saying this occurred daily, 15 percent once or twice a week and 11 percent at least once a fortnight. A further 30 percent was on a less frequent basis. Only 20 percent reported not having seen someone drop litter in the year prior to surveying.



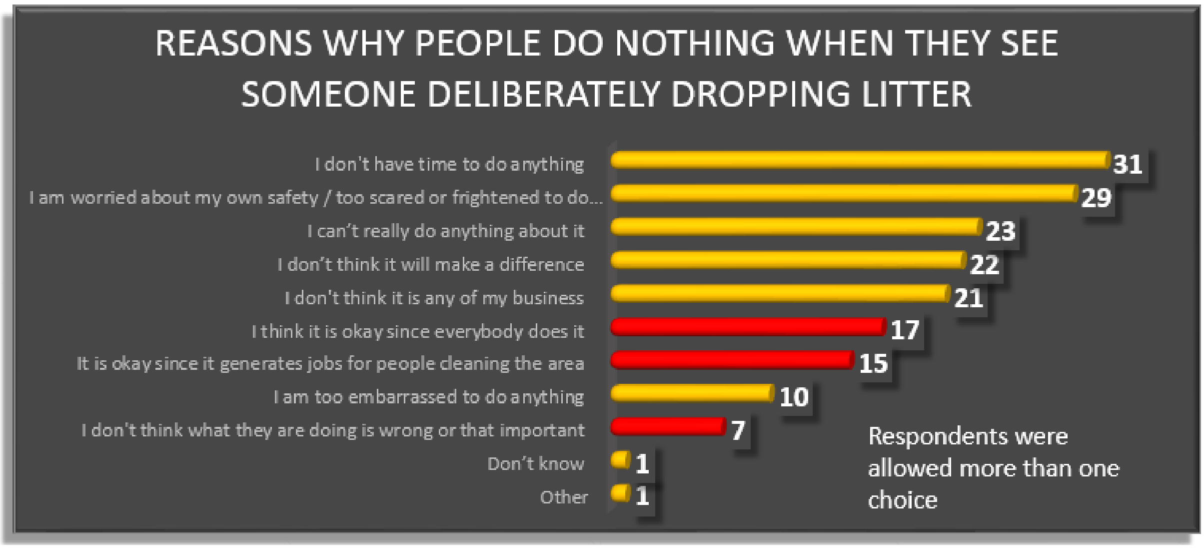
Notwithstanding the possible bias by respondents who may not identify the indiscriminate discarding of waste as littering, **58% of South Africans see someone dropping litter at least once a month**

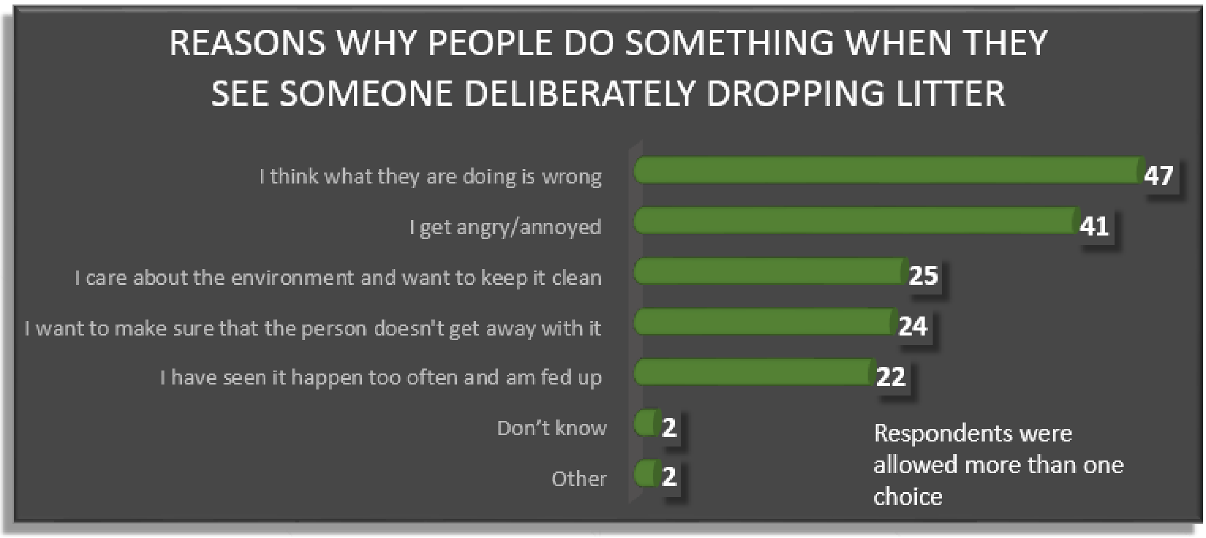
In response to seeing someone deliberately litter, 42 percent said that they ignore the behaviour or do nothing. When asked the reasons for this inaction, the most frequently mentioned responses were lack of time to do anything (31 percent) and worry over safety/fear (29 percent). Notable but slightly less commonly mentioned responses were beliefs that they could not do anything about it (23 percent), that it would not make a difference (22 percent), and that it was not any their business (21 percent). A final set of reasons, referred to by less than a fifth of adults, included views that deliberate littering is acceptable to litter since everyone does it (17 percent), that it creates jobs for those cleaning the area (15 percent), and that it is not wrong or important (7 percent). A tenth (10 percent) were too embarrassed to do anything about seeing someone else drop litter.



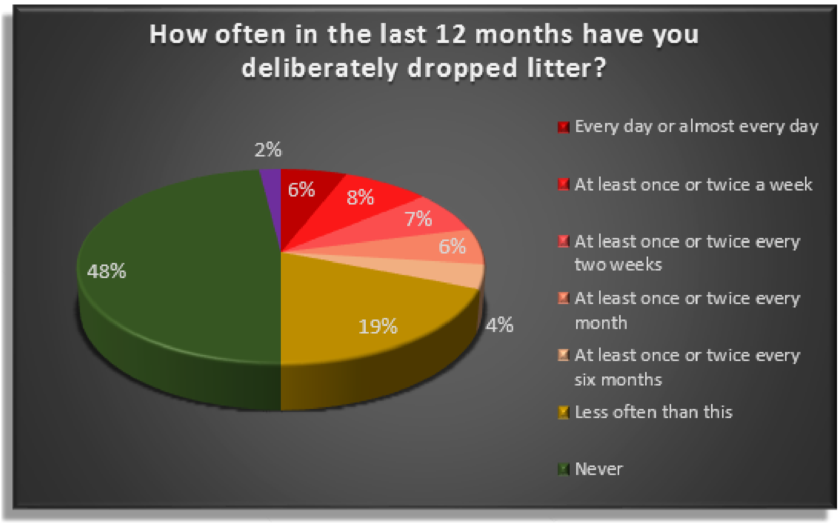
Notwithstanding the possible bias towards what respondents may perceive as more socially laudable, acceptable or expected behaviour, **42% of South Africans do not respond when seeing someone littering**

A further 41 percent said that they personally do something when they see someone deliberately litter, while 12 percent try to get someone in authority to intervene. Negligible shares take some other form of action (3 percent) or express uncertainty (2 percent) about how they typically respond. The main reasons provided for personally intervening or getting an authority figure to intervene were a sense that it is morally wrong (47 percent), and feelings of anger or annoyance (41 percent). Subsidiary motivations included care for the environment and a desire to keep it clean (25 percent, a desire to hold the litterer accountable (24 percent) and feeling fed up seeing littering happen frequently (22 percent).



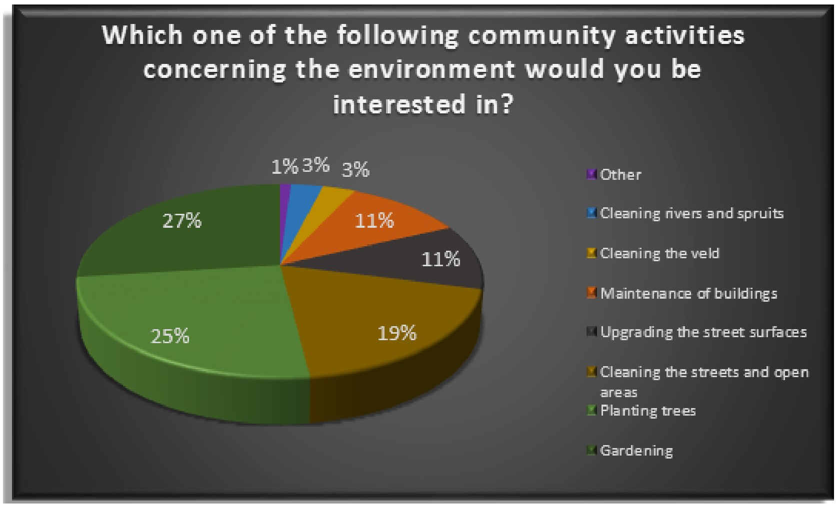


In the year prior to surveying, 50 percent of South Africans admitted that they had deliberately dropped litter, with 14 percent doing this a least a couple of times a week, 13 percent doing this between one and four times a month, and 23 percent doing this less often. By contrast, 48 percent said they had never dropped litter deliberately in the last year, while 2 percent were uncertain in response.



Notwithstanding the possible bias towards what respondents may perceive as more socially laudable, acceptable or expected behaviour, **50% of South Africans deliberately drop litter from time to time**

The survey ended by asking respondents which community activity concerning the environment they would be most interested in (from a precoded set of seven options). South Africans expressed greatest interest in community gardening activities (27 percent) and planting trees (25 percent), followed by cleaning streets and open areas (19 percent). Building maintenance and upgrading street surfaces was each mentioned by 11 percent, while less than five percent mentioned cleaning rivers and spruits, and cleaning the veld.



Although 52% of South Africans would be interested in 'community greening' activities, "cleaning the streets and open areas" is the 3rd most popular choice for community environmental activities

6 WHAT ARE THE IMPLICATIONS?

6.1 Poor air quality

The following section is an edited extract of the South African State of Air Report 2018 and readers are encouraged to read the report for more in depth, fully referenced, information on South Africa's air quality. Poor air quality has undisputed negative impacts on the health and well-being of humans, other animals and plants. Many air pollution health studies have been conducted in areas in South Africa where air quality was identified as poor or potentially poor in the 2007 National Framework for Air Quality Management.

The South Durban Health Study was conducted in 2004 and 2005 to assess the influence of industrial and vehicular emissions on respiratory health in Durban's South Industrial Basin. The study found that ambient concentrations of NO_2, NO, PM_{10}, and SO_2 were significantly associated with negative impacts on health like decreased lung function in children and persistent asthma. In addition, the study reported that attending primary school in south Durban, compared to north Durban, significantly increased the risk for persistent asthma. For adults, living in communities in the south, as compared to the north, was significantly associated with hay fever, and somewhat associated with chronic bronchitis, wheezing with shortness of breath, and hypertension.

A Vaal Triangle Priority Area (VTAPA) health study was conducted in 2006 and included a community health survey, a child medical survey and a human health risk assessment. A vulnerability assessment in the VTAPA communities considered population sensitivity (children below 15 years of age and the elderly above 65 years of age) and socioeconomic status (the unemployed, people living below the poverty level of R400 per person per month, and people who live in informal houses). Different areas in the VTAPA were found to have different vulnerability scores. Taking vulnerability/sensitivity and ambient particulate matter (PM) concentrations into account, it was concluded that people living east of Three Rivers and west of Sebokeng are three to seven times more at risk of suffering from health impacts associated with PM than the rest of the population in the VTAPA.

The concentration of industry in Richards Bay and the potential impact on ambient air quality led to the Richards Bay Health Study in 2009 linking health issues to poor air quality. It was reported that the number of patients diagnosed with upper respiratory tract infection (URTI) comprises 12 percent of the total patients who attended the Richards Bay and Mandlanzini Clinics between 2009 and 2011. The trends in URTI cases indicated that coughing, chest pains, wheezing, flu, fever, headaches and asthma are the most prevalent URTI symptoms recorded from the Richards Bay communities between 2009 and 2011. Little seasonal variation in the occurrence of URTI cases was found with the minor exception of increased asthma during summer and spring and increased flu and fever during winter periods. Tests showed that the majority of respondents were classified as having normal respiration (60 percent) with obstructive respiration accounting for 30 percent and the balance being associated with restrictive respiration. Ambient concentrations of PM_{10}, NO_2 and SO_2 were generally low relative to the national Ambient Air Quality Standards (NAAQS). Furthermore, the dominant source of energy in Richards Bay is electricity (78 percent), with wood (3 percent) and paraffin (2 percent) being the next most used single fuel types. Using dispersion models, geospatial assessments and available in-situ air quality measurements the study reported at least four priority areas in which air pollution can be expected to have the greatest impact on health. The largest area was reported to be around the Richards Bay industrial area, with Felixton, around Empangeni and the area just south of Nseleni also identified.

Growing concerns regarding exposure and the impact of air pollution on health led to the Western Cape, Department Forestry, Fisheries and the Environment and Development Planning (DEA&DP) conducting a study in 2016. Other studies have assessed the risk associated with exposure to common air pollutants from sources, including specific sources such as heavy-duty vehicles and mine dumps such as traffic. Some sub-places in two municipal areas were at risk of acute and or chronic effects from exposure to PM_{10}. These areas were the Paarl (acute effects) and Bluedowns (acute and chronic effects) risk assessment areas within the Drakenstein Local Municipality and Cape Town Metropolitan Municipality respectively. The risk assessment areas in the Theewaterskloof (Grabouw) and Saldanha Local Municipality showed a low potential for adverse effects from exposure to the modelled $PM_{2.5}$ concentrations, using the NAAQS as a benchmark. In the Mossel Bay Local Municipality 25 sub-places were identified where individuals in those areas may develop adverse health effects. In the Drakenstein Local Municipality, six sub-places in Wellington and all of the sub-places in Paarl were also at risk and in the Cape Metro 28 sub-places in the risk assessment areas were potentially at risk of adverse effects.

In Pretoria West where short term and longer-term ambient concentrations of PM_{10}, SO_2, NO_2, CO and O_3 were below the NAAQS, a 2017 report noted that no health risk was found to be associated with acute and intermediate exposure, but infants and children were more likely to suffer health effects. Long-term chronic exposure to normal and worst-case exposure scenarios to each of the pollutants posed some levels of risks for sensitive individuals.

Ambient air pollution concentrations in excess of prescribed health standards are unacceptable and exceedances are more serious in areas where people reside. Vulnerability caused by poverty, disease, lack of education, and poor living conditions exacerbates the problem. In 2012, researchers assessed the association between 24-hour average ambient PM_{10}, NO_2 and SO_2 concentrations and daily respiratory (RD), cardiovascular (CVD) and cerebrovascular (CBD) mortality in Cape Town. For models that included entire year data, an inter-quartile range (IQR) increase in PM_{10} (12 mg/m^3) and NO_2 (12 mg/m^3) significantly increased CBD mortality by 4 percent and 8 percent, respectively. A significant increase of 3 percent in CVD mortality was observed per IQR increase in NO_2 and SO_2 (8 mg/m^3). The study further reported that during a warm period, PM_{10} was significantly associated with RD and CVD mortality, NO_2 had significant associations with CBD, RD and CVD mortality, and SO_2 was associated with CVD mortality. None of the pollutants were associated with any of the three outcomes in the cold period.

A 2015 research report investigated the association between the frequency of truck traffic and allergic rhinitis symptoms, rhinoconjunctivitis and hayfever among 13- to 14-year-old school children in the City of Ekurhuleni Metropolitan Municipality. Rhinitis, hay fever, current rhinitis and current rhinoconjunctivitis were significantly associated with the frequency of trucks passing near residences almost all day on week days supporting the hypothesis that traffic related pollution plays a role in the prevalence of allergic rhinitis symptoms in children residing in the area. No association was observed between truck traffic and hay fever in the multiple analyses.

There is increasing evidence that environmental factors such as air pollution from mine dumps increase the risk of chronic respiratory symptoms and diseases. Another 2015 research report investigated the association between proximity to mine dumps and prevalence of chronic respiratory disease in people aged 55 years and older. Elderly persons in exposed and unexposed communities from five pre-selected mine dumps in Gauteng and North West Province were included in a cross-sectional study. Exposed elderly persons had a significantly higher prevalence of chronic respiratory symptoms and diseases than those who were unexposed. Multiple logistic regression analysis results indicated that living close to mine dumps was significantly associated with asthma, chronic bronchitis, chronic cough, emphysema, pneumonia and wheeze. Residing in exposed communities, currently smoking, ex-smoking, use of paraffin as main residential cooking/heating fuel and low level of education emerged as independent significant risk factors for chronic respiratory symptoms and diseases.

6.2 Poor water quality

Water is essential for life on earth and poor water quality has an effect on all life on earth. In terms of human health, poor water quality can kill you. In 2015, it was estimated that 1.8 million people died, and 1 billion people got sick around the world because of contaminated water. As is often the case with pollution, it is usually low-income communities that are disproportionately at risk because their homes are often closest to the most polluting industries, or they draw their water directly from untreated sources like polluted rivers and wells. Waterborne pathogens, in the form of disease-causing bacteria and viruses from human and animal waste, are a major cause of illness from contaminated drinking water. Diseases spread by unsafe water include cholera, giardia, and typhoid. Even in wealthy nations, accidental or illegal releases from sewage treatment facilities, as well as runoff from farms and urban areas, contribute harmful pathogens to waterways.

Industrial and agricultural pollutants like lead and heavy metals such as arsenic and mercury and pesticides and nitrate fertilizers are all entering our water supplies and once ingested, these toxins can cause a host of health issues, from cancer to hormone disruption to altered brain function. Children and pregnant women are particularly at risk. Even swimming can pose a risk. Swimming is water that is polluted by sewage can lead to skin rashes, pinkeye, respiratory infections, and even hepatitis. But poor water quality is not only a human health problem. Healthy ecosystems rely on a complex web of animals, plants, bacteria, and fungi – all of which interact, directly or indirectly, with each other. Harm to any of the components of this web can create a chain reaction that can degrade entire aquatic environments.

When water pollution causes an algal bloom in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plant and algae growth, which in turn reduces oxygen levels in the water. The absence of oxygen in water bodies is known as eutrophication. Eutrophication suffocates plants and animals and can create "dead zones" where dams, rivers and streams are essentially devoid of life. In certain cases, these harmful algal blooms can also produce neurotoxins that affect wildlife. Chemicals and heavy metals from industrial and municipal wastewater are also toxic to aquatic life, often reducing an organism's life span and its ability to reproduce. These pollutants also make their way up the food chain as predators eat their prey – a process known as bioaccumulation.

6.3 Polluted oceans

Although our oceans are impacted in the same way as our fresh water, marine ecosystems often suffer additional threats. For example, marine debris, which can strangle, suffocate, and starve animals. Much of this solid debris, such as plastic bags and drinks cans, gets swept into sewers and storm drains and eventually out to sea, turning our oceans into a veritable soup of garbage that sometimes consolidating to form floating waste patches. Discarded fishing gear and other types of debris are responsible for harming hundreds of different species of marine life.

Meanwhile, the ocean acidification resulting from increased atmospheric concentrations of CO_2 is making it tougher for shellfish and coral to survive. As the world's oceans get more acidic, it is harder for shellfish and other species to build shells and acidification may also impact the nervous systems of sharks, and other marine life.

6.4 Polluted soil

Soil pollution, also known as soil contamination, refers to the presence of human-made chemicals in the soil – usually at harmful concentrations. Common soil contaminants include heavy metals, solvents, petroleum hydrocarbons, pesticides, and herbicides. Healthy soil is essential to the growth of good quality crops and other plants. When plants grow in polluted soil, the yield is negatively impacted in terms of both quantity and quality. Many plants are unable to grow on contaminated soil. Microbes living in the soil also die, which can cause areas with contaminated soil to become wastelands with little or no plant growth. The failure to grow properly affects animals and people dependent on these plants for food. Thus, the entire food chain can suffer as a result of soil contamination.

When plants can no longer grow properly, the soil becomes vulnerable to the erosional forces of both wind and water. Wind can pick up the soil contaminants, which remain in the air as suspended contaminants. Rainfall washes soil pollutants into nearby water bodies, and these toxic substances can render the water unfit for consumption and domestic use. Soil that is contaminated with agricultural herbicides and pesticides also ends up in water bodies when farmland is eroded by rainwater. Thus, soil pollution can lead to both air and water pollution. The impacts of soil contamination also have negative effects on the health of animals and humans. Plants grown in polluted soil can absorb the contaminants, which eventually enter the human body directly by consumption of such plants or through the food chain. Animals that depend on such plants as a food source also suffer. The contaminants can also enter the human or animal body through direct inhalation. Pollution might also infiltrate the soil layer and enter groundwater that is used for drinking water.

The health effects of soil contaminants depend on a variety of factors, such as the nature of the pollutant, mode of attack, and vulnerability of the exposed population. Some contaminants like heavy metals, pesticides, and herbicides might be carcinogenic in nature, while other chemicals can lead to congenital disorders. The health effects of exposure to soil contaminants can also lead to liver toxicity, kidney failure, and neurological disorders.

6.5 Lost or degraded ecological infrastructure

As explained in the section on “Why is the environment important” – Ecological infrastructure refers to naturally functioning ecosystems that deliver valuable services to people, such as fresh water, climate regulation, soil formation and disaster risk reduction. It is the nature-based equivalent of built or hard infrastructure, and it is just as important for providing services and underpinning socio-economic development. Ecological infrastructure includes, for instance, healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat, which together form a network of interconnected structural elements in the landscape. Ecosystem services are the many and varied benefits that we get for free from the natural environment and properly-functioning ecosystems –ecological infrastructure. When we lose or degrade our ecological infrastructure, we lose or degrade the ecosystem services they provide.

In terms of so called ‘provisioning services’ when we lose or degrade our ecological infrastructure our losses include: food (e.g. seafood and game), crops, wild foods, and spices; raw materials (including timber, skins, fuel wood, organic matter, fodder, and fertilizer); genetic resources (including crop improvement genes, and health care); water; biogenic minerals; medicinal resources (including medicinal plants, pharmaceuticals, chemical models, and test and assay organisms); energy (hydropower, biomass fuels); ornamental resources (including fashion, handicraft, jewellery, pets, worship, decoration and souvenirs like furs, feathers, ivory, orchids, butterflies, aquarium fish, shells, etc.).

In terms of so called ‘regulating services’ when we lose or degrade our ecological infrastructure our losses include Carbon sequestration and climate regulation; predation that regulates prey populations (including so-called pest populations); waste decomposition and detoxification; purification of water and air; and pest and disease control.

In terms of so called ‘cultural services’ when we lose or degrade our ecological infrastructure our losses include: cultural (including use of nature as motif in books, film, painting, folklore, national symbols, architect, advertising, etc.); spiritual and historical (including use of nature for religious or heritage value or natural); recreational experiences (including ecotourism, outdoor sports, and recreation); science and education (including use of natural systems for school excursions, and scientific discovery); Therapeutic (including Ecotherapy, social forestry and animal assisted therapy)

In terms of supporting services, this includes the loss or degradation of services such as nutrient recycling, primary production, soil formation, habitat provision and pollination. This makes it impossible for ecosystems to continue providing the services described above. In summary, and put very simply – when the environment gets sicker and sadder, we get sicker and sadder. If it is healthy and happy, we are healthy and happy.

6.5.1 Degraded marine ecosystems

6.5.1.1 Fishing environmental impacts

Fishing inevitably has an impact on the marine environment. Yet, although varying between each of the fisheries sectors, the degree of environmental impact depends on a number of factors including, but not limited to:- (i) the type of fishing, (ii) regulation of the sector, (iii) effectiveness of enforcement, (iv) the fishing method, (v) type of fishing gear used, and (vi) the nature and robustness of species and habitats exposed to the fishing activity (of which some are more vulnerable than others to overfishing or disturbance). Nevertheless, some generic environmental impacts can be described. The universal impact is on the targeted species, though some industries such as bottom trawling may have bycatch and habitat damage issues that may be worse than the impacts on the target species. This environmental impact generally reduces the target species' biomass and therefore negatively impacts other species predating on these resources. This can disturb the balance of processes in the food web and hamper healthy ecosystem functioning. For example, overfishing and targeting of juveniles especially sardine in the small pelagic fishery is considered to have substantial impacts on the ecosystem structure and function in altering the composition and spatial distribution of these populations, with unexpected consequences for the African penguin, and spatial measures are required to minimize competition between the commercial sector and this endangered species that, among others, plays a role in ecotourism.

Fishing also has impacts on non-target species. This occurs most commonly through bycatch, where species are accidentally (and in some instances, intentionally) caught and either retained or discarded. There is a fair amount of 'overlap' where species are caught in multiple fishing sectors. For example, horse mackerel is targeted by midwater trawl, and is a bycatch species of the hake trawl and pelagic purse seine fisheries. Net-based fisheries are most prone to bycatch owing to the low level of selectivity of the fishing method, and species of concern have been identified for the trawl sector including biscuit skate. The inshore hake trawl fishery, for example, is known to encounter a substantial high-diversity bycatch as a result of high fish diversity occurring on the Agulhas Bank with the majority of these species retained. Other sectors, like the tuna pole fishery is a highly targeted fishery with virtually zero unintentional bycatch. Other bycatch impacts are found in the longline fishery, as it has deemed responsible for the declining populations and threatened conservation status of several shark, sea bird and turtle species. Although improved seabird bycatch mitigation measures have reduced seabird mortality; shark, turtle and marine mammal bycatch continue to be a concern that is being addressed.

Fishing using mobile gear also has impacts on habitats, most notably sea floor (benthic) habitats and associated biota on account of bottom trawling due simply to the nature of the fishing activity, which involves dragging a net over the sea floor. The extent of impact is influenced by the size of the trawled area, frequency of fishing effort and the habitat type. Structurally complex habitats (e.g. cold-water coral reefs) and habitats that are relatively undisturbed by natural perturbations (e.g. deep-sea benthic environments) are highly susceptible to impacts from trawl gear. Unintentional impacts on other species can be caused by lost gear that results in ghost fishing, although this issue is understudied in South Africa.

6.5.1.2 Maritime transport and ports environmental impacts

Possible impacts of maritime transport and port activities on the marine environment is marine pollution by ships, marine pollution and ballast water discharge. The shipping industry in South Africa has potential to impact on marine biodiversity through oil spills as a result of shipping accidents or deliberate discharge of oil, oily residues or contaminated ballast water. Ship-to-ship transfers, that is, the transfer of cargo between ships positioned alongside each other, either while stationary or underway, come with a higher risk of accidents, causing marine pollution. Pollution reduces the quality of the ocean, making it less suitable for marine life. Oil spills can have far-reaching environmental impacts due to the interconnectedness of oceans. A number of oil spill incidents occurred around South Africa per year between 2001 and 2006.

Ballast is required to ensure safety of ships and their operation. Ballast water can however impact the marine environment through the accidental introduction of non-native species when ballast water is discharged. This has been identified as the most important mode of alien invasive species introduction in South Africa, with hull fouling and ballast water contributing to 50 percent and 37 percent of introductions respectively. More than 22 million tons of ballast water are discharged in South African ports and harbours annually.

Other pathways of introduction are marine aquaculture and petroleum infrastructure. Invasive species can result in serious ecological and economic problems in marine environments, and a common result as the invasive species proliferate, is the severe depletion of biological diversity.

The majority of invasive alien marine species occur on the West Coast of South Africa, with ports and harbours around the country forming hotspots for the introduction of invasive alien species. In spatial terms, temperate species originating from the northern hemisphere predominate on the West and South Coasts, while species from the southern hemisphere occur largely on the East Coast. Apart from posing a serious threat to coastal and marine biodiversity, invasive alien species can also have serious economic impacts through their detrimental effect on commercial fisheries stocks, including marine aquaculture.

Ports have a statutory responsibility to maintain navigation channels for port users, which requires dredging of port sediment to keep the channels functional. Port and port infrastructure expansion developments, navigational dredging and the dumping of dredged material cause loss and/or disturbance of habitat and marine biodiversity through physical smothering or chemical or heavy-metal contamination of disposal sites. South Africa currently have designated dredged material disposal sites located near port cities and coastal towns. There has been an increase in the volume of dredged material disposed between 2006 and 2011. Most of the material was generated as a result of port maintenance dredging operations. Shipping, dredging and port expansion work leads to underwater noise which may disturb marine wildlife. Shipping causes air pollution through emissions by the fishing, cargo and passenger transport, tourism, and oil and gas industries. The International Maritime Organization (IMO) are seeking global agreement on lowering ship emissions. In terms of NOx, the use of shore-based electricity generation as opposed to that generated by ships would significantly reduce NOx emissions, thereby enhancing air quality especially in and around ports.

Maritime transport is a minor contributor to transport sector emissions in South Africa and the rest of the world, being less than 1 percent this is due to maritime transport operating mainly beyond South African boundaries.

6.5.1.3 Sea and freshwater abstraction environmental impacts

Whereas abstraction of sea water for desalination has little to no environmental impacts (discharge of brine has significant impacts though), the reduction of river flow leads to critical impacts on the marine and coastal environment. As such, it leads to a reduced sediment supply to the coast with implications for beach and subtidal habitats. Reduced sediment input can change beach morphodynamic state, altering the beach biodiversity, accelerating beach erosion and can even lead to the loss of beach habitat. In the subtidal environment, riverine inputs provide important sediment inputs for the maintenance of unconsolidated sediment habitats such as mud banks. Reduced river inputs reduce the spatial extent of such habitats, which may have implications for fisheries such as South Africa's sole fisheries. Many of these habitats are also important for ecological processes. For example, the endemic and threatened white steenbras *Lithognathus lithognathus* spawns on submarine fluvial fans, a localised habitat of limited extent, associated with mixed mud and sand banks deposited by rivers in the South-East Cape coast. Changes in salinity and water temperature linked to flow alteration also impact thermohaline fronts which affects plankton feeding communities and the fish, birds and mammals that feed on the concentrated food associated with these habitats.

6.5.1.4 Wastewater discharge environmental impacts

Disposal of land-derived wastewater has a significant potential to impact the marine environment. The degree of the impact however depends significantly on the type of wastewater treatment and the resultant quality of effluent discharged, the quantity disposed, and the location of the outfalls which determines the assimilative capacity and sensitivity of the receiving marine environment. Typically, the environmental impacts are:

- Marine pollution including reduced water and sediment quality. This can lead to possible mortality of organisms from organic, metal, and radioactive contaminants, especially from industrial discharges.
- Risk of eutrophication through addition of nutrients (e.g., nitrogen, phosphates and derivatives). This can possibly lead to changes in the species composition of phytoplankton communities, toxin producing and harmful algal blooms. Submerged vegetation could be lost through shading, development of hypoxic conditions due to decomposition of excess plant biomass, changes in benthic community structure due to hypoxia or toxic algae, and fatalities of fauna due to oxygen deficiencies caused by the addition of organic matter.
- Litter in wastewater may harm wildlife through ingestion or entanglement.
- Addition of faecal material may lead to pathogens (bacteria, viruses or parasites) causing illness/infection if ingested through recreational water use or consumption of marine aquaculture products (e.g., shellfish).

6.5.1.5 Possible environmental impacts of submarine cables and pipelines

Environmental impacts of submarine cables and pipelines will take place during design and exploration work, particularly during construction, but also during possible dismantling after termination of use. Investigations for the planning of the underwater infrastructure are generally associated with possible impacts caused by underwater noise from hydrographic and other survey vessels and disruption of habitats through extraction for sampling purposes. The main impacts occur during construction stages: The laying of cables and pipelines leads to seabed disturbance and associated impacts (damage, displacement or disturbance) on flora and fauna, increased turbidity, remobilisation of contaminants from sediments and alteration of sediments. Along with noise and visual disturbance, these effects are generally temporary. In addition, their spatial extent is limited to the cable corridor.

While pipelines are one of the safest modes of transporting oil and gas and have failure rates much lower than the railroads or highway transportation, failures do occur. In such case, significant impacts on the marine environment may however occur if the pipeline system is damaged or fails and oil or gas discharged into the sea.

The impact on the marine environment during construction phases will also be higher in biologically or ecologically sensitive marine areas, both for submarine cables and oil and gas as well as wastewater discharge pipelines.

- Destruction and disturbance of foreshore and seabed, and other coastal habitats through reclamations, structures, vegetation clearance, and harvesting;

- Sedimentation, contamination and eutrophication of coastal waters including estuaries, harbours, coastal lakes from point and non-point source discharges;
- The introduction and spread of alien and invasive plants, domestic animals and pests in the coastal environment associated with increasing activities on the coast; and
- Migratory species (particularly seabirds that use coastal land) are vulnerable to loss of any of the habitats they require, and/or obstructions along their migratory route.

6.5.1.6 Marine renewable energy impacts

The emerging use of Marine Renewable Energy (MRE) may have a significant impact on the marine environment if deployed at scale in future, as evidence from abroad and research shows. Yet, the degree of the environmental impact depends on a number of factors including but not limited to attributes of the deployed device (e.g., static or dynamic), the type of device (e.g., wave or current), and the spatial scale of the installations (e.g., single device or arrays).

Although some of these impacts may be environmentally undesirable, studies suggest that, if appropriately managed and designed, MRE devices may also increase local biodiversity and potentially benefit the wider marine environment. Installations could act as both artificial reefs and fish aggregation sites, and *de facto* marine protected areas as they limit other resource extracting uses in the area; with associated positive effects on biodiversity and fisheries.

The key environmental impacts from offshore wind installations are noise, from construction and operation, and the collision risks for sea birds. For devices capturing energy from waves or currents, the key environmental impacts are the potential for collision with cetaceans and fish, species disturbance through the creation of electromagnetic fields and underwater noise. Habitat loss may occur on the basis of construction of any marine renewable energy device.

Physical systems act as drivers for the sustainability and health of organisms in the marine environment. The installation of marine renewable energy devices may affect the system by changing natural flow patterns around installations, which can alter sediment distribution and transport. In addition, energy removal may change the operation of a waterbody. A small number of devices will not create measurable changes, but large commercial arrays might alter the system over time.

6.6 Observed climate change impacts in Southern Africa

The following section is an edited extract of the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, 2022 with a focus on the significance of the inferences at the continental, regional (Southern Africa) and/or national level. Readers are encouraged to read the report for more, in-depth information on the sixth assessment.

6.6.1 Human life and health

Recent estimates suggest that human-induced climate change was responsible for almost 44 percent of heat-related deaths in South Africa (1991–2018). In many of South Africa's districts, this equates to dozens of deaths per year. There are already large inequalities in people's health due to their economic status, social behaviours, and where they live (rural people have worse access to quality healthcare services). Climate change magnifies these existing health inequalities. The health impacts of climate change disproportionately affect people with the lowest incomes, and in some cases, impacts differ by gender and age too. The most vulnerable are young children (<5 years old), the elderly (>65 years old), pregnant women, individuals with pre-existing illness, physical labourers and people living in poverty or affected by other socioeconomic determinants of health.

The KwaZulu-Natal floods were declared a provincial disaster on the 13 of April 2022. On the 17 of April 2023, 435 fatalities were reported, and the homes, businesses, roads, bridges, and electricity and water infrastructure were damaged or destroyed. An estimated 130000 people have been affected, with more than 19182 houses and 264 schools destroyed. The worst affected districts included Ugu, eThekwini, King Cetshwayo, uMgungundlovu, and iLembe. At the end of May 2022, approximately 448 fatalities were reported, and the homes, businesses, roads, bridges, as well as electricity and water infrastructure, have been damaged or destroyed. An estimated 130 000 people have been affected, with more than 19 182 houses and 264 schools destroyed. The most affected areas in May 2022 were Hluhluwe, eThekwini, Jozini, KwaDukuza, Mandeni, Maphumulo, Mkhambathini, Mthonjaneni, Mtubatuba, Ndwedwe, Nongoma, Ulundi, Umdoni, Umhlabuyalingana, uMhlathuze, uMlalazi and uPhongolo District Municipal areas.

For more additional information on the recent and future climate changes in South Africa and their impact on health and behavior readers are encouraged to read the Major Climate Change-induced Risks to Human Health in South Africa article.

Table: Number of incidents and impact per District/Metro Municipality

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

According to the National State of Water Report, 2022 the worst infrastructure damage in eThekwini was observed at the Surfside residential complex, which suffered significant damage due to a lack of stormwater infrastructure in development under construction upstream of the complex. The May floods also washed away the various repairs underway at the Umdloti Water Treatment Works.

6.6.2 Ecosystems and biodiversity

Temperatures in southern African freshwater bodies have risen by about 0.1-0.3°C per decade. Increases in temperature, changes in rainfall, and reduced wind speed have altered the physical and chemical properties of freshwater bodies, affecting the water quality and productivity of algae, invertebrates and fish. Increased carbon dioxide levels in the atmosphere and climate change are influencing the growth of natural vegetation across African landscapes. Woody plants are expanding their range, particularly into grasslands and savannas. Vegetation changes affect wild animal species and people's livelihoods. For instance, bird, reptile and mammal species that depend on grassland habitats become rarer, as woody plants spread. In southern Africa, shifting geographic distributions of anchovy, sardine, hake, rock lobster and seabirds have been linked to climate change. Extreme heat days have increased across South African national parks since the 1990s. This reduces animal mobility, decreasing animal viewing opportunities. Tourists and employees also fear heat stress. Reduced tourism decreases revenue for national park management.

6.6.3 Grassy ecosystems

According to the Annual Review of Environment and Resources Volume 47, 2022, grassy ecosystems, particularly the ones that fall within the ecosystem uncertain space, are declining due to increasing CO_2, land use conversion, and the loss of the processes (fire, herbivory) that maintain their health and integrity. The scale and extent of ecosystem loss vary geographically, as do the combination of processes determining their loss. This trend is likely to continue due to a persistent problem of poor protection, mismanagement, and misclassification of grassy ecosystems. The changes (and their causes) in grassy ecosystems need explicit recognition to identify opportunities for management and appropriate restoration actions to secure the integrity, biodiversity, and ecosystem services of grassy ecosystems.

Researchers found that –

- The extent of grassy ecosystems is declining through land conversion and changing ecosystems processes. The combination of pressures and changes varies spatially. The spread of grasses (indigenous and invasive) into new habitats is creating novel environmental conditions, particularly for fire.
- Rising CO_2 is a prominent threat to the future of grassy ecosystems that needs more recognition. Ironically, proposed plans for tree planting to counteract rising CO_2 are likely to accelerate the rate of loss of grassy ecosystems—with global consequences. This threat has emerged due to a profound misreading of the landscape stemming from a forest-centric restoration narrative built by cultural narratives causing the misclassification and devaluing of grassy ecosystems.
- Grassy ecosystems falling within the ecosystem uncertain envelope are similar in that interactions with climate and disturbance shape their presence. Yet how the strength of the different interacting components varies between grassy ecosystems remains to be quantified.
- There are gaps in understanding the mechanisms that gave rise to the evolution and spread of grassy ecosystems. There are large gaps in the ability to understand the combined impact of climate change and rising CO_2 on the evolution and distribution of grassy ecosystems, particularly grassy ecosystems.
- Colonial attitudes have spread the idea that disturbance from fire and animals is unnatural, yet disturbance is an integral component of the evolution, distribution, and future of grassy ecosystems.

6.6.4 Food systems

Future warming will negatively impact African food systems by shortening growing seasons and increasing water stress. Wheat yields in southern Africa are projected to decline by over 50 percent by 1.5°C global warming, even with adaptation. The projected declines in yields for some crops may be partially compensated by increasing concentrations of atmospheric carbon dioxide; however, global warming above 2°C will result in reduced yields of staple crops across most of Africa compared to 2005 yields, even with adaptation options being implemented and increasing carbon dioxide fertilisation effects. Relative to 1986-2005, global warming of 3°C is projected to reduce labour capacity in agriculture by 30-50 percent in sub-Saharan Africa due to higher temperatures. Research on regionally important cash crops, such as sugarcane, remains limited. Climate change threatens livestock production in southern Africa including through a combination of negative impacts on the availability and quality of animal fodder, availability of drinking water, direct heat stress on animals, and the prevalence of livestock diseases.

Rangeland net primary productivity is projected to decline 37 percent for southern Africa over the 2000-2050 period, under a high warming scenario. At 2°C of global warming, the risk to southern African fisheries becomes very high and marine fisheries catch potential is projected to decline by 10-30 percent. For inland fisheries, higher levels of global warming are associated with a larger proportion of commercially harvested fish species becoming locally extinct.

6.6.5 Water

There is increasing demand for water for agricultural and energy production in southern Africa. Governments are responding with ambitious plans to expand irrigation and hydropower infrastructure, especially in the Zambezi River basin. One study found that hydropower revenues in the driest climate scenarios could be 58 percent lower in the Zambezi River basin, the highest risk of any river basin, and 30 percent lower in the Orange River basin by 2050 compared to revenues under current climate conditions. In the wettest modelled climate scenario, hydropower revenues could be more than 20 percent higher in the Zambezi River basin and 50 percent higher in the Orange River basin than they would be in the current climate. The combination of increasing societal demands on limited water resources and future climate change is expected to intensify water-energy-food competition and trade-offs. The likelihood of severe climate conditions, such as the reduced rainfall that caused the multi-year drought in Cape Town, has increased due to human-induced climate change.

6.7 Water security: water availability and demand allocation

Nationally, the water supply systems are at a deficit of 96 M m³/year (1%), predicted to be 3.4 % by 2040. Irrigation and municipal (urban water supply) remain the largest water use sectors. It is expected that relative to other use sectors, by 2040, the municipal and afforestation sectors will see an increase of 36 percent and 3 percent respectively.

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

Table: Water use per sector projections

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

As reflected in the following table, large systems where water requirements exceed water available are: (i) Outeniqua in Western Cape (-6 M m³/year); (ii) Amathole in the Eastern Cape (-11 M m³/year); (iii) Olifants in

Limpopo (-33 M m³/year); (iv) Orange in NC, FS, EC (-147 M m³/year); and Umgeni in KwaZulu-Natal (-62 M m³/year).

Table: Water availability and requirement in large systems

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

7 WHAT IS THE OUTLOOK?

7.1 Air quality

Given that air pollution knows no borders and is an issue of global concern, the United Nations Environment Programme's UNEP 2019 Global Environmental Outlook (GEO 6) provides an up to date outlook in respect of air quality at an international level – Emissions generated by human activity continue to alter the composition of the atmosphere, leading to air pollution, climate change, stratospheric ozone depletion and exposure to persistent, bioaccumulative and toxic chemicals.

Air pollution is the main environmental contributor to the global burden of disease, leading to between 6 million and 7 million premature deaths and welfare losses estimated at US$5 trillion annually. Air pollution exposure, especially to fine particulate matter, is highest for urban residents in some countries with rapid urbanization trends and for the approximately 3 billion people who depend on burning fuels such as wood, coal, crop residue, dung and kerosene for cooking, heating and lighting. The elderly, very young, ill and poor are more susceptible to the impact of air pollution.

Globally, decreasing emission trends from local air pollutants in certain sectors and regions have been offset by larger increases in others, including some rapidly developing countries and areas of rapid urbanization. Available data indicate that emissions decrease significantly when regulations are put in place.

International agreements have been successful in addressing specific chemicals. Both improvement of energy efficiency and pollution control techniques may be used to achieve lower air pollutant emissions. As controls have been placed on power plants, large industrial facilities and vehicles, the relative contribution of other sources, including agriculture, domestic fuel use, construction and other portable equipment, and forest or open fires, has grown in importance.

Electricity generated from non-renewable resources and the fossil fuel production and consumption sectors ("energy") is the largest anthropogenic emitting sector of SO_2 and non-methane volatile organic compounds and the main emitting sector of other air pollutants, including greenhouse gases.

Government capacity and political will to manage air pollution and climate change varies significantly. Some regions have well-developed systems of national-to-local policies and compliance and enforcement programmes, although ambition levels in terms of both scope and policy may differ. In other regions, international agreements or national legislation may exist, but implementation and compliance and enforcement are often affected by weak national-to-local institutional capacity. Future policy efforts can build upon renewed attention to those issues in international forums and several decades of experience with various governance strategies in different countries. Between 1998 and 2010, there was a five-fold increase in the number of national climate laws (more than 1,500 laws and policies worldwide) and by 2012 those laws covered 67 percent of all emissions. Some city and subnational governments are leading the way with benefits for other parts of their countries.

To a large extent, the South African air quality outlook mirrors that reflected in the UNEP 2019 Global Environmental Outlook (GEO 6) report. Emissions generated by human activity continue to alter the composition of our ambient air. Air pollution is probably the main environmental contributor to the national disease burden with a number of new reports estimating many premature deaths and welfare losses in pollution hotspots like the Highveld Priority Area. Air pollution exposure, especially to fine particulate matter, is highest for residents in dense settlements where people depend on burning fuels such as wood, coal, crop residue, dung and paraffin for cooking, heating and lighting. Our most vulnerable people, the elderly, very young, ill and poor, are the most susceptible to the impact of air pollution. Decreasing emission trends from local air pollutants in certain sectors and regions have been offset by larger increases in others. However, there appears to have been some air quality improvements since the promulgation of the NEM: AQA. Although International agreements have been successful in addressing specific chemicals, like ozone-depleting substances, others like mercury still remain a challenge. Improvements in both energy efficiency and pollution control techniques have achieved lower air pollutant emissions and will continue to do so. As controls are enforced on power plants, large industrial facilities and vehicles, the relative contribution of other sources, including agriculture, domestic fuel use, construction and other portable equipment, and forest or open fires, will grow in importance. Electricity generated from coal and the fossil fuel production and consumption sectors ("energy") is South Africa's largest anthropogenic emitting sector of SO_2 and non-methane volatile organic compounds and the main emitting sector of other air pollutants, including greenhouse gases. Government capacity and political will to manage air pollution varies significantly between the national department and provincial and local authorities. Although South Africa has a well-developed system of national-to-local policies and compliance and enforcement programmes, implementation and compliance and enforcement is often affected by policy conflicts and weak institutional capacity. Future policy efforts will build upon renewed attention to these issues in international forums and several decades of experience with various governance strategies in different countries. Between 1997 and 2018, there has been a significant increase in the number of air quality regulations and some cities are leading the way with benefits for other parts of the country, e.g., eThekweni's SO_2 reduction interventions.

Notwithstanding the above, South Africa has made much progress in our approach to air quality management over the last decade. This is especially evident based on the substantial growth in capacity and capability through advanced governance mechanisms, public information platforms such as SAAQIS, the number of regulations and notices published, delivery of statutory obligations such as air quality management plans (AQMPs), long term data sets on emissions and ambient concentrations and the development of an Air Quality Index, just to mention a few milestones. The processes put in place are all the expected cornerstones of any emerging air quality management system and while they may not be as scientifically or technically advanced as some systems in Europe or Northern America, they are certainly considered to be robust and fit for purpose.

It should also be noted that: (i) efficient and effective air quality management aimed at ensuring that Ambient Air Quality Standards are met and maintained is fully aligned with, and is a significant contributor to the realisation of, NDP Chapter 10: Promoting Health; and (ii) that the efficient and effective realisation of the GHG mitigation components of NDP Chapter 5: Ensuring Environmental Sustainability and an Equitable Transition to a Low-Carbon Economy, will also have a significant positive impact on South Africa's air quality.

While there has been substantial investment in the tools to diagnose and understand the temporal, spatial and sectorial scale of the air quality problem, there appears to be limited evidence on the implementation of interventions to resolve these problems. Like many countries, addressing air pollution and climate change continues to be a challenge due to a number of influencing factors such as:

- low public, political and institutional recognition of the growing public health crisis and understanding of the complexity of the challenge;
- keeping up with the rate and scale of economic growth and urbanisation;
- implementing truly transformative interventions, consistent with the scale of the challenge; and
- limited perceptions of personal exposure to air pollution and health protection and a willingness or ability to take action to address the problem.

Notwithstanding these challenges, South African air quality appears to be improving marginally. However, these improvements may be related more to a slowed economy than to specific air quality management interventions.

Another important outlook relates to the significantly positive air quality impacts that would accrue from the transition to the low-carbon economy and society required to successfully mitigate the worst climate change impacts.

Finally, although pollution concentrations may be reducing, recent evidence from the World Health Organisation (WHO) continues to suggest that many pollutants should be considered non-threshold pollutants – i.e., there is no safe ambient concentration. Therefore, many cities and national governments are exploring working beyond compliance with their own air quality standards and working towards WHO guidelines.

7.2 Water quality

7.2.1 Fresh water quality

Given that South Africa's freshwater resources are shared with our neighbours, the United Nations Environment Programme's UNEP 2019 Global Environmental Outlook (GEO 6) provides an up-to-date international outlook in this regard – Population growth, urbanization, water pollution and unsustainable development are all increasing pressure on water resources across the world, and that pressure is further exacerbated by climate change. In most regions, slow-onset disasters, such as water scarcity, drought and famine, lead to increased migration. Increasing numbers of people are also being affected by severe storms and floods.

Increasing glacial and snowpack melt as a result of global warming will affect regional and seasonal water availability, especially in Asian and Latin American rivers, which provide water for some 20 per cent of the global population.

Changes to the global water cycle, including extreme events, are contributing to water quantity and quality problems, with impact distributed unequally across the world.

In most regions, water quality has worsened significantly since 1990, owing to organic and chemical pollution, such as pathogens, nutrients, pesticides, sediments, heavy metals, plastic and microplastic waste, persistent organic pollutants and salinity. Some 2.3 billion people (approximately 1 in 3 of the global population) still lack access to safe sanitation.

Approximately 1.4 million people die annually from preventable diseases, such as diarrhoea and intestinal parasites, that are associated with pathogen-polluted drinking water and inadequate sanitation.

Without effective countermeasures, human illnesses due to antimicrobial-resistant infections may become a major cause of death from infectious diseases worldwide by 2050. Water plays a key role in this, as anti-microbial-resistant bacteria are now found in sources of treated drinking water worldwide, stemming from antibiotics entering the water cycle through domestic sewage and industrial wastewater disposal, agriculture, intensive livestock rearing and aquaculture. In addition, various endocrine-disrupting chemicals are now widely distributed through the freshwater system on all continents, with long-term impact on foetal underdevelopment and male infertility.

On the positive side, 1.5 billion people gained access to basic drinking water services over the 15-year period from 2000 to 2015. However, women and girls still carry most of the physical burden of transporting water in many developing countries, reducing the time available for them to participate in productive activities and education. The positive impact of women being able to spend time on other activities should be widely acknowledged, since economic surveys indicate that they typically reinvest up to 90 percent of their income in their families, improving family health and nutrition, and increasing access to schooling for their children.

Worldwide, agriculture uses an average of 70 percent of all freshwater withdrawals, rising to 90 per cent in many poorer countries. The competition for more water from cities and industry creates an imperative to improve the efficiency of agricultural water use while at the same time producing more food and using fewer and less harmful inputs.

Many aquifers are depleting rapidly due to over-abstraction for irrigation, drinking water, industrial and mining uses. More sustainable management and better monitoring of surface and groundwater is urgently needed.

Promoting water-use efficiency, water recycling, rainwater harvesting, and desalination is becoming increasingly important to ensure greater water security and more equitable water allocation for different users and uses. The agricultural sector needs substantial improvements in water-use efficiency and productivity. The industrial and mining sectors also have strong potential for increasing water-use efficiency, recycling and reuse, as well as for limiting water pollution. Broader adoption of water-sensitive urban design, including infrastructure to manage storm water, grey water, wastewater and managed aquifer recharge, would improve water management and urban water outcomes.

Freshwater ecosystems are among the world's most biodiverse habitats and valuable natural infrastructures. Wetlands buffer against impact from climate change (both drought and floods) and improve water quality, but 40 percent of all wetlands have been lost since 1970 through agricultural development, urbanization, infrastructure development and overexploitation of water resources. Severe consequences include the loss of inland fisheries, which affects the livelihoods of millions of people.

The total annual economic cost of wetland losses over the 15-year period from 1996 to 2011 has been estimated at US$2.7 trillion. Greater investment, both public and private, would facilitate more sustainable wetland management and restoration.

The decomposition, due to human intervention, of peatlands, a type of wetland that stores more carbon than all the world's forests combined, currently contributes approximately 5 percent of annual global carbon emissions. The thawing permafrost in boreal peatlands, agricultural conversion of some tropical peatlands and the transformation and loss of other peatlands are causing increased carbon emissions, infrastructure damage and wildfires. Protection and restoration of peatlands, including rewetting of drained peatlands, is an important climate change mitigation strategy.

Innovative and integrated policy mixes are essential to manage interactions between water, food, energy, transport, climate change, human health and ecosystems. Good governance includes integrated water resource management, as illustrated by integrated flood risk management, ecosystem-based approaches in subnational and transboundary basins, circular economy and other approaches that promote sustainable consumption and production as one approach towards achieving sustainable development and substantive progress on decoupling water use from economic growth through increasing water efficiency. Such approaches support improved land-use planning and cross-sectoral policy coordination between government departments.

Social equity and gender equality remain key aspects for achieving Sustainable Development Goal 6 on fresh water. Enhanced participatory processes will enable greater knowledge input from local and indigenous communities into decision-making. Goal 6 can only be achieved by engaging the public, private and non-governmental sectors, civil society and local actors, and by taking into account other interlinked Sustainable Development Goals.

Multilateral environmental agreements governing water resources and water-related ecosystem management and climate change can support the embedding of integrated water resource management in the rule of law through national and local legislation. Increased investment in the scope and rigour of standardized water data is essential to improve policy and governance for sound water management.

As with climate change, the South African freshwater outlook largely mirrors that reflected in the UNEP 2019 Global Environmental Outlook (GEO 6) report. Population growth, urbanization, water pollution and unsustainable development is all increasing pressure on water resources and that pressure will be further exacerbated by climate change. In Southern Africa, slow-onset disasters, such as water scarcity, drought and famine, may lead to increased migration. Increasing numbers of people are also being affected by severe storms and floods. Changes to South Africa's water cycle, including extreme events, are contributing to water quantity and quality problems, with impact distributed unequally across the country – e.g., there are examples of floods and droughts being experienced around the country at the same time. Water quality has probably worsened significantly since 1990, owing to organic and chemical pollution, such as pathogens, nutrients, pesticides, sediments, heavy metals, plastic and microplastic waste, persistent organic pollutants, salinity and acid mine drainage. Many South Africans still lack access to safe sanitation despite massive improvements since 1994. Many South Africans die annually from preventable diseases, such as diarrhoea and intestinal parasites, that may be associated with pathogen-polluted drinking water and inadequate sanitation. Without effective countermeasures, human illnesses due to antimicrobial-resistant infections may become a major cause of death from infectious diseases by 2050.

On the positive side, most South Africans have gained access to basic drinking water services over the 15-year period from 2000 to 2015. However, women and girls still carry most of the physical burden of transporting water in many rural areas, reducing the time available for them to participate in productive activities and education. Agriculture uses around 60 per cent of all freshwater withdrawals. The competition for more water from cities and industry is creating an imperative to improve the efficiency of agricultural water use while at the same time producing more food and using fewer and less harmful inputs. Promoting water-use efficiency, water recycling, rainwater harvesting, and desalination is becoming increasingly important to ensure greater water security and more equitable water allocation for different users and uses. The agricultural sector needs to learn from the successes in the Western Cape and make substantial improvements in water-use efficiency and productivity. The industrial and mining sectors also have strong potential for increasing water-use efficiency, recycling and reuse, as well as for limiting water pollution. Broader adoption of water-sensitive urban design, including infrastructure to manage storm water, grey water, wastewater and managed aquifer recharge, would improve water management and urban water outcomes.

Despite their importance, many South African wetlands have been lost since 1970 through agricultural development, urbanization, infrastructure development and overexploitation of water resources.

Innovative and integrated policy mixes are being explored to manage interactions between water, food, energy, transport, climate change, human health and ecosystems. However, the good governance required for integrated water resource management is seen as a major challenge.

7.2.2 Transforming sanitation into the future

According to the National State of Water Report, 2022, most South Africa's urban population sanitation needs are addressed through reticulated waterborne systems. The requirement for the technical functioning of these systems is water. According to Pillay and Bhagwan (2021) and research produced by the Water Research Commission (WRC), South Africa is over-exploiting its water resources, and withdrawals are expected to increase over the next 20 years. The flushing of 9 to 12 litres of potable water with faeces may not be viable in the near future and represents one area amongst many where South Africa's high per capita usage could be reduced.

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

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

- New sanitation that meets user needs and expectations while less demanding natural resources. The new sanitation must be replicable on a large-scale and the components must be easily sourced throughout the supply chain;
- Circular economy principles in which products in the value chain are recycled or re-used with the addition of other revenue streams;
- Establishing market needs and demands;
- Presenting a RDI pathway to achieve technical, policy and procurement targets in line with the vision;
- Creating a sanitation manufacturing industry around the technical advancements and creating several new jobs and employment around this.

7.3 Land and soil quality

Given that land and the quality of our soils is an issue of global concern, the United Nations Environment Programme's UNEP 2019 Global Environmental Outlook (GEO 6) provides an up-to-date outlook in this regard – Food production is the largest anthropogenic use of land, using 50 percent of habitable land. Livestock production uses 77 percent of agricultural land for feed production, pasture and grazing. Furthermore, traditional livestock provides livelihoods for many indigenous and local communities. Sustainable land management can address food security while preventing the loss of the contribution made by nature and promoting gender and social equality. Adequately feeding 10 billion people by 2050 will require an increase of 50 percent in food production, while some 33 percent of global edible food is lost or wasted, of which approximately 56 percent occurs in developed countries. Increasing productivity has slowed down the expansion of agricultural land, but inefficient or unsustainable farming systems are often associated with environmental and soil degradation and biodiversity loss, and an increase in crop specialization and distribution can raise the risk of poor harvests.

Securing land rights for local communities can help to turn land assets into development opportunities and secure more sustainable use of land. For most people, land is their most important asset. Women represent 43 percent of those active in agriculture, yet they hold the title to less than 20 percent of agricultural land. Insecure access to land resources hinders sustainable land management. Indigenous and other forms of community-managed land could generate billions of US dollars' worth of ecosystem benefits through, among other things, carbon sequestration, reduced pollution, clean water and erosion control. Those benefits could justify securing land tenure and the right to inheritance for women and indigenous and local communities. Decreasing the gender gap in access to information and technology, and access to and control over production inputs and land, could increase agricultural productivity and reduce hunger and poverty. Policies empowering women, indigenous peoples, family farmers and pastoralists to ensure that those groups have secure access to land resources, fertilizers and other inputs, knowledge, extension services, financial services, markets, opportunities for adding value and non-farm employment can facilitate the achievement of the Sustainable Development Goals and reduce environmental impact, increase agricultural productivity and contribute to reducing poverty and hunger.

Land degradation and desertification have increased, with land degradation hotspots covering approximately 29 percent of global land, where some 3.2 billion people reside. Investing in avoiding land degradation and restoring degraded land makes sound economic sense and the benefits generally far exceed the costs.

Whilst the pace of deforestation has slowed, it continues globally. Furthermore, although many countries are now taking steps to increase their forest cover, it is primarily being done through plantations and reforestation, which may not provide the same range of ecosystem services as natural forests.

Urban clusters – meaning urban centres and their suburbs – have grown by a factor of approximately 2.5 since 1975, and in 2015 accounted for 7.6 percent of global land, affecting, among other things, the hydrological cycle and soil functions, causing urban heat islands.

Achieving the land-related Sustainable Development Goals requires adequate land and water resource management. Innovative technologies, sustainable land management strategies, nature-based solutions and land-resource stewardship (such as sustainable forest management, agro-silvo-pastoral production systems, conservation agriculture, integrated crop production and agroforestry) can contribute to making agriculture sustainable. Payment for ecosystem services, land restoration and land titling need to be more effectively promoted and adopted. When compatible with local culture, such strategies contribute to better management and conservation of land resources and are integral for the reduction of hunger (Sustainable Development Goal 2). Economic incentives for agriculture, including distortive agricultural production subsidies, contribute to land degradation, and their reduction and removal will be important for the achievement of sustainable agriculture.

Sustainable land-use planning and management can protect high-quality, fertile agricultural soil from competing interests, thus maintaining land-based ecosystem services such as food production, and preventing land from flooding and disaster. Frameworks targeting land degradation, such as the Land Degradation Neutrality initiative under the United Nations Convention to Combat Desertification, may also contribute to climate change mitigation and resilience. Yet the policy framework on land management remains complex and incomplete.

Models predict a marked increase in the frequency and severity of droughts in the winter rainfall and Cape coastal regions towards 2100

Turning to the specific South African situation, the following section provides an edited and contextualised extract of the executive summaries of the Trends of Desertification, Land Degradation and Drought (DLDD) Indicators of the UNCCD for South Africa, Phase 2: Final Report of March 2019. Readers are encouraged to read this report for more in depth, fully referenced, information on the outlook for land degradation in South Africa.

Land degradation, which includes desertification amongst other processes, encompasses changes in soil properties or vegetation characteristics, which lead to a persistent decline or loss of ecosystem services essential to sustaining life. It is the consequence of a set of key processes, which are active in arid and semi-arid environments, where water is the main limiting factor of land use and for ecosystem functions. Land degradation is a broad term that also encompasses circumstances of reduced biological productivity of the land. The United Nations Convention to Combat Desertification (UNCCD) provides a framework for affected countries to effectively address the problem of desertification, land degradation and drought (DLDD).

As a signatory to the UNCCD, the South African government through the Department Forestry, Fisheries and the Environment commissioned a two-phase study on desertification, land degradation, drought and land cover assessment to inform policies, rehabilitation programmes and strategies to monitor and reduce the impacts. Phase

2 of this research covers trends in land productivity using the following indicators: drought occurrences, salinization, biomass production, soil carbon stocks, bush encroachment, land cover change causes, and soil erosion.

South Africa's soil carbon stock has decreased between 2000 and 2014. In 2000, a loss of 370 667 Gg had already occurred due to land use change and this loss has increased

The Standard Precipitation Index (SPI), which is a measure of rainfall deficit, was applied in drought assessments. The 24-month SPI indicated that in 2000 and 2001, some parts of SA experienced mild to extremely wet conditions. South Africa was hardly hit by drought conditions from 2003 to 2005. The southern to eastern coastal areas and lowveld areas in the northeast experienced drought during the early part of the 2009/10 season. The central parts of the country were affected by drought conditions in 2012 and 2013. The Western Cape region was severely hit by drought conditions during the 2016-2017 period.

The future impact of climate change on drought occurrences was also evaluated. Warming of up to 2.5°C is projected for five out of the six projections for the 2041-2070 period with the sixth downscaled projection indicating warming that exceeds 3°C across most of the interior. The warming relative to the baseline period is projected to exceed 4°C across the western to central interior by most of the downscaled projections for the 2071-2100 period. Projections of rainfall changes are less robust than the projections of temperature changes and exhibit more complexities. For example, when the 1 mm rainfall events are considered, which is essentially a proxy for the number of rain days, there is a general pattern of an increase of these events over the western to central interior during the 2041-2070 period.

The difference in the long-term mean 24-month SPI between a future period (2071-2100) and a baseline period (1961-1990) was also assessed by SPI time series on a 24-month time scale. The winter rainfall region and Cape coastal region show a marked increase in the frequency of occurrence as well as the amplitude of droughts towards 2100. The western region of SA also exhibits a signal of increased drought occurrences towards 2100, although not as pronounced as for the winter rainfall region and the Cape south coast region.

The assessment of salinization in biomes showed that those with the highest electrical conductivity (EC) were found in the western parts of South Africa with the lowest rainfall and highest aridity. The Desert and Succulent Karoo Biomes in the arid regions of South Africa are clearly saline if the median EC is used as an indicator of salinity. The Grassland and Indian Ocean Coastal Belt Biomes in the higher rainfall regions, on the other hand, are apparently non-saline. No major changes in soil salinity are expected if the year 2080 is used for future predictions.

The overall area under alien species invasion has decreased, with the main reductions occurring in the Northern Cape. From the change maps, it can be concluded that most of the new patches were mapped in the North West Province along the border with Botswana as well as along other drainage lines. The MODIS annual cumulative net primary productivity (NPP) maps showed changes between 2000 and 2013. Parts of the Eastern Cape, KwaZulu-Natal, Mpumalanga and Limpopo provinces showed high amounts of NPP in 2000 (from 12 961 to 30 562 g C/m^2/year) whereas Northern Cape, Western Cape, Free State and North West showed lower values of NPP. The year-on-year assessment of biomass showed that there has been a decrease in biomass production from 2000 to 2013. The assessment of soil carbon stock in South Africa showed that soil carbon has been lost in the 14-year period between 2000 and 2014. In 2000, a loss of 370 667 Gg had already occurred due to land use change and this loss has increased.

The success in efforts to control and reverse land degradation rests not only upon knowledge of the status, causes or the impacts, but also on adopting systematic and integrated approaches that address the physical, biological and socio-economic aspects of the processes of land degradation, desertification and drought. To increase the reliability of the generated information as well as documenting trends including inter-decadal and inter-annual comparisons, the country needs to apply standardized assessment approaches and tools. Achieving the UNCCD targets requires long-term strategies focussing simultaneously on affected areas, land rehabilitation, conservation and sustainable management of land and water resources, as well as building capacity, particularly at the community level.

7.4 Biodiversity

Given that the loss of biodiversity is an issue of global concern, the United Nations Environment Programme's UNEP 2019 Global Environmental Outlook (GEO 6) provides an up-to-date outlook in respect of biodiversity at an international level –

A major species extinction event, compromising planetary integrity and Earth's capacity to meet human needs, is unfolding. Biodiversity refers to the diversity of living things at the genetic, species and ecosystem levels. It helps to regulate climate, filters air and water, enables soil formation and mitigates the impact of natural disasters. It also provides timber, fish, crops, pollination, ecotourism, medicines, and physical and mental health benefits.

Environmental and human health are intricately intertwined, and many emerging infectious diseases are driven by activities that affect biodiversity. Changes to the landscape (through natural resource extraction and use, for example) can facilitate disease emergence in wildlife, domestic animals, plants and people. Zoonoses are estimated to account for more than 60 percent of human infectious diseases.

Genetic diversity is declining, threatening food security and the resilience of ecosystems, including agricultural systems and food security.

Populations of species are declining, and species extinction rates are increasing. At present, 42 percent of terrestrial invertebrates, 34 percent of freshwater invertebrates and 25 percent of marine invertebrates are considered at risk of extinction. Between 1970 and 2014, global vertebrate species population abundances declined by on average 60 percent. Steep declines in pollinator abundance have also been documented.

Ecosystem integrity and functions are declining. Ten out of every fourteen terrestrial habitats have seen a decrease in vegetation productivity and just under half of all terrestrial ecoregions are classified as having an unfavourable status.

Native and non-native invasive species threaten ecosystems, habitats and other species. The economic costs, both direct and indirect, amount to many billions of dollars annually.

Biodiversity loss is also an equity issue, disproportionately affecting poorer people, women and children. If current rates of decline continue, future generations will be deprived of the health benefits of biodiversity. The livelihoods of 70 percent of people living in poverty directly depend on natural resources.

The critical pressures on biodiversity are habitat change, loss and degradation; unsustainable agricultural practices; the spread of invasive species; pollution, including microplastics; and overexploitation, including illegal logging and trade in wildlife. Illegal trade in wildlife, fisheries and forest products is worth between US$90 billion and US$270 billion per annum. There is evidence to suggest that climate change will pose the gravest threat in the future, as species, including disease vectors, migrate with temperature shifts.

Although governance efforts are progressing, greater efforts are required to achieve international objectives, such as the Aichi Biodiversity Targets within the United Nations Convention on Biological Diversity's Strategic Plan for Biodiversity 2011–2020, and the Sustainable Development Goals. Over 190 National Biodiversity Strategies and Action Plans have been submitted to the Convention, although their quality and reliability, as well their subsequent implementation, remains uneven; the Cartagena and Nagoya Protocols to the Convention provide a deeper governance context. There is increasing international collaboration between various law enforcement authorities in combatting illegal wildlife trafficking.

The science-policy interface for biodiversity and the contribution that nature makes to people was strengthened in 2012 through the establishment of the Intergovernmental Platform for Biodiversity and Ecosystem Services. Parties to the Convention on Biological Diversity are negotiating the post-2020 global biodiversity framework. Negotiations under the United Nations Convention on the Law of the Sea continue towards an agreement on the sustainable use and conservation of marine biological diversity beyond national jurisdiction.

Several multilateral environmental agreements provide additional governance architecture on biodiversity, including the Convention on Wetlands of International Importance especially as Waterfowl Habitat and the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The continual updating of the International Union for Conservation of Nature Red List of Threatened Species and other independent monitoring efforts, such as the Global Biodiversity Information Facility, the consideration of the multiple values of biodiversity and the inclusion of the value of biodiversity in national economic valuation methods, will support and inform the implementation thereof. Furthermore, there is a pressing need to expand ecosystem assessments to better understand the global state of ecosystems and the trends therein.

Protecting species and ecosystems requires conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from the utilization of genetic resources. Species and ecosystems are most effectively safeguarded through the conservation of natural habitats and there is clear evidence that conservation can help to reduce biodiversity loss. Implementation, management and representative coverage of different ecosystems within protected areas remains insufficient. Less than 15 per cent of terrestrial habitats, including inland waters, and less than 16 per cent of coastal and marine areas within national jurisdiction are protected areas.

Biodiversity is slowly being mainstreamed or integrated into health, gender and other equity concerns through such efforts as the 2015–2020 Gender Plan of Action under the Convention on Biological Diversity and its relationship to the Convention's Strategic Plan for Biodiversity 2011–2020 and the achievement of the Aichi Biodiversity Targets. Indigenous peoples and local communities play a key role in biodiversity protection by offering bottom-up, self-driven and innovative solutions, based on traditional knowledge and the ecosystem approach. However, protected areas can adversely affect indigenous communities if access to natural resources within protected areas is denied.

Ex situ conservation of genetic material provides safeguards for maintaining adaptive potential, in particular of crop and agricultural species. Gene banks and seed collections complement in situ conservation of genetic resources, yet the conservation status of genetic diversity for most wild species remains poorly documented. Yet accelerating biodiversity loss and the large, escalating costs of inaction, including numerous threats to human health, require an urgent increase in global investment in sustainable use and conservation, and the consistent integration of biodiversity concerns into all facets of economic and social development.

Greater focus on strengthening governance systems; improving policy frameworks through research; policy integration; implementation; and encouraging partnerships and participation, are all measures that have the potential to address the greatest pressures on biodiversity. Efforts to combat biodiversity loss must also address poverty eradication, food security challenges, gender inequality, systemic inefficiencies and corruption in governance structures and other social variables.

Identification of the countries of origin of genetic resources, in accordance with the Convention on Biological Diversity and the Nagoya Protocol thereto, will help to ensure progress against the objectives of those instruments and the fair and equitable sharing of benefits arising from the commercial utilization of those resources with such countries.

7.5 Oceans and coasts

Given that we share our oceans with all the nations of the world, the United Nations Environment Programme's UNEP 2019 Global Environmental Outlook (GEO 6) provides an up-to-date outlook in respect of oceans and coasts at an international level –

The principal drivers of change facing oceans and coasts are ocean warming and acidification, ocean pollution and the increasing use of oceans, coasts, deltas and basins for food production, transportation, settlement, recreation, resource extraction and energy production. The main impacts of those drivers are marine ecosystem degradation and loss, including death of coral reefs, reduced marine living resources and the resulting disturbance of marine and coastal ecosystem food chains, increased nutrient and sediment run-off and marine litter. Those impacts interact in ways that are just beginning to be understood and their interaction may amplify their effect. If left unaddressed, there is a major risk that they will combine to produce a destructive cycle of degradation and that the ocean will no longer provide many vital ecosystem services (for example, livelihoods, income, health, employment, and aesthetic, cultural and religious values).

More effective compliance, enforcement and other instruments are needed, as current efforts are not sufficient to achieve the aims of the Sustainable Development Goals, particularly Goal 14. Interventions based on emerging technologies, considering a precautionary approach, in accordance with international agreements (where applicable), and strategic management approaches, such as resilience-based management and ecosystem-based management, can contribute to improved conservation of marine ecosystems and marine living resources.

A holistic, integrated monitoring and assessment of the marine environment needs to be fostered hand in hand with the implementation of pollution reduction measures to achieve and maintain the targets of "Good Environmental Status" of the marine environment, including harmonization of assessment criteria and methods at all levels. To be effective, such measures should be combined with actions to mitigate and adapt to climate change and reduce the input of pollution and litter to the oceans while promoting their conservation and sustainable use.

The rate of human-induced release of greenhouse gases is driving rising sea levels, changes in ocean temperatures and ocean acidification. Coral reefs are being devastated by those changes. Mass coral bleaching, induced by chronic heat, has damaged many tropical reefs beyond recovery. The collective value of coral reefs has been estimated at US$29 billion per annum. The loss of coral reefs has an impact on fisheries, tourism, community health, livelihoods and marine habitats. Interventions based on emerging technologies and sustainable management approaches (such as resilience-based management, integrated coastal zone management and ecosystem-based management) are key to building resilience and may help to preserve some areas of reef, but Governments should prepare for a dramatic decline (if not a collapse) of coral reef-based industries and ecosystem services, as well as negative effects on food chains related to the decline and collapse of coral reefs.

The oceans play an important role in the global economy and are likely to become increasingly important. Fisheries and aquaculture currently generate US$252 billion annually. Small-scale fisheries support the livelihoods of between 58 million and 120 million people. Fish provide 3.1 billion people with over 20 per cent of their dietary protein and contain nutrients important for their health. Ensuring the sustainability of capture fisheries and aquaculture requires significant investment in monitoring, assessment and operations management and, in many cases, strong local community-based approaches. Investment in fisheries monitoring and gear technologies can improve selectivity of target species when harvesting and reduce habitat impact, both in ocean fisheries and aquaculture.

Measures to minimize the effects of fishing on the ecosystem have had mixed success. Where resource assessments and monitoring, control, and surveillance and enforcement measures are not available, overfishing and illegal, unreported or unregulated fishing continues and may be expanding.

Marine litter, including plastics and microplastics, is now found in all oceans, at all depths. The scale and importance of the problem has received increasing attention in recent years, but there are still large gaps in knowledge. Current estimates suggest that input of plastic marine litter linked to domestic waste mismanagement in coastal areas amounts to some 8 million tonnes annually, 80 per cent of which originates from land-based sources. Marine plastic litter can result in a significant ecological impact from entanglement and ingestion, and can also act as a vector for the transport of invasive species and other pollutants. Abandoned, lost or otherwise discarded fishing gear (ALDFG) is a major source of marine litter. Not only is ALDFG highly harmful, but it also reduces numbers of fish stock and constitutes a significant economic threat, given its ability to damage maritime vessels, fisheries and ecosystem services. The growing presence and abundance of microplastics has potential adverse effects on the health of both marine organisms and humans. Furthermore, marine litter has a significant economic impact on a range of coastal sectors, such as tourism and recreation, shipping and yachting, fisheries, aquaculture, agriculture and human health. The damage to fishing gear in Europe alone is estimated at more than US$72 million per annum and the cost of cleaning beaches is estimated at US$735 million per annum, a figure which is increasing.

Improving waste management, including recycling and end-of-life management, is the most urgent short-term solution to reducing input of litter to the ocean. Longer-term solutions include improved governance at all levels, and behavioural and systemic changes that reduce plastic pollution from the production and use of plastic, and increase recycling and reuse. A holistic and evidence-based approach, considering the full life-cycle approach to waste management should be applied.

Cleaning up coasts and beaches can provide environmental, social and economic benefits, and trapping surface litter in the ocean may be effective in small areas, but such efforts should not distract from action to stop litter entering the ocean. While many relevant international agreements exist, there is no global agreement that addresses the issue of marine litter and microplastics in a comprehensive and integrated manner. Coordination and cooperation between international bodies could be enhanced to progress international agreement.

Policy-sensitive indicators used to track progress in addressing key pressures and drivers may not fully capture the multiple dimensions of pressures and drivers. Area-based indicators, such as Aichi Biodiversity Target 11 on the coverage of marine protected areas under national jurisdiction, do not alone establish that such areas are effectively managed; nor can they guard against the impact of climate change or pollution. Efforts to develop methods to evaluate the effectiveness of protected areas and their contribution to overall ocean health are therefore critical. The lack of standardization and compatibility between the methods used and the results obtained in various bottom-up projects makes an overall assessment of the status of marine litter across large geographic areas difficult.

7.5.1 Coastal and underwater infrastructure

The following section is an edited extract of the National Data and Information Report for Marine Spatial Planning, 2021 and readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African marine spatial planning.

Given the growing population along the coast and the coastal-based industries, the trend of increasing coastal development will accelerate. Growing demand for space will lead to more coastal land being developed for buildings, structures and facilities.

With the rise in sea-levels and a predicted increased risk of storm surges, the country's coastal infrastructure may be placed under increasing threat. This will likely increase the demand for coastal defence infrastructure. The impacts of climate change will also lead to the construction of new desalination plants along the coast of South Africa, particularly in the Cape Provinces.

An increase in marine and coastal tourism may also lead to developing coastal and tourism-associated infrastructure in certain sections along the coast. This includes the development and upgrade of the country's maritime transport infrastructure: boat launch sites, small harbours, marinas, and the commercial ports, which are necessary elements of the tourism cruise ship sector, all of which are also a pre-requisite to other human uses of the ocean such as fisheries and mining.

The communications sector and its contribution to the South African economy is an important factor for the country's future development. Submarine cables will remain a critical component in the future. The extent to which any new cables will be laid in the marine waters of South Africa cannot be determined at this stage.

In case that marine renewable energy production sites will be developed, submarine power cables may need to be installed in the medium to long term. With the intended growth of the offshore oil and gas sector in South African waters, an extension of the existing system of pipelines is to be expected. Given the growth in coastal population and industries, new wastewater discharge outfall pipelines may need to be installed in future.

7.5.2 Marine monitoring and research

The following section is an edited extract of the National Data and Information Report for Marine Spatial Planning, 2021 and readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African marine spatial planning.

Environmental monitoring and research will inform future marine policy development and implementation. It will also identify knowledge gaps and influence the country's priority research areas to investigate and there is likely to be a need for collaborative research efforts and a new emphasis on understanding the socioeconomics of marine activities. It is likely that new knowledge will emerge on:

- Marine bio-resources, including novel chemicals, new and sustainable food supplies and bioenergy;
- Increased and new forms of sub-sea oil and gas or other geological resources recovery and the potential reuse of oil and gas fields for carbon capture and storage in the future;
- New technologies for introducing marine renewable energy production in the mid-term;
- The seabed and its resources and biodiversity, especially in deep waters through increasingly detailed maps; and
- New approaches to planning, management and governance in the marine and coastal realm.

Unlocking the economic potential of South Africa's oceans and maintaining a healthy marine environment for the benefit of society and industry depends on environmental monitoring and research. The existing spatial activities and areas of interest for monitoring and research, including the protection of areas that serve as reference sites and which have not been impacted by human use must be secured and integrated in the forthcoming marine area plans.

7.5.3 Fishery

The following section is an edited extract of the National Data and Information Report for Marine Spatial Planning, 2021 and readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African marine spatial planning.

The fisheries sector has, despite the declining status of some of the country's major marine fishery resources, a key role in contributing to enhanced food security and socio-economic development. Given the significance of wild fisheries in sustaining jobs and livelihoods of hundreds of thousands of South Africans through commercial, recreational and small-scale fisheries, a central strategic policy objective for the sector is therefore improved fisheries management, including improved place-based protections to ensure the industry is sustainable, regulation, monitoring and compliance in order to progressively rebuild depleted fish stocks. We need to ensure that the spatial requirements for supporting the rebuilding of fish stocks are properly built into the marine spatial planning requirements. This will require an improved representative network of marine protected areas designed to support the requirements of each fishery. This could also include fisheries exclusion zones, protection of spawning sites and exclusion zones for specific fishing sectors. It is a national objective to develop an equitable, diverse, viable and competitive fisheries sector over time through sustainable use of the marine living resources.

7.5.4 Maritime and underwater cultural heritage

The following section is an edited extract of the National Data and Information Report for Marine Spatial Planning, 2021 and readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African marine spatial planning.

The government's objective is to ensure the adequate conservation and accessibility of South Africa's maritime and underwater cultural heritage resources for the benefit of current and future generations through:

- Heritage promotion and advocacy, including awareness-raising and education, signage projects, social media engagement, youth programmes, field schools, university courses, publication of promotional material;
- Enhancing public access to, and enjoyment of, maritime and underwater cultural heritage sites and objects through targeted projects;
- Identification of, and research into, maritime and underwater cultural heritage resources;
- Protection and conservation of maritime and underwater cultural heritage resources through the permitting and development application processes;
- Adequate monitoring and inspection of maritime and underwater cultural heritage resources;
- Initiatives that seek to build capacity (human and financial) in the field of maritime and underwater cultural heritage;
- Enhanced regional and international cooperation, especially through networks established in terms of the 2001 United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the protection of underwater cultural heritage; and
- Demonstrating the role of maritime and underwater cultural heritage resources management in driving inclusive socio-economic development through exploring synergies with the tourism and culture sectors.

7.5.5 Marine and coastal tourism

The following section is an edited extract of the National Data and Information Report for Marine Spatial Planning, 2021 and readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African marine spatial planning. The vision in relation to coastal and marine tourism under the Operation Phakisa is to grow a world class and sustainable coastal and marine tourism destination that leverages South Africa's competitive advantages in nature, culture, and heritage. The strategic objective for coastal and marine tourism under Operation Phakisa: Oceans Economy is to reach a R21.4 billion direct contribution to South Africa's Gross Domestic Products (GDP) and double the number of jobs to 116,000 by 2026. The 2017 Cabinet approved Coastal and Marine Tourism Implementation Plan aims at a nodal/cluster approach that seeks to:

- Prioritise destinations rather than individual tourism projects/products;
- Support the enhancement of the general environment in which attractions and products are located;
- Strengthen the linkages between attractions and improves the quality of the tourist experience within destinations; and
- Strengthen the linkages with other areas of Operation Phakisa.

7.5.6 Mineral and petroleum exploration and exploitation

The following section is an edited extract of the National Data and Information Report for Marine Spatial Planning, 2021 and readers are encouraged to read the report for more, in-depth, fully referenced, information on the South African marine spatial planning.

The exploitation of the country's offshore geological resources has the potential to contribute to job creation and economic development. The overarching strategic policy objectives for the minerals and hydrocarbon industry are therefore aimed at growing the sector which entails prospecting and exploration activities, especially in areas not yet explored, to enable mining of minerals and production of oil and gas where economically feasible, socially sound and with the least environmental impact possible.

The offshore oil and gas growth area of Operation Phakisa: Ocean Economy seeks to create an environment that promotes exploration in order to drill 30 exploration wells within the next 10 years. Eleven initiatives have been identified for implementation until 2024, with the spatially relevant ones being:

- Exploit the broader research opportunities presented by offshore oil and gas exploration. This will unlock a wealth of data on ecosystems, marine resources and ocean-related renewable energy, and ensure this data flows to key data users.
- Develop capability for sub-surface research and data gathering.

The Department of Mineral, Resource and Energy is also in the process of conducting an in-depth study on the offshore mineral geology which will provide more concrete data on the potential, value and exact location of offshore mineral resources. This is in line with the strategic objectives to conduct exploration activities as a means to strengthen the sector's knowledge on concentrations of minerals that would merit commercial exploitation through physical extraction.

7.6 Climate change

The science is clear that action to address the causes and impacts of climate change by a single country or small group of countries will not be successful. This is a global problem requiring a global solution through the concerted and cooperative efforts of all countries. Should multi-lateral international action not effectively limit the average global temperature increase to below 2°C above pre-industrial levels, the potential impacts on South Africa in the medium- to long-term are significant and potentially catastrophic. With this, and given the global nature of climate change, the United Nations Environment Programme's UNEP 2019 Global Environmental Outlook (GEO 6) provides an up-to-date outlook in respect of climate change –

Climate change is a priority issue affecting both human systems, including human health, and natural systems – air, biological diversity, freshwater, oceans and land – and which alters the complex interactions between those systems. Historical and ongoing greenhouse gas emissions have committed the world to an extended period of climate change, which is leading to global warming of air and ocean; rising sea-levels; melting glaciers, permafrost and Arctic sea ice; changes in carbon, biogeochemical and global water cycles; food security crises; fresh water scarcity; and more frequent and extreme weather events. Higher atmospheric concentrations of carbon dioxide also lead to ocean acidification and affect the composition, structure and functionality of ecosystems. Time is running out to prevent irreversible and dangerous impacts of climate change. Unless greenhouse gas emissions are radically reduced, the world is on course to exceed the temperature threshold set out in the Paris Agreement under the United Nations Framework Convention on Climate Change. That makes climate change a global driver of environmental, social, health and economic impact and heightened society-wide risks.

Society-wide risks associated with environmental degradation and climate change effects are generally more profound for people in a disadvantaged situation, particularly women and children in developing countries. Many of these impacts are serious or irreversible and may lead to loss of livelihood, increased morbidity and mortality, and economic slowdown, and have greater potential for violent conflict, human mass migration and decreasing social resilience. Measures for more effective adaptation are now urgently required, especially for populations and regions which are in a vulnerable situation. Global increases in anthropogenic greenhouse gas emissions and climate impacts have occurred, even while mitigation activities have taken place in many parts of the world. Globally, economic and population growth continue to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion. Atmospheric concentrations of long-lived greenhouse gases continue to increase, driven primarily by fossil fuel extraction and use for electricity generation, industry and transport, although they are also affected by land use, land-use change, agriculture and forestry. The evidence of current global climate change is unequivocal.

Since 1880, the global average surface temperature has increased by between approximately 0.8 degrees Celsius and 1.2 degrees Celsius. Eight of the ten warmest years on record have occurred within the past decade. If greenhouse gas emissions persist, global average temperatures will continue to increase at the current rate, crossing the temperature target agreed as part of the Paris Agreement between 2030 and 2052. The Paris Agreement committed countries to holding the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels, recognizing that doing so would significantly reduce the risks and impact of climate change. Current nationally determined contributions, presented in Paris in 2015, constitute only one third of the mitigation required to establish a least-cost pathway for staying well below 2 degrees Celsius.

To maintain a good chance of remaining well below a 2 degrees Celsius temperature increase, emissions need to drop by between 40 and 70 per cent globally between 2010 and 2050, falling to net zero by 2070. Achieving the goals set out in the Paris Agreement requires transformational changes leading to deep reductions in greenhouse gas emissions and the balancing of emission sources and sinks. In addition to emissions reductions for CO_2, the main anthropogenic greenhouse gas, decreasing emissions of short-lived climate pollutants (also called forcers), specifically black carbon, methane, tropospheric ozone and hydrofluorocarbons, provide opportunities to limit warming in the short term and are a critical component of an integrated climate change mitigation and air-quality management programme. However, since long-lived greenhouse gases dominate climate forcing in the long term, decreasing emissions of short-lived climate pollutants in the short term needs to be combined with mitigation of long-term greenhouse gases. Non- CO_2 emissions in pathways that limit global warming to 1.5 degrees Celsius show deep reductions that are similar to those in pathways limiting warming to 2 degrees Celsius.

Although the UNEP 2019 Global Environmental Outlook (GEO 6) report paints a relatively challenging outlook picture, the World Economic Forum's 14th edition of its global risk assessment, The Global Risks Report 2019, paints a far bleaker outlook. In a clear indication of exasperation, the report asks the question – "Is the world sleepwalking into a crisis?" –

Global risks are intensifying but the collective will to tackle them appears to be lacking. Instead, divisions are hardening. The world's move into a new phase of state-centred politics, noted in The Global Risks Report 2018, continued throughout 2018. The idea of "taking back control"—whether domestically from political rivals or externally from multilateral or supranational organizations—resonates across many countries and many issues. The energy now being expended on consolidating or recovering national control risks weakening collective responses to emerging global challenges. We are drifting deeper into global problems from which we will struggle to extricate ourselves.

In a section entitled 'Climate Catastrophe', the Global Risks Report 2019 notes – Environment-related risks dominate the report for the third year in a row, accounting for three of the top five risks by likelihood and four by impact. Extreme weather is again out on its own – highest likelihood and highest impact.

The year 2018 was another one of storms, fires and floods. Of all risks, it is in relation to the environment that the world is most clearly sleepwalking into catastrophe. The Intergovernmental Panel on Climate Change (IPCC) bluntly said in October 2018 that we have at most 12 years to make the drastic and unprecedented changes needed to prevent average global temperatures from rising beyond the Paris Agreement's 1.5ºC target. In the United States, the Fourth National Climate Assessment warned in November that without significant reductions in emissions, average global temperatures could rise by 5ºC by the end of the century. Global risk managers seem increasingly worried about environmental policy failure: having fallen in the rankings after Paris, "failure of climate-change mitigation and adaptation" jumped back to number two in terms of impact this year. The most frequently cited risk interconnection was the pairing of "failure of climate-change mitigation and adaptation" and "extreme weather events".

The accelerating pace of biodiversity loss is a particular concern. The Living Planet Index, which tracks more than 4,000 species across the globe, reports a 60 percent decline in average abundance since 1970. Climate change is exacerbating biodiversity loss and the causality goes both ways: many affected ecosystems—such as oceans and forests—are important for absorbing carbon emissions. Increasingly fragile ecosystems also pose risks to societal and economic stability. For example, 200 million people depend on coastal mangrove ecosystems to protect their livelihoods and food security from storm surges and rising sea levels. One estimate of the notional economic value of "ecosystem services"—benefits to humans, such as drinking water, pollination or protection against floods—puts it at US$125 trillion per year, around two-thirds higher than global GDP.

In the human food chain, loss of biodiversity affects health and socioeconomic development, with implications for well-being, productivity and even regional security. Micronutrient malnutrition affects as many as 2 billion people. It is typically caused by a lack of access to food of sufficient variety and quality. Nearly half the world's plant-based calories are provided by just three crops: rice, wheat and maize. Climate change compounds the risks. In 2017, climate-related disasters caused acute food insecurity for approximately 39 million people across 23 countries. Less obviously, increased levels of carbon dioxide in the atmosphere are affecting the nutritional composition of staples such as rice and wheat. Research suggests that by 2050 this could lead to zinc deficiencies for 175 million people, protein deficiencies for 122 million, and loss of dietary iron for 1 billion.

Despite the global expressions of concerns, South African risk managers do not appear to share the views of their international counterparts. Indeed the 5th edition of the Institute of Risk Managers of South Africa's (IRMSA) national risk assessment, the Risk Report: South Africa Risks 2019, has no environment or environment-related risks included in its top 10 risk in terms of likelihood or impact. Indeed, 'climate change' is not even mentioned once in the 105-page report. Not even water is listed despite Cape Town almost running out of water at the time of publication.

Although South Africa may not itself 'be sleepwalking into a crisis', the climate change outlook does not look good. Like the rest of the world, although the growth rate of our greenhouse gas emissions appears to be slowing, it is not falling sufficiently. If this situation does not change dramatically over the next 20 years, then South African, and humanity as a whole, is likely to face a very grim future indeed. This notwithstanding, the following section is based on South Africa's Third National Communication under the United Nations Framework Convention on Climate Change, 2018 report and readers are encouraged to read the report for more in depth, fully referenced, information on the South African climate change outlook.

From a South Africa perspective, significant progress has been made in South Africa since it submitted its Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2011 in terms of the local generation of detailed regional climate futures for the country. Extensive ensembles of projected climate change futures are now available, derived using both statistical and dynamical downscaling techniques. These projections make feasible the identification of plausible climate futures for each of the South African provinces, and in some cases, the identification of actionable messages for adaptation. A key feature of the projected climate change futures of South Africa is that temperatures are to increase drastically under low mitigation. For the far-future period of 2080-2099, temperature increases of more than 4°C are likely over the entire South African interior, with increases of more than 6°C plausible over large parts of the western, central and northern parts. Such increases will also be associated with drastic increases in the number of heatwave days and very hot days, with potentially devastating impacts on agriculture, water security, biodiversity and human health. The model projections indicate that even a modest-high mitigation pathway can still significantly decrease the amplitude of this warming. Nevertheless, it should be realised that South Africa is already committed to relatively large (compared to the global average) increases in near-surface temperatures, even under high-mitigation futures.

Under low mitigation scenarios it is also likely that the larger Southern African region will experience generally drier conditions, already by the mid-future (2046-2065) but particularly in the far-future (2080-2099). This pattern is projected robustly by global climate models and their statistical and dynamic down-scalings, and is of great significance: South Africa exhibits, even under present-day climate, a generally dry and warm climate – should this low mitigation future of significantly hotter and drier conditions materialise, it will greatly limit the available opportunities for adaptation. It may be noted that under low mitigation, a minority of down-scalings are indicative of rainfall increases over the central interior of South Africa, and/or over the southern interior regions and the Cape south coast. Moreover, extreme convective rainfall events are projected to plausibly increase over the interior regions under low mitigation, even in the presence of a generally drier climate. Under high mitigation, the projections are indicative of potentially very different rainfall futures for South Africa. Even under a modest-high mitigation pathway, the projected pattern of drying is significantly weaker. In fact, a fairly large number of projections are indicative of generally wetter conditions over the central and eastern interior regions, whilst the remaining projections remain indicative of generally drier conditions. This, in combination with the significantly reduced warming that is projected for southern Africa under high mitigation, emphasises how important it is for South Africa to strive for a (global) high mitigation pathway, i.e. highly ambitious reductions in global GHG emissions.

Starting with the South African agricultural sector, this sector is highly diverse in terms of its activities and socio-economic context. The agriculture sector employs approximately 860 000 people and is critical in terms of national food security as well as supporting thousands of urban and rural households in terms of subsistence agriculture and small-scale production. The sector is considered to be one of the most critical economic sectors in terms of potential impacts of climate change in South Africa. Agriculture is impacted directly by changes in precipitation, temperature and evaporation and through secondary impacts including disaster risk and health issues. The most significant climate change risks and vulnerabilities to agriculture in South Africa include increasing temperatures and more variable precipitation that are likely to have significant impact on a wide variety of crops and forestry products. The yields of rain-fed crops such as maize, wheat and sorghum are likely to be affected most drastically, whilst irrigation demands projected to increase due to increased temperatures.

Moreover, more extreme temperature events will directly impact farm labour through enhanced heat stress conditions. Livestock production will also be negatively affected under oppressive temperatures. Adaptation strategies in agriculture include the implantation of Climate Smart Agriculture, improved water management, improved monitoring and early warning, the development of knowledge and decision support systems, and the development of new crop varieties and technologies to support farming.

The interaction between climate change stressors, estuarine processes and features and biotic responses are complex, with multiple interactions which can both amplify and moderate responses. Analysis shows that KwaZulu-Natal and West Coast estuaries will be the most influenced by climate change from a structural and functional perspective. This is contrary to the current monitoring programmes which are focussing on biotic responses in the biogeographic transition zones (e.g. the Transkei and western Southern Cape). In the case of KwaZulu-Natal the major driver of change is increased runoff into the numerous small, perched temporarily open/closed estuaries, which may result in more open mouth conditions, a decrease in retention time and a related decrease in primary productivity and nursery function. In contrast, west coast estuaries may be negatively impacted as a result of reduction in runoff, related decrease in nutrient supply and an increase in sea level rise. This in turn may increase salinity penetration in permanently open estuaries and increase mouth closure in temporarily open ones. Similar to KwaZulu-Natal, west coast estuaries will experience a decline in primary production and loss of nursery function. Although Wild Coast, Eastern and southern Cape estuaries may show some shifts in mouth states, nutrient supply, salinity distribution and ultimately production (e.g. fisheries), the most likely impacts of climate change along these coastal regions will be the change in temperature (nearshore and land), associated species range expansions or contractions and changes in community structure.

The bimodal rainfall zone of the Southern Cape is projected to plausibly exhibit an increase in the frequency and magnitude of large floods as well as the duration and intensity of droughts. This region is characterised by medium to small catchments wherein bimodal rainfall ameliorates flow variability and confers a degree of stability on estuarine habitats. An increase in the magnitude of floods can cause deeper scouring of mouth regions, thereby increasing tidal amplitude and exposure of sub-tidal habitats and communities. The effect of sea level rise, and related increase in tidal prisms, will be less apparent along the KwaZulu-Natal coastline, where with the exception of estuarine lakes and bays, the majority of estuaries are perched whilst it will be more apparent along the southern and Western Cape coast with their more extended coastal floodplains.

South Africa exhibits multiple risks that contribute to the overall burden of disease (i.e. the quadruple burden of disease), which currently puts stress on the health sector. This stress may make the sector as a whole more vulnerable to climate change due to the additional stress a changing climate may put on the system. South Africa does have health policies in place, but action is needed to implement these. The challenging burden of disease in South Africa may make people more vulnerable to the health impacts from climate change (e.g. through pre-existing conditions). However, the impact of pre-existing conditions on the resultant health impact from climate change in South Africa is not quantified. There is a lack of understanding on the linkages between climate and health in South Africa (e.g. quantitative link between high temperatures and mortality). Thus, the current impact of climate-related diseases is not quantified, nor is the vulnerability of communities to such risks. Without a better understanding of the current health burden, it is not possible to understand how climate-sensitive health risks will change in a changing climate. A quantitative vulnerability and risk assessment for the health sector should be performed; this would help to identify the most important health risks, as well as begin to identify the most vulnerable populations or communities. Adaptation strategies can then be tailored to region or communities based upon their risks and vulnerability. The South African health system is also vulnerable to the health status and disease burden of people from neighbouring countries. For example, a majority of malaria in South Africa is not from local transmission. The potential impact on the health sector from climate change has both public and occupational health implications, and both of these aspects need to be considered in adaptation plans.

The climate variability and change threats to terrestrial ecosystems include rising average temperatures, more temperature extremes, changes in rainfall intensity and magnitude, a higher likelihood of extreme events (such as droughts, floods, heat waves, etc.) throughout South Africa, shifting rainfall season, sea level rise and rising atmospheric concentrations of carbon dioxide (CO_2). In addition, non-climatic conditions such as changes in the occurrence, seasonality and severity of fire and land use change resulting from climate variability and change are also presented in this report. These threats vary in their importance between the biomes, increase over time through the 21st century, and increase with the level of greenhouse gas emissions globally.

The nature of human settlements in developing countries makes them particularly vulnerable to the potential impacts of climate change. Each of the settlement types (urban, informal settlements, rural and coastal) have variable vulnerability and exposure to the projected impacts of future climate changes. These variabilities are as a result of Apartheid legacy, spatial variabilities, planned and unplanned growth and dispersion patterns, topography and numerous socioeconomic factors. Addressing the vulnerabilities of the risk areas is a priority for building resilience to climate changes. Different human settlement types and locations having varying vulnerabilities and capacities will experience the hazards associated with the present and future climate changes to an unequal extent. Higher vulnerability and lower coping capacity areas will have increased risk exposure to climate related hazards; informal settlements and their population being the most exposed. Projected climate changes are likely to compound the impacts felt by the most exposed populations and therefore building adaptive capacity in these areas should be a priority. A deficit in infrastructure and provision of services in some areas acts as barriers to adaptation] and increases vulnerability to climate change.

This can be compounded by a lack of resources, unclear regulations and unexpected consequences resulting from previous mal-adaptation or poor development practices. Reducing capacity for necessary operation and maintenance is also contributing to the failure of critical infrastructure needed to mitigate the potential impacts and development risks associated with climate change. The development of human settlements impacts on many other sectors such as transport, energy, water and food production and as such a renewed focus on climate compatible development for human settlements will result in reduced climate change risks and vulnerabilities in these associated sectors.

In terms of disaster risk management, climate change is likely to increase existing vulnerabilities to disaster risk. South Africa's history and resulting urban form has resulted in a high level of vulnerability to disaster risk that must be addressed. Addressing existing issues of lack of development will also provide benefits in terms of reducing the risks and vulnerabilities to climate-related disasters. One of the most significant developments since South Africa submitted its Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2011, has been the Disaster Management Amendment Act No. 16 of 2015. The Act now explicitly provides for the inclusion of climate change in disaster risk assessments through all spheres of government and mandates measures to reduce the risk of disaster through adaptation to climate change and the development of early warning mechanisms. Mainstreaming risk reduction, adaptation and management into development activities are important policy goals for responding to climate change and disaster risk and requires a shift in thinking towards more pro-active risk reduction and adaptation planning from a current largely re-active system.

Under an unconstrained greenhouse gas emissions scenario, modelling results suggest a change in runoff that lies between a 20 percent reduction to a 60 percent increase. If global emissions are constrained the risk of extreme increases and reductions in runoff are sharply reduced, and the impacts lie between a 5 percent decrease and a 20 percent increase in annual runoff. Climate change will affect water quality but in many areas the impacts may be masked by changes in land use, or compliance to effluent standards. Some of the impacts can be foreseen and can be mitigated by careful planning to include potential climate change in water quality management strategies.

7.6.1 Possible climate futures

The following section is an edited extract of the Working Group I contribution to the IPCC Sixth Assessment Report that addresses the most up-to-date physical understanding of the climate system and climate change, bringing together the latest advances in climate science.

The following headline statements summarise the main conclusions of the Working Group I report –

- Global surface temperature will continue to increase until at least mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades.
- Many changes in the climate system become larger in direct relation to increasing global warming. They include increases in the frequency and intensity of hot extremes, marine heatwaves, heavy precipitation, and, in some regions, agricultural and ecological droughts; an increase in the proportion of intense tropical cyclones; and reductions in Arctic Sea ice, snow cover and permafrost.
- Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.
- Under scenarios with increasing CO_2 emissions, the ocean and land carbon sinks are projected to be less effective at slowing the accumulation of CO_2 in the atmosphere.
- Many changes due to past and future greenhouse gas emissions are irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level.

8 WHAT ARE WE DOING ABOUT IT AND IS IT WORKING?

8.1 Climate change

In terms of climate costs, given the significant vulnerabilities identified across the sectors of water, agriculture, forestry and health, and for urban and rural settlements, the coastal zone and ecosystems, there is a strong case for an important future area of work in vulnerability analysis, namely the estimation of climate costs. It is important to quantify how future changes in the mean climate and in the attributes of extreme events may increasingly impact on the South African economy. Such costs may be incurred directly through for example reduced crop yield and damage in infrastructure, but also indirectly through downstream effects to the economy (e.g. reduced crop yield leading to increasing food prices). Moreover, it is important to estimate to what extent investments in adaptation interventions can alleviate climate costs, as a justification for these interventions. Such cost estimations will be of immense value for South Africa (and for developing countries in general) to negotiate fair support from for example the Adaptation Fund of the United Nations Framework Convention on Climate Change (UNFCCC). It is important for such estimations of climate costs, and the costs of adaptation investments, to be performed against the background of the socio-economic futures of South Africa – this is due to the strong dependence of climate vulnerability on the socio-economic state of a country. An increased research thrust is therefore also needed for the development of socio-economic futures for South Africa, including how these futures may be influenced by a changing climate.

In terms of adaptation options, South Africa has presented its commitment to responding to climate change challenges through the development of the 2011 National Climate Change Response Policy White Paper. However, the country is a developmental state that seeks to develop the economy and reduce the levels of inequality and poverty experienced. It is recognised that climate change is likely to impact on the ability to meet these development goals. As such the country has presented its commitment to tackling climate change through the development of its Intended Nationally Determined Contributions (INDCs). The INDC outlines the overall aspirations for adaptation and provides the timelines and levels of investment needed to achieve these goals. Whilst the INDC represents the broader vision for adaptation planning that is aligned with the National Development Plan 2030, significant progress has already been made with respect to developing the adaptation response strategies that are aligned to short-to-medium term policies and strategies.

At a sectoral level, adaptation plans have been developed for the key socio-economic sectors identified in the NCCRP as being vulnerable to climate change. In the water sector for example, the Climate Adaptation Strategy for the sector outlines a number of strategic adaptation actions for addressing climate change impacts. These options range from planning for new dams to developing new groundwater sources and further highlights the need to improve flood warning systems and to ensure that water allocation is sufficiently flexible to cope with climate change. Importantly, the strategy also highlights the need to protect water allocations to poor and marginalised communities, particularly under drought conditions.

In the case of Agriculture, Forestry and Fisheries, sector-related climate change strategies have also been initiated which includes a Climate Change Sector Plan and a Climate Change Adaptation and Mitigation Plan that addresses agriculture and forestry. Climate Change Adaptation Plans have also been developed for South Africa's Biomes, presenting potential adaptation responses to guide current and future decision makers in protecting South Africa's natural ecosystems and biodiversity in the face of climate change. A climate change adaptation plan has been developed for the health sector that focusses on nine health and environmental risks and further seeks to improve health systems readiness to climate change. Adaptation planning within South African cities is occurring alongside the need to address the problems of poor spatial and development planning inherited from the apartheid era. Human settlement typologies in the country are diverse, each with its own set of developmental challenges and potential to be impacted by climate change. A Climate Change Adaptation Sector Plan for Rural Human Settlements has been developed to support the creation of sustainable livelihoods that are resilient to climate change. This plan calls for access to climate resilient services and infrastructure in rural areas to be promoted through climate resilient rural housing programmes that include rainwater harvesting, solar water heaters and off-grid/mini grid electrification, environmentally friendly and socially acceptable sanitation solutions. In addition to this plan, policies that impact on human settlement design and development require the inclusion of climate change considerations. For example, spatial planning and land-use management legislation requires incorporating environmental requirement such as climate change. The National Environmental Management: Integrated Coastal Management Act No. 24 of 2008 also requires that coastal provinces and municipalities develop management programmes that allow for potential climate change impacts to be considered in all coastal planning and management. Further to this, amendments to the country's disaster risk management legislation require all organs of state to not only indicate how it will invest in disaster risk reduction but also climate change adaptation. As such, at both a provincial and local government level, numerous adaptation plans have been developed or are underway. At a national level, the country has also embarked on a process to develop a National Adaptation Strategy that will consolidate and prioritise these local, provincial and sectoral adaptation options. The country has also recognised that it has a responsibility to effectively report on its adaptation initiatives and investments, and has thus developed a Monitoring and Evaluation (M&E) system that will be used to track progress toward becoming climate resilient.

New insights are emerging through observed ecosystem and species changes and improved modelling methods (Dynamic Global Vegetation Modelling, DGVM), relating to structural shifts in biomes. These are updating earlier broad projections developed through application of correlative niche-based modelling (NBM) approaches. Woody encroachment of the Grassland and Savanna biomes appears to be a major ongoing climate-change related trend, which was not fully anticipated by earlier modelling efforts. This may be because direct effects of rising atmospheric CO_2 on vegetation are emerging as a potential driver of woody plant encroachment.

The high inherent variability in southern African rainfall and variance between impacts methodology together reduce the precision with which projections of climate change impacts on biodiversity and ecosystems can be made. As a consequence, a deliberate monitoring program to enhance detection and attribution of climate change impacts on biodiversity and ecosystems would be a valuable planning and policy support intervention.

As mentioned above, there is no national scale, directed effort to monitor biodiversity changes specifically to test for climate change impacts. However, several efforts launched for purposes of inventory and stock taking, such as the South African National Bird Atlas Program (SABAP), and the Protea Atlas initiative, can be leveraged through repeat data gathering to serve this purpose.

The concept of vulnerability has become increasingly important in the climate change research community, with extensive developments taking place in the vulnerability assessment field over the last few decades. The complexity involved in defining and measuring the various geographical, spatial, temporal and social dimensions of vulnerability has resulted in a multitude of methodologies for assessing and understanding vulnerability. As a consequence there is generally a lack of consensus regarding the appropriate frameworks and 'best' methodologies for assessing vulnerability. In South Africa, there is no standard approach or best practise guidelines for measuring vulnerability. This makes monitoring of vulnerability and the evaluation of adaptation measures considerably challenging, and precludes comparing different sectors or localities as well as assessing vulnerability over time. However, initiatives are underway to strengthen future vulnerability assessment work in South Africa by building on a number of currently available tools such as the Let's Respond Toolkit], [South African Risk and Vulnerability Atlas (SARVA), and the Climate Change Response Plan Toolkit. This notwithstanding, building on South African expert insights and recommendations, practical translations of how to conduct vulnerability assessments are available as are a number of South African case studies. In South Africa, there is a constantly growing body of sectoral knowledge on climate change vulnerability. The country saw a great expansion of information from the 2011 Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC) to the much more detailed and in-depth Long-Term Adaptation Scenario (LTAS) reports (2013/2014).

In terms of South Africa's climate change mitigation undertakings, the South African Constitution is the supreme law governing the country and all other laws and policies need to align with it. Key policies and measures guiding the country's efforts to stabilise GHG emissions have been developed in conjunction with private sector and civil society. A number of these policies and measures incorporate a climate change focus, demonstrating the nation's commitment to mitigation and adaptation efforts.

These policies include the 2010 New Growth Path Framework, the 2011 National Climate Change Response Policy White Paper and the 2012 National Development Plan 2030. The government has also made significant investments in research and mitigation activities to ensure the national climate change goals are met, for example, the 2008 Long Term Mitigation Scenarios study and the Mitigation Potential Analysis that followed in 2014.

South Africa is actively driving future mitigation measures to respond to climate change by means of, for example, the recently promulgated Carbon Tax Act No. 15 of 2019 which provides for the imposition of a tax on the carbon dioxide equivalent (CO_2e) of greenhouse gas emissions. Other key anticipated activities to support carbon tax include the development of desired emission reduction outcomes and company level carbon budgets. South Africa has also implemented many sector specific climate change initiatives in the energy, industry, transport, agriculture forestry and other land use and waste sectors.

In the energy sector, South Africa's policies and measures to mitigate climate change broadly aim to provide support for [mitigation] actions, diversify electricity generation and liquid fuel sources, facilitate carbon capture and storage, promote energy efficiency and reduce coal bed methane. Government's initiatives include the Department of Energy's Renewable Independent Power Producer Procurement Programme, which has been widely recognised as an innovative and successful measure for developing the local renewable energy market. A further highlight is the cumulative, national energy efficiency savings of at least 23% which occurred between 2000-2012. These energy efficiency savings surpassed the target of 12% outlined in the National Energy Efficiency Strategy.

In terms of industry, one of the actions of the National Development Plan 2030 in the context of climate change related to the industry sector is the carbon-pricing mechanism. Carbon pricing is supported by a wider suite of policy [mitigation] instruments to drive energy efficiency. Green industry investments are a key focus area and updates are made annually through the Industrial Policy Action Plan. In this sector, the Department of Trade and Industry has provided various incentives related to the development and use of green technologies adding to the mitigation efforts in the sector. Mitigation initiatives are also supported by National Treasury through various tax rebates in the amended Income Tax Act No. 58 of 1962. The Department of Energy has been driving the development of low-carbon initiatives in the industry and South Africa is a host party to 56 registered projects and 35 registered programmes forming part of the Clean Development Mechanism (CDM).

The transport sector mitigation opportunities identified for the country fall under the following broad categories: modal shift; demand reduction measures; more efficient vehicle technologies; more efficient operations and alternative lower-carbon fuels. The Department of Transport leads the development of initiatives aimed at reducing emissions in the transport sector, the biggest being public transportation. Some of the activities that the country is developing and implementing include biofuel programmes as well as support of the local electric vehicle industry in South Africa through several strategic new technology interventions.

In terms of Agriculture, Forestry and Other Land Use, these sectors includes production and removal of emissions. There are three key policies that relate to climate change mitigation. The National Forests Act No. 84 of 1998 which supports activities that sequester GHG emissions such as those relating to sustainable management, conservation and protection of natural forests and woodlands. The 2005 Woodland Strategy Framework for the Department of Water Affairs and Forestry outlines mitigation principles for the sector. Woodlands which cover about 30% of the land surface area are important due to their fire adaptation potential and potential as carbon sinks or sources. The Draft Climate Change Sector Plan for Agriculture, Forestry and Fisheries of 2013 outline mitigation elements for this sector and promotes minimum tillage and land use changes that convert land from GHG sources to sinks.

In terms of waste, the two main policies for the waste sector are the National Environmental Management: Waste Act No. 59 of 2008 and the 2009 National Policy on Thermal Treatment of General and Hazardous Waste which recognise the significance of mitigating climate change. The 2011 National Waste Management Strategy (a legislative requirement of the Waste Act) promotes waste minimisation, re-use, recycling and recovery and has a key output of reducing the GHG emission to mitigate climate change and improve air quality. These objectives are supported by the 2011 Municipal Waste Sector Plan which highlights waste reuse, waste recycling and flaring or recovery of landfill gas.

South Africa has initiated the development of a National Climate Change Response Monitoring and Evaluation System Framework. The main objective of the system is to track the country's transition towards its long-term vision of a climate-resilient and lower carbon economy and society. Mitigation and lower carbon development strategies will be formulated for each significantly emitting sector or sub-sector. The strategies will include measurable and verifiable indicators for each programme and measure. The monitoring and evaluation system will cover all aspects of climate change monitoring and evaluation and will be coordinated by the Department Forestry, Fisheries and the Environment.

South Africa's projections for climate change mitigation form part of the 2014 Mitigation Potential Analysis process. As part of this process projections were made for 2020, 2030 and 2050 with projected GHG emissions trajectories categorised by the sectors, energy, transport (subcategory of energy), industrial processes and products use, agriculture forestry and other land use, and waste. A summary of the outcome of this work is provided in section What is the outlook subsection Climate change mitigation.

8.1.1 A just transition framework

The following section is an edited extract of the Framework for a Just Transition in South Africa, 2022 report, readers are encouraged to read the report for more, in-depth, fully referenced information.

The just transition framework is positioned at the nexus of climate and development issues in South Africa. The framework therefore supports South Africa's broader efforts for an inclusive economy that benefits most citizens to enable deep, just, and transformational shifts (i.e., addressing the triple challenges of poverty, inequality and unemployment), in the context of delivering an effective response to climate change (i.e., improving resilience, making substantial cuts to greenhouse gas emissions, and protecting and promoting the health of communities).

In addition, the framework brings coordination and coherence to just transition planning process in South Africa. It sets out a shared vision for the just transition, principles to guide the transition, and policies and governance arrangements to give effect to the transition.

The framework also considers the alternative economic models that may be needed to enable a just transition as well as significant capital mobilisation, from both public and private sources domestically and internationally.

Fundamentally, the framework focuses on four sectors and value chains which form part of the formal economy that are at risk in the transition, namely: (i) the coal value chain; (ii) the auto value chain; (iii) agriculture; and (iv) tourism.

8.1.1.1 Key policy areas for a just transition

The following policy areas outlined in the 2022 Framework for a Just Transition in South Africa constitute a basic framework to address the challenges of a just transition for all South Africans. These policies should be applied in an integrated manner and aligned so that policies in one field do not undermine objectives and measures in other policy fields.

Human resource development and skills development

South Africa faces deep-seated structural challenges in the economy, centred on unusually profound inequality and high levels of unemployment. As a result, affected groups may not be able to shift into new opportunities in the transition. Skills development and education is therefore essential to respond to the transition risk and support people in becoming more climate resilient. Recommendations in this framework are focused on three broad areas: (i) reskilling and upskilling existing adult workers so that they are better equipped to navigate the transition; (ii) aligning the skills development system with the anticipated labour force needs of the future, particularly focused on green jobs to support a just transition; and (iii) ensuring foundational skills through the education system to improve the adaptative capacity of the broader workforce.

Industrial development, economic diversification, and innovation

Industrial development and economic diversification are essential to supporting a just and equitable transition. New economic clusters will be needed to create new jobs and replace jobs where they may be lost. These clusters can be designed to meet local needs, for instance, by producing local necessities such as food, construction materials, entertainment, education, or healthcare; alternatively, these clusters can provide products for regional or global markets. Rising numbers of small and informal business are critical for a more resilient and equitable economy.

New economic clusters need not only be thought of in the context of energy or industry, but also in terms of the "biodiversity economy," which encompasses businesses and other economic activities that either directly depend on biodiversity for their core business, or that contribute to the conservation of biodiversity through their activities. According to the National Biodiversity Assessment Report, 2018, the biodiversity economy, for example generates over 418,000 jobs in South Africa, with jobs in sectors such as the restoration of biodiversity, fisheries, wildlife ranching, biodiversity-based tourism, traditional medicine, and indigenous tea production. Many of the biodiversity-related jobs are outside the urban centres and are labour intensive, contributing to rural development, poverty alleviation, inclusive growth, and labour absorption.

Social protection measures

While some workers and communities may be able to transition to new jobs and industries, others will require transitional or long-term support according to their unique situations. Support for the chronically poor and unemployed (i.e., through the social security system) may differ from transitional mechanisms to support those affected by longer-term sectoral changes in the economy or by immediate climate-related disasters. The current social security system has significant gaps, with no mandatory system for social security pension provision, and no provision for people without income but who do not meet the criteria to receive social grants (affecting the 18 - 59 age group). The Department of Social Security has proposed a comprehensive reform of social security and retirement provisions, and further work is being undertaken to define the scope and structure of these social protection measures in the context of South Africa's fiscal constraints.

8.1.1.2 Collective action

According to the 2022 Framework for a Just Transition in South Africa, effective governance at the national, provincial, and municipal levels will be central to achieving a just and equitable transition in South Africa – implementing plans, building consensus, mobilising resources, coordinating implementation, and monitoring progress. The nature of climate risks and the urgency of the transition is such that stakeholders must work intentionally and in concert. A just transition will therefore benefit through collective action by all social partners, requiring a shared commitment towards –

- Engaging under the principles of transparency, openness, impartiality and consensus, effectiveness and relevance, and coherence;
- Finding ways to better integrate the children, the youth, and women into policymaking for the just transition at national, provincial, and local levels (e.g., provision of childcare, travel support, multiple languages); and
- Developing just transition plans through a spatial lens, considering different just transition approaches in different regions (e.g., Mpumalanga will need a new regional development plan beyond coal; the disparities in the rural areas and coastal regions of South Africa make certain communities more vulnerable than others, etc.).

8.1.1.3 Finance for a just transition

Achieving a just transition in South Africa will require significant capital mobilisation, from both public and private sources, both domestically and internationally. The 2022 Framework estimates that South Africa will require at least US$250 billion over the next three decades to transform the energy system, with at least US$10 billion allocated toward “climate justice outcomes” – the heart of the transition – to support workers and communities in the transition e.g., compensation, retraining, relocation, and rehabilitation of regions and communities. The estimated US$250 billion excludes the additional requirements to transition to a fully green economy, including strengthened adaptation measures.

The following interlinked strategies are required to mobilise capital towards a just transition in South Africa –

- Reviewing existing mechanisms, such as taxes and subsidies, and determining whether they are “fit for purpose” or require adjustments to support a just transition e.g., piggybacking on the carbon tax or developing more avenues for own-source revenues for cities or municipalities.;
- Revisiting whether and how public resources have been effective in supporting improved service provision and in closing the inequality gap;
- Creating a business case for just transition projects, with a particular focus on identifying financing mechanisms for infant industries;
- Improving the efficiency of public spending, including to just transition projects;
- Gradually eliminating perverse and/or regressive subsidies that do not support a just transition;
- Applying economic instruments to support a just transition, such as performance-based grants, progressive subsidies, tax benefits, tax rebates, or incentive schemes;
- Integrating the just transition framework into the national budget and reorienting state spending in support of a just equitable transition;
- Integrating climate-related risks and the just transition imperative into all investment decisions;
- Employing a common taxonomy for tracking just transition financial flows, aligned with National Treasury’s Green Finance Taxonomy (National Treasury 2022), and disclosing these flows in a manner that supports transparency and optimal policy and economic decisions,;

- Utilising green and other thematic bonds to mobilise capital for climate and transition projects, enabling access to large pools of institutional capital;
- Expanding the use of blended finance to catalyse new investment opportunities for the just transition, supporting private investor participation; and
- Encouraging public-private partnerships to deliver capital-intensive infrastructure projects that support a just transition.

8.1.2 Climate change mitigation

Chapter 5 of South Africa's National Development Plan 2030 (NDP) – Ensuring Environmental Sustainability and an Equitable Transition to a Low Carbon Economy – states that by 2030, South Africa should have transitioned to an environmentally sustainable, climate-resilient, low-carbon economy and just society. In order to strengthen and provide guidance on the implementation of Chapter 5 of the NDP, the National Planning Commission (NPC) has embarked on a process to develop a national vision of a Just Transition to a low carbon economy and climate-resilient society by 2050 (a notably longer time horizon).

A bottom-up process of engaging various stakeholders began in 2018, with the NPC hosting workshops in all nine provinces to engage multi-stakeholder participants, including business, society, business, government, labour, communities, experts, etc. on society's expectations on the just transition vision. What is coming out of these dialogues is that the transition should be a long-term planned and well managed process – where worker's jobs and livelihoods, especially of the most vulnerable, poor and working-class communities are protected. A High-Level Summit on a "2050 Vision and Pathways for a Just Transition" was initially proposed for June 2020.

8.1.2.1 Climate change mitigation response

The following section is an edited extract of the 2023 Annual Report for Mitigation Action Quantification and readers are encouraged to read the report for more, in-depth, fully referenced information.

Green Buildings in South Africa

It has become critical to design, construct and operate buildings that are energy efficient, resource efficient and environmentally responsible. Green Buildings offer an opportunity to save energy, reduce waste, cut down on greenhouse gas emissions, conserve natural resources; all while improving water and air quality. Green Buildings also offer their occupants better health and productivity and are additionally cost-efficient to operate. Green building practices can have a significant impact on combating climate change and help to create truly sustainable communities. In 2007, South Africa established the Green Building Council South Africa (GBCSA), which is a non-profit, non-governmental organization that supports green construction. The Green Building Council South Africa (GBCSA) aims to transform the built environment for the future. GBCSA certifies buildings and precincts that have worked through rigorous rating systems and provided evidence, so that they may be proclaimed certified green buildings. Weighing factors that are specific to each different tool are then applied to the scorecard to get the final rating. The weighting differs per tool to reflect the distinct environmental concerns in the different building sectors.

Development of Hydrogen Projects in South Africa

South Africa's ambition to develop a hydrogen economy began with the approval of the HySA Strategy by Cabinet in 2007. The Department of Science and Technology, now the Department of Science and Innovation, identified Hydrogen Fuel Cell Technology (HFCT) for its potential to reduce emissions and secure the country's energy future. It is estimated that South Africa has the potential to produce 6 to 13 million tons of green hydrogen and derivatives a year by 2050. South Africa currently produces approximately 2% of global hydrogen output (all grey hydrogen), with Sasol being the leading producer through its Fischer-Tropsch coal to liquid fuel process.

Hydrogen is seen as an opportunity to revamp the country's industrial sector and achieve its emissions reduction goals by 2050 while reducing socioeconomic inequality. The country's vision is guided by its Hydrogen Society Roadmap (HSRM) released in 2021, which sets clear targets to reach by 2050. South Africa aims to deploy 10 gigawatts (GW) of electrolysis capacity in Northern Cape by 2030 and produce about 500 kilotons of hydrogen annually by 2030. This growth is forecasted to create 20,000 jobs annually by 2030 and 30,000 by 2040. Hydrogen has the potential to help the country reach a net-zero economy by 2050.

Greenhouse gas impacts of nationally implemented mitigation actions

Assessing the greenhouse gas (GHG) impacts of policies and measures is a key step towards developing effective GHG mitigation strategies to attain the aspirations of the National Climate Change Response Policy (2011), the National Development Plan 2030 and the National Determined Contribution targets. Impact assessment supports evidence-based decision making by enabling policymakers and stakeholders to understand the relationship between policies and expected GHG impacts.

An evaluation of selected climate mitigation actions focussed on quantitative assessments has been undertaken where data sets were available. The total mitigation emissions quantified in the 2023 Annual Report for Mitigation Action Quantification is for the period 2010 to 2020. Over the assessment period a total of 248.831MtCO_2e of emissions have been reduced. The figure below shows the contribution from the implemented mitigation actions to the total emissions reduced. The main contribution came from implementing fuel switch to natural gas projects (33%), followed by Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) which accounts for 29%, 12L Tax Incentive (11%), the least contributing action is Bus Rapid Transport System.

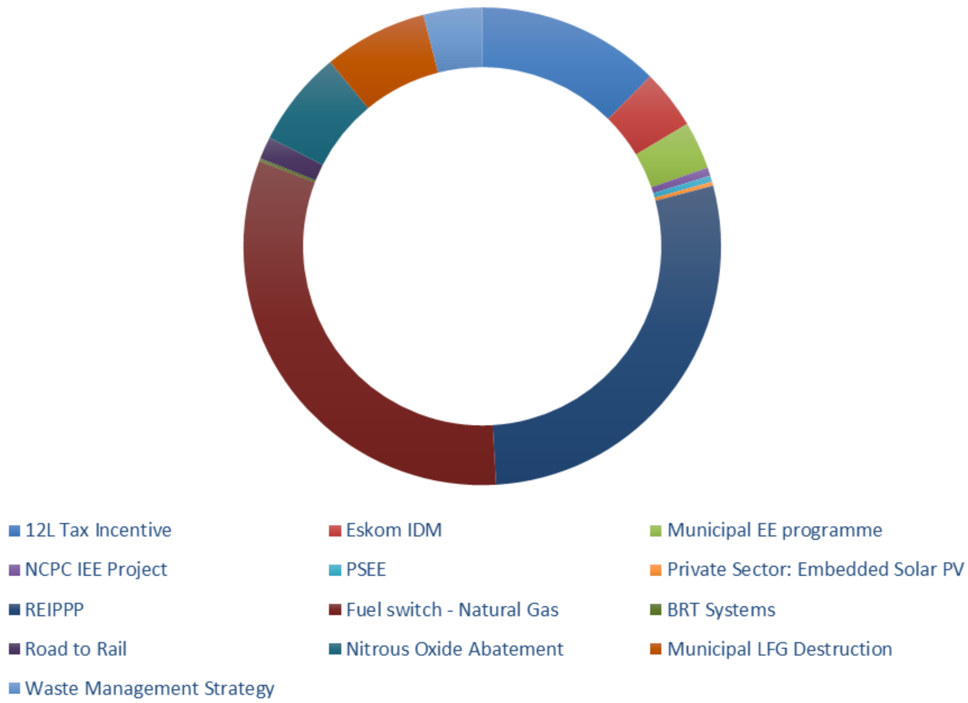


Figure: Contribution of the implemented mitigation actions to the total emissions reduced for the period of 2010-2021.

8.1.2.2 Sectoral emission targets

South Africa has clear goals for climate change mitigation in national policy, and an international commitment to reduce greenhouse gas emissions that is consistent with national policy. The Department of Forestry, Fisheries and the Environment (DFFE) has developed and is institutionalising the climate mitigation system for South Africa, which seeks to drive down greenhouse gas emissions from the economy. One of the instruments that is included in this system is Sectoral Emission Targets (SETs) (previously known as Desired Emission Reduction Outcomes in the National Climate Change Response Policy) as defined in the draft Climate Change Bill. The SETs are either quantitative or qualitative greenhouse gas emission targets or aspirations assigned to an emitting sector or sub-sector, over a defined period. SETs will be defined and allocated as soon as the Climate Change Bill becomes law. These will be determined for three rolling 5-year periods; and will be reviewed every 5 years.

National government departments would be expected to align, adjust, upscale and/or develop and implement Policies and Measures (PAMs) to ensure emissions from within a sector or sub-sector remain within the Sectoral Emission Targets (SETs). The PAMs are policy instruments implemented by government and applied across the economy, over a wide range of sectors, to help South Africa achieve its emission reduction goals. The PAMs may include regulatory instruments (specifically legislation, regulations and standards), economic instruments (for example, incentives and taxes), and government procurement programmes or direct investment by government. These may be cross-cutting (across more than one sector) or specific to individual sectors or subsectors and may achieve abatement through action by government or induce action by others. Many government departments and agencies, cities and provinces, are already implementing measures which have mitigation as a goal (for instance the emissions constraint in the Integrated Resource Plan 2019), or have significant mitigation benefits (for instance energy efficiency measures and the extension of efficient public transport, such as bus rapid transit systems). The Carbon Tax is also one of the policy instruments articulated through the 2011 National Climate Change Response Policy White Paper as one such policy intervention/ instrument to influence behavioural change on industry to internalize external costs associated with greenhouse gas emissions.

Table: Sectors currently considers for SETs

SETs focus	Policy Sector	Lead Department/Entity
Non-Environmental Sector	Energy	Department of Mineral Resources and Energy
	Transport	Department of Transport Department of Mineral Resources and Energy
	Human Settlements, including buildings, wastewater	Department of Human Settlements Department of Public Works Department of Mineral Resources and Energy Department of Water and Sanitation
	Industry	Department of Trade, Industry and Commerce Department of Mineral Resources and Energy
	Land	Department of Agriculture, Land Reform and Rural Development
	Agriculture	Department of Agriculture, Land Reform and Rural Development
Environmental Sectors	Environment	Department of Forestry, Fisheries and Environment: Biodiversity, Environmental Programmes, Chemicals and Waste, Forestry, Integrated Environmental Management

The Climate Change Bill makes provision for the provincial and local government spheres to conduct climate change needs and response assessments, and based on these, develop and implement climate change response implementation plans as a component of and/or in conjunction with provincial, metropolitan or district municipality's planning instruments policies and programmes. This should allow for the provincial and local governments to also contribute to the SETs process, and not just the national sector departments.

The individual and total effect of existing and proposed PAMs on GHG emissions reduction to meet the national trajectory, SETs and international obligations such as the Nationally Determined Contribution will be assessed. These assessments of the adequacy of the existing and planned PAMs are undertaken by making comparison with the national trajectory, SETs and international obligations, providing an indication of the gap between what existing and planned PAMs would achieve, and what is required.

The SETs Framework was approved by Cabinet in November 2021. The purpose of this Framework is to outline an approach that DFFE will follow when coordinating the process towards allocation and implementation of Sector Emission Targets (SETs) with the line sector departments, provinces and local governments. When allocating the SETs to sectors, it will be very important to understand the socio-economic impacts of the sectoral emission targets. Thus, an assessment will be done with the view to minimizing negative impacts on workers and communities with stakes in high-carbon sectors that will wind down, and to maximize positive opportunities for new decent jobs in the low-carbon growth sectors of the future (ensuring just transition).

8.1.2.3 Mitigation plans (applicable to private/business entities)

The companies whom the Minister has given carbon budgets are expected to prepare, submit and implement mitigation plans to demonstrate how they are going to reduce/manage their GHGs towards the achievement of their carbon budgets. For the first phase, companies have to prepare mitigation plans through the Pollution Prevention Plan Regulations, developed under the National Environmental Management: Air Quality Act, 2004 (Act no. 39 of 2004).

On 21 July 2017, the Minister published a Notice Declaring six GHGs as priority air pollutants (the Declaration Notice), under section 29(1)(a), read with section 29(4) of the National Environmental Management: Air Quality, Act 2004, (Act No. 39 of 2004) ("the Act"). The priority six greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). The Minister also published the National Pollution Prevention Plans Regulations, 2017 which prescribe the requirements for submission and approval of pollution prevention plans, under sections 53(a), (o) and (p), read with section 29(3) of the Act, for implementation on the same day. Paragraph 3(1) of the Declaration Notice requires that a person conducting a production process set out in Annexure A to the Declaration Notice, which involves emission of greenhouse gases in excess of 0.1 Megatonnes (Mt) annually, reported as carbon dioxide equivalents (CO_2-eq), and/or if so, directed by the Minister, submits a Pollution Prevention Plan (PPP), to the Minister for approval. By 31 March 2019, the DFFE received thirty-nine (39) PPPs submissions from companies. The Climate Change Act when promulgated, should empower the Minister to develop regulations to compel companies to prepare and submit carbon budgets aligned to- and implement mitigation plans.

8.1.2.4 Statistics and PPP implementation progress thus far

Regulation 3(2) stipulates that "A first Pollution Prevention Plan (PPP)" must cover a period from the date the regulations are promulgated up to 31 December 2020. During this phase, a total of +/- 40 PPP submissions were received by 21 June 2018 for consideration. The PPPs were considered and approved as per regulation 4(3). The approved PPPs were required to monitor and report progress against the approved PPP.

The regulation requires that the PPP must be reconciled at the end of each five-year period phase, i.e., 31 December 2020 for the first generation plans. The mitigation measures that were reportedly implemented up to the 31 December 2020 commitment period, included both direct and indirect emissions with a total of 5 513 657,43 tCO_2eq emissions estimated to be potentially avoided during the first phase (2018-2020). This is the reported implementation performance against the estimated +-17 Mt CO_2eq from the original 2018 commitment. For the subsequent PPP submission, companies were provided with five months to develop and finalize their new PPP for the period 01 January 2021 to 31 December 2025. Thus, the subsequent plans were due for submission on 31 May 2021. A total of thirty-six (36) companies submitted their subsequent PPP for consideration, with the proposed mitigation intervention anticipated to reduce a total of 36 876 671,85 tCO_2eq, greenhouse gas emissions for both scope 1 and scope 2 emissions.

To track implementation progress, companies with approved PPPs are required to monitor and evaluate the implementation of their plan and submit their progress report by the 31st of March each year, thus far, companies have reported their implementation progress for the 2021 and 2022 reporting period.

8.1.2.5 Greenhouse gas emission mitigation potential analysis

The first Greenhouse Gas Emission Mitigation Potential Analysis (MPA) was published in 2014, with the overall objective of conducting an updated, bottom-up assessment of mitigation potential in key economic sectors in order to identify a set of viable options for reducing GHGs. The development of the MPA involved:

- Setting baselines and projecting greenhouse gas emissions into the future;
- Conducting an in-depth assessment of the mitigation potential for key sectors and sub-sectors of the economy;
- Identifying the best available mitigation options for key sectors and sub-sectors informed by amongst others: Multi-Criteria Analysis (economic, social, environmental, readiness, institutional arrangements, policy landscape, technology needs) to assess implementability of identified options and Costs and benefits of achieving emission reduction outcomes for key sectors and sub- sectors (Marginal Abatement Cost Curves - MACC).

Marginal abatement cost curves (MACCs) for key sectors and subsectors were constructed. The MACCs provide estimates of mitigation potential and marginal abatement costs for broad mitigation measures. Estimates of national mitigation potential have been derived from the sectoral MACCs and ranked in terms of level of implementability at national level for each of the technologies.

Emissions are projected based on the National Greenhouse Gas Inventory and sector plans (policies and strategies) also form part of the inputs to the MPA. Some of the key modelling assumptions are drawn from the National Development Plan 2030, gross domestic product (GDP) and sectoral growth rates as projected by the South African National Treasury and other key government departments. The Mitigation Potential Analysis is currently being reviewed and updated.

8.1.2.6 National emissions trajectory

The national emissions trajectory serves as the country's benchmark against which South Africa's greenhouse gas emission reduction performance is measured. This also informs South Africa's international obligations in the form of a Nationally Determined Contribution (NDC) or variant thereof. This is informed by all necessary measures (existing and additional) - including projections, developmental and sectoral plans, as well as measures identified in the MPA. In order to set the country on track to achieving its national greenhouse gas emissions goal, a range of pathways should be developed to consider different ways in which South Africa could reduce its greenhouse gas emissions. These pathways must be linked to the 2050 vision.

The Peak, Plateau, Decline Emissions (PPD) Trajectory Range, as reflected in the NCCRP (see the document published by the Department of Environmental Affairs (DEA) in 2011 entitled Defining South Africa's Peak, Plateau and Decline Greenhouse Gas Emission Trajectory as referenced in section 6.4.2. of the NCCRP) and the NDP, is being used as the benchmark against which the emission reduction performance is measured. In this regard the Republic's greenhouse gas emissions are meant to:

- Peak in the period 2020 to 2025 in a range with a lower limit of 398 Megatonnes (109 kg) (Mt) CO_2- eq and upper limits of 583 CO_2-eq and 614 Mt CO_2-eq for 2020 and 2025, respectively;
- Plateau for up to ten years after the peak within the range with a lower limit of 398 Mt CO_2-eq and upper limit of 614 Mt CO_2-eq; and
- from 2036 onwards, decline in absolute terms to a range with lower limit of 212 Mt CO_2-eq and upper limit of 428 Mt CO_2-eq by 2050.

The PPD will need to be reviewed to respond to the vision. This will involve quantitative articulation of the vision – also creating the long-term desired state for country (for example, carbon neutral South Africa by 2050). A broad range of structural changes will be necessary, in order to ensure that the South African economy achieves this vision. This requires assessing the current situation and aligning development with climate goals (reliable data and analysis, for which collaboration with experts is necessary). The Climate Change Act will empower the Minister to develop the national greenhouse gas emissions trajectory (target) with a review every 5 years.

8.1.2.7 Back-casting pathways

Once the 2050 vision is agreed to, it will be necessary to use a back-casting technique, which helps in working backwards to identify policies and plans that would support the vision. From this, a number of pathways to achieve the vision would be developed. Planning teams with analytical and sectoral expertise should be established to engage in detailed scenario work to develop transformation pathways towards achieving the national targets (economy wide). Sectoral details will have to be analysed in significant detail, laying out different scenarios to understand trajectories of investment, technology take-up, emissions reduction, and market change. The correct incentives will accelerate positive change, while misalignment can hold back action to implement the pathway(s). For example, one envisaged pathway would suggest the phase out of coal use for electricity generation. Considerations would need to be made for some industrial sectors such as iron, steel and cement manufacturing that do not have options for process heat. For such pathway(s) to be realised, there would be a need to provide solutions for fuel switch and policy packages to support manufacturing in these sectors.

To inform a decision to arrive to a preferred pathway, a socio-economic study will have to be conducted. This should look at activities associated with all the proposed pathways in terms of jobs created and/or lost; estimate the capital and operating costs to implement the respective activities, including investment costs, estimate costs resulting from shifting, substituting or closure of assets and/or activities as a result of the new pathway(s); analyse other non-monetary social impacts associated with the pathways such as health impacts, skills requirements.

8.1.2.8 National determined contributions

In the Paris Agreement, Parties collectively agreed to limit "the increase in the global average temperature to well below 2°C above pre-industrial levels, and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels". Article 4 of the Agreement sets out Nationally Determined Contributions (NDCs) as the instrument countries must develop to present their part of the global effort to "reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity and "in the context of sustainable development and efforts to eradicate poverty".

South Africa's NDC has both adaptation and mitigation objectives with the mitigation commitments taking the form of a peak, plateau and decline emission trajectory that is significantly more ambitious than that reflected in South Africa's 2011 National Climate Change Response Policy.

South Africa submitted its updated National Determined Contributions in September 2021. The updated NDC mitigation targets are contained in the table below:

Table: South Africa's updated NDC mitigation targets

Year	Target	Corresponding period
2025	South Africa's annual GHG emissions will be in a range from 398-510 Mt CO_2-eq.	2021-2025
2030	South Africa's annual GHG emissions will be in a range from 350-420 Mt CO_2-eq.	2026-2030

The DFFE has finalised the country's Low Emissions Development Strategy. This is in response to the call by the Paris Agreement for countries to communicate their low emissions development strategies by 2020. The document presents South Africa's first Low Emission Development Strategy (SA-LEDS) generated after the adoption of the Paris Agreement. The South African LEDS will serve as an implementation plan for the mitigation part of the NDC.

Carbon Budgets have been identified as one of three primary mitigation measures forming critical components of the South African mitigation system (the others being Sectoral Emissions Targets and Carbon Tax). In simplified terms, a Carbon Budget is a greenhouse gas (GHG) emissions allowance allocated to a company over a defined time period. It is a means for regulating the emission of greenhouse gases in the economy. A carbon budget sets a maximum volume of greenhouse gas emissions that an entity is allowed to emit over a certain time period. A carbon budget is allocated for a period of five years. Attempts to align the companies' budgets with the national trajectory and the sectoral targets will be made in the future mandatory carbon budget regime. The DFFE is currently implementing first phase carbon budgets (2016-2020). These are voluntary, mainly, due to lack of legislation. Second and subsequent phases will be determined for three rolling 5-year periods and will be reviewed every five years. The Climate Change Act will empower the Minister to allocate and review mandatory carbon budgets. Also, the alignment of carbon budget and carbon tax will be anchored in the Climate Change Act. As per the Greenhouse Gas Emissions Reporting Regulations, gases to be considered for carbon budgets are: Carbon Dioxide (CO_2), Methane (CH_4) Nitrous Oxide (N_2O), Hydrofluorocarbons (HFC's), Perfluorocarbons (PFC's) Sulphur Hexafluoride (SF_6) and Nitrogen Trifluoride (NF_3).

Carbon Budgets will cover all activities as defined in the forthcoming Climate Change Act. These will include direct emissions (Scope 1) such as stationary combustion emissions from heat or energy generation, process emissions and fugitive emissions. Carbon Budgets will be allocated at a company level.

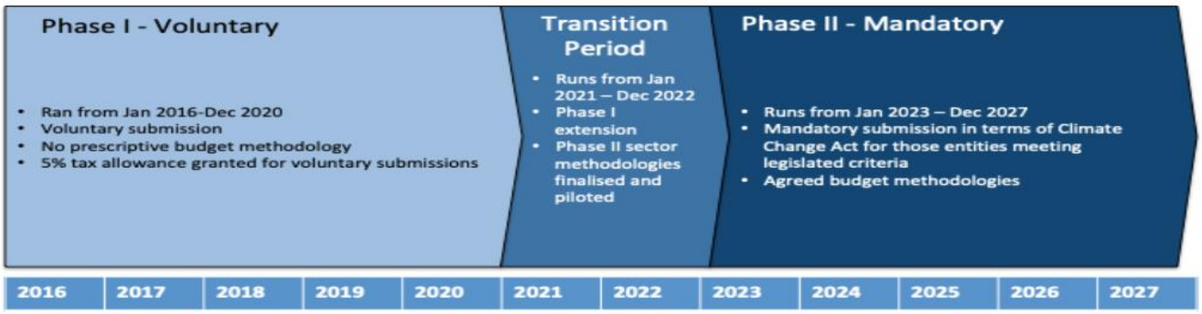


Figure: Carbon budget development timeline

In summary, the methodological tiers are defined as follows:

- Bottom Tier - Fixed Target: Budgets are sector-wide fixed reductions:
- Middle Tier - Mitigation Potential: Budget is underpinned by the mitigation potential assessed in the mitigation model: and
- Highest Tier - Benchmarking: Budget is/are benchmark intensity/intensities, determined at a company level but underpinned by performance data at facility level.

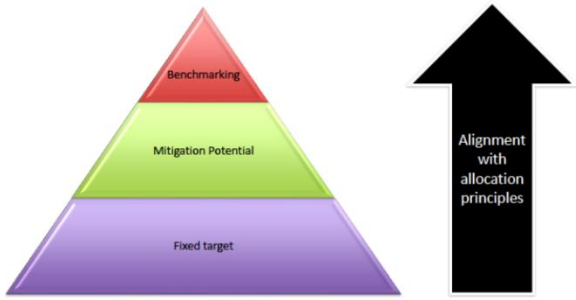


Figure: Tiered approach to carbon budget allocation

The DEFF has developed a three tier approach for the allocation of carbon budgets to companies. The bottom tier is a fixed target in which budgets are sector wide fixed reductions. The middle tier is a budget underpinned by the mitigation potential assessed in the mitigation model. The top tier is benchmarking in which a budget is a benchmarked intensity determined at company level but underpinned by performance data at facility level.

In the Fixed Targets, carbon budgets are set by allocating a share of GHG emissions space to industry and mining from the GHG emissions target. The space is then divided up between individual industry and mining companies. This method does not consider emissions reduction potentials or the context of each sector or company and can thus be considered 'top-down'. The basis of this approach is the definition of the share of national emissions allocated to industry and mining. This can be readily estimated using the mitigation potential analysis (MPA). The MPA contains input data from 2000 to 2015 and projection of emissions to 2050. The share of emissions is estimated by dividing the modelled industry and mining GHG emissions by the economy-wide emissions number (industry and mining GHG emissions are the sum of the fuel combustion and process emissions of all relevant sectors).In the Mitigation Potential, the modelled mitigation potential is used as guidance for the allocation of carbon budgets. The mitigation model includes a stakeholder based assessment of what emissions reductions are possible per economic sector. Only the industry and mining sectors are considered. The MPA can be used as a guide to identify the emissions reductions that will be assigned to companies. It is however, not company specific. Thus, the applicability of each mitigation measure identified in the model will be assessed individually as companies within each sector may use different technologies, material inputs and may already have implemented identified mitigation measures.

In the Product-Level Benchmarks, company carbon budgets are based on a specific performance level of emissions per unit output of a specified product. Operating philosophies and approaches differ markedly between industrial and mining sector companies, leading to different emissions intensities per unit production. Factors that impact emission intensities include types of fuels used, efficiency of fuel use, manufacturing and mining processes, technologies used in the operations, input materials used and techniques used to manage waste gases. In certain cases, it may be vastly complex and time consuming to link emissions with a unit of product. This may arise when there are no, or very few comparable companies within a sector or when the production processes are complex, consisting of many nuanced sub-processes, each with its own by-products and emissions. In these instances, a fall-back approach can be used. This assesses emissions per unit heat generated, per fuel consumed and per reductant used (process emissions).

In terms of allocating methodologies, the DFFE has placed product-level benchmarking at the top of the methodological hierarchy based on an assessment of both what is possible in the South African context (utilizing data available through existing reporting and disclosure mechanisms) and an assessment of global best practice.

In the South African context, the selection of product-level benchmarking as the top tier has been informed by an evaluation of each proposed methodology against the feasibility, fairness, equality, robustness, effectiveness, flexibility, alignment with the policy objectives and competitiveness principles.

8.1.2.9 GHG mitigation analysis

South Africa has various key mitigation Policies and Measures and associated mitigation actions, which have been developed to inform and facilitate the country's transition to a low carbon economy. The table below indicates key mitigation measures implemented in response to climate change –

Prioritised Actions
Carbon offsets - in Carbon Tax Act system
Carbon offsets - not in Carbon Tax system - voluntary carbon market
Section 12L Energy Efficiency Tax Incentive
Section 37B Waste Recycling Incentive
Carbon tax on industry
Eskom Integrated Demand-side Management
IPP Procurement Programme - Renewable Energy
IPP Procurement Programme - Gas
NCPC Industrial Energy Efficiency Programme
Private Sector Energy Efficiency Programme
Renewable Energy Certificate Programme
SANS 204 certifications: Energy efficiency in Green Buildings
Section 12B Tax Incentive
Landfill gas extraction from municipal landfill sites
Renewable energy - LFG to energy

8.1.3 Climate change adaptation measures

8.1.3.1 Potential adaptation options in Southern Africa

The following section is an edited extract of the Intergovernmental Panel on Climate Change Sixth Assessment Report, 2022 with a focus on the significance of the inferences at the continental, regional (Southern Africa) and/or national level. Readers are encouraged to read the report for more, in-depth formation on the potential adaptation options.

Adaptation is the key priority for Africa, since we are and will be impacted by the effects of climate change the most. Some of the adaptation actions in Southern Africa include the following:

- Ecosystem-based adaptation;

- Investments in land-based adaptation;
- The introduction of drought- and pest-tolerant crop and livestock varieties – but often farmers with the lowest incomes cannot afford these without assistance. Nevertheless, adaptation limits for crops in Africa will increasingly be reached for global warming of 2°C.
- Management of water use amongst different users;
- Promotion and increased use of local and indigenous knowledge;
- Integration of climate adaptation into social protection programmes;
- Effective adaptation in human settlements relies on addressing climate risks throughout planning and infrastructure development; and
- The development and use of early warning systems.

However, the ability of southern African to effectively adapt is restricted by the lack of efficient means of implementation.

Third country strategy paper, 2017-2021

The Government of Flanders has a long history of development cooperation with South Africa. Since 2001, Flanders and South Africa have partnered with the Government of Flanders on several programs including the Country Strategy Paper (CSP I, 2005-2008) and Country Strategy Paper 2012-2016 (CSP II). Through these foci, programs aimed to address poverty, inequality and unemployment in South Africa have been implemented. Flanders and South Africa have agreed on a third Country Strategy Paper (CSP III), which will run over the period 2017 - 2021. The CSP III has been designed to focus on Climate Change and the green economy as levers to further address poverty, inequality and unemployment in South Africa. The CSP III has two specific objectives, namely:

- To strengthen and enhance the knowledge base for climate change adaptation (CCA); and,
- To foster active participation in CCA from multiple actors such as government, civil society, private sector, academia, multilateral organisations and local communities (Government of Flanders 2017).

The CSP III has an indicative budget of EURO 25 million over the 2017-2021 period, which will be divided across the following programs:

- **Reaping the potential of entrepreneurship for a climate-smart inclusive green economy in South Africa**. The project is in its 2nd of 3 years of implementation with: 11 Climate Smart Enterprises selected and received grants; the SEED South Africa digital Symposium 2020 being hosted; and one (1) publication on policy and climate finance instruments published.
- **Keep it Cool Climate Change Education** – the program utilises the education sector as a strategic resource in South Africa's transition towards a more climate resilient society. Secondary schools in KZN, Eastern Cape and Limpopo address climate change through education supported by multiple actors at national, provincial and district level.
- **Building resilience and reducing vulnerability of smallholder farmers** by focusing on mango farming enterprises, water and eco-system based services to reduce the negative impacts of climate change. The is a Gender and Climate Change Adaptation awareness raising program, thus far: offering training in both Hebron and Vhembe; 120 Small Scale Farmers trained on Climate Resilient Agriculture; Partnership Building

and Training with Provincial Government Departments and Municipalities on the National Adaptation Strategy; 2 Baseline Research Reports and 2 Alternative Livelihoods Assessment Reports produced; and exchange and learning visits to Umgibe KZN facilitated.

- **Communal Agricultural Transformation (CAT)** – a collaboration between OLIVE LEAF Foundation (OLF) and the Savory Institute (SI) on empowering people restoring land. The project entered its 2nd of 3 years of implementation with: four people trained as accredited facilitators; community mobilisation and context development in five (5) villages and one (1) farmers group; one (1) village Holistic Management plan completed; five (5) village farmers' associations established; and one (1) business plan developed as a business enterprise development activity.
- **Enabling community-based adaptation in the Mkhuze River Ecosystem in KZN** – the project in its 2nd of 3 years of implementation, and has established three (3) demonstration gardens at community hubs in KwaJobe, Mandlakazi and Gumbi. The project has started to introduce climate smart crops, such as cassava; 170 community members have been trained in permaculture in the first year of project; 27 men and women attended the leadership training on the traditional councils which was well received; and the project continues to work with local vendors to source building materials and expertise to complete hub renovations.
- **Micro-aquaponics Lappies**, a proof of concept of community embedding – the project is in its 2nd of 3 years of implementation with: several smart (solar) aquaponics systems procured and implemented at community level in Diepsloot and Soweto; stimulation and adoption of technology through workshops and trainings; developed a step-by-step guide to design, implement and monitor the community based solar systems; site identification, preparations and agreements completed.
- **Towards an inclusive green economy**, showcasing sustainable land use management projects in the Kruger to Canyons Biosphere Region. The project also entering its 2nd of 3 years of implementation with Agro ecology training in households; demonstration gardens at schools initiated; conservation agreement and visioning workshop with the community; completed a vegetation baseline study; and instigating of savings groups and market access study in progress.
- **Building climate resilience of coastal communities**, ecosystems and small-scale fishers through implementing community and ecosystem-based adaptation activities and diversifying livelihoods. The project is also entering its 2nd of 3 years of implementation with signed MoA with Ngqushwa Local Municipality; signed lease agreement for the Hamburg Environmental Centre; signed Agreement with the CSIR; agreement with Abalobi at advanced stage; and a Kogelberg Community Liaison Officer appointed.
- **Increasing resilience and reducing vulnerabilities of local communities** to the effects of climate change: Promoting Ecosystem Based Adaptation (EbA) in South Africa. Seven (7) workshops including EbA financing, capacity building, coastal EbA, EbA in biomes, EbA community of practice and one (1) meeting hosted across the country.
- **DFFE Adaptive Capacity Facility (ACF):** implementing 3 Climate Change Adaptation projects in District Municipalities. Thus far two (2) ACF staff members contracted; implementation plan has been written and agreed upon. ACF currently working on criteria for selection of the 3 most vulnerable District Municipalities in South Africa to implement projects.

The following additional projects are at their final stages of approval:

- Unlocking climate finance for Climate Change Adaptation;

- Addressing Climate Risk and Building Adaptive Capacity in South Africa's Biosphere Reserves: towards Sustainable Water and Ecosystem Management;
- An Integrated Climate-driven Multi-Hazard Early Warning System (ICMHEWS); and
- Adaptive response and local scale adaptation for improving water security and increasing resilience to climate change in selected municipalities of South Africa.

Adaptation fund project implementation

The Adaptation Fund is a global fund that is geared towards financing climate change adaptation projects that have concrete, on-the-ground, benefits that will help communities deal with the impact of climate change. Through the South African National Biodiversity Institute's accreditation as a National Implementing Entity, the Institute is currently implementing the following two projects which are valued at $10 million.

uMngeni Resilience Project

The project "Building resilience in the Greater uMngeni Catchment, South Africa" (US$7 495 055) aims to increase resilience of vulnerable communities through interventions such as early warning systems, climate-smart agriculture and climate proofing settlements. The overall objective of the uMngeni Resilience Project is to reduce the vulnerability of rural communities and small-scale farmers in the uMgungundlovu District Municipality (uMDM) in KwaZulu-Natal, South Africa, to the impacts of climate change. This is to be achieved by increasing climate resilience and adaptive capacity by combining traditional and scientific knowledge in an integrated approach to adaptation.

The project is enabling this through implementing a suite of complementary gender-sensitive project interventions, focusing on: (i) early warning and ward-based disaster response systems; (ii) ecological and engineering infrastructure solutions specifically focused on vulnerable communities, including women; (iii) integrating the use of climate-resilient crops and climate-smart techniques into new and existing farming systems; and (iv) disseminating adaptation lessons learned and policy recommendations, to facilitate scaling up and replication. Four sites were selected as demonstration sites for the project based on the results of a vulnerability assessment, stakeholder consultations, and subsequent short-listing and ground-truthing through site visits. The sites are: (i) low-lying high-density settlements; (ii) the rural area of Ward 8 of Vulindlela, Msunduzi Local Municipality; (iii) the rural farming area of Ward 8 of Swayimane, uMshwathi Local Municipality; and (iv) the rural area of Ward 5 of Nhlazuka, Richmond Local Municipality.

The project has made significant progress and below is a high-level summary of the projects impacts:

- Number of people with reduced risk to climate change-driven floods, storms, fires and drought, as a result of project interventions is 803 community members (528 females and 275 men);
- One (1) early warning system (agro-meteorological) benefiting vulnerable communities is in place;
- Hundred percent of the uMgungundlovu District Municipality in the KwaZulu-Natal province is covered by an improved monitoring network to allow early detection of flooding threats to vulnerable communities;
- Area of farms, community or home gardens in target areas in which climate-resilient project interventions are being implemented is 504 ha in Swayimane, 30 ha in Vulindlela, and 18 ha in Nhlazuka within the uMgungundlovu District Municipality; and
- Forty-eight percent (48%) of community members in target areas have increased awareness, as a result of the project, of climate change adaptation and options to enhance climate resilience.

Community adaptation small grants facility project

The Small Grants Facility (SGF) is a four-year community-based adaptation pilot project which aims to ensure that vulnerable, rural communities in two project target areas in South Africa (Namakwa District in the Northern Cape and Mopani District in Limpopo) have reduced vulnerability and increased resilience to the anticipated impacts of climate variability and change.

The SGF is funded by the Adaptation Fund, endorsed by the Department Forestry, Fisheries and the Environment as the National Designated Authority (NDA), implemented by the South African National Biodiversity Institute (SANBI) as the National Implementing Entity (NIE), and executed by SouthSouthNorth Trust (SSNT) as the Executing Entity. The project is locally supported by the Namakwa and Mopani District Municipalities and locally facilitated in the Districts by Conservation South Africa (CSA) as the Namakwa Facilitating Agency and CHoiCe Trust as the Mopani Facilitating Agency.

Thus far the project has contracted 12 Small Grant recipients to implement small grant projects on Climate Smart Agriculture; Climate Proof Settlements and Climate Resilient Livelihoods that build the climate resilience of vulnerable community members against the impacts of climate change. The projects have exceeded the targeted project objective as the original target for the direct beneficiaries was 600 and 1029 women and 818 men have increased climate resilience in production landscapes and socio-economic systems.

An example of a successful project implemented at the Mopani District in the Limpopo province by the Ramotshinyadi HIV/Aids Youth Guide is the establishment of a communal garden in the Mamanyuha village, which introduced climate smart agricultural techniques to improve food security. Since accessing financial resources from the Community Adaptation Small Grants Facility project, the Ramotshinyadi organisation has built its capacity to implement climate change adaptation interventions. These include practices such as agro-ecology, climate smart water storage, drip-irrigation techniques and poultry farming.

Left: Ms Suzan Mathipa (centre) with farmers at the Mamanyuha communal garden showing a voucher from the Department of Agriculture, Land Reform and Rural Development (DALRRD); Right: Tomato harvesting at the communal garden.

With the COVID-19 Pandemic and subsequent National Lockdown, Ramotshinyadi experienced challenges in transporting locally farmed agricultural produce to sell to retail markets. Additionally, the National Lockdown meant that crop seedlings and poultry feed could not be purchased. This negatively affected crop production and livelihoods of the farmers.

Following an advertisement by the Minister of Agriculture, Land Reform and Rural Development on the interventions aimed at supporting smallholder farmers affected by the coronavirus outbreak in South Africa, Ramotshinyadi received relief vouchers to the value of R50 000. This helped Ramotshinyadi and the farmers to access and purchase supplies such as poultry feed, chicks, medication, and seedlings following the relaxation of the National Lockdown Restrictions.

8.1.3.2 National Climate Change Adaptation Strategy

The National Climate Change Adaptation Strategy, 2020 (NCCAS) provides a common vision of climate change adaptation and climate resilience for South Africa, and outlines priority areas for achieving this. The NCCAS's vision draws on South Africa's National Climate Change Response Policy (NCCRP), the National Development Plan, the National Strategy for Sustainable Development (NSSD), the adaptation commitments included in South Africa's Nationally Determined Contributions (NDCs), sector adaptation plans, provincial adaptation plans and municipal adaptation plans. The NCCAS builds upon principles in other legislation and policy in South Africa, including the National Environmental Management Act, the guiding act for environmental issues, and the Constitution, particularly Section 24, that enshrines the right to a safe and healthy environment.

The NCCAS is an important step forward for South Africa, as it:

- Acts as a common reference point for climate change adaptation efforts in South Africa in the short to medium term, 2 providing guidance for all levels of government, sectors and stakeholders affected by climate variability and change.
- Provides a policy instrument which articulates South Africa's national climate change adaptation objectives to provide overarching guidance to all sectors of the economy.
- Facilitates the degree to which development initiatives at different levels of government and business integrate and reflect critical climate change adaptation priorities, and thus inform resource allocation by the various stakeholders towards climate change resilience.
- Guides a strong, coherent and coordinated approach to climate change adaptation activities between different institutions and levels of government.
- Supports South Africa in meeting its international obligations by defining the country's vulnerabilities, and its plans to reduce these vulnerabilities and leverage opportunities. It outlines the required resources for these actions, whilst demonstrating progress on climate change adaptation.

The NCCAS also serves as South Africa's National Adaptation Plan fulfilling the country's international obligations as outlined in the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC). The NCCAS forms the basis for meeting South Africa's adaptation commitments outlined in the NDC. The NCCAS is a ten-year plan that will be reviewed every five years.

Strategic objectives of the national climate change adaptation strategy

The South Africa's NCCAS is intended to be the cornerstone for climate change adaptation in the country and to reflect a unified, coherent, cross-sectoral, economy-wide approach to climate change adaptation. It outlines priority areas for adaptation, both to guide adaptation efforts and to inform resource allocation. The strategic objectives of the NCCAS are as follows:

- Objective 1: Build climate resilience and adaptive capacity to respond to climate change risk and vulnerability.
- Objective 2: Promote the integration of climate change adaptation response into development objectives, policy, planning and implementation.

- Objective 3: Improve understanding of climate change impacts and capacity to respond to these impacts.
- Objective 4: Ensure resources and systems are in place to enable implementation of climate change responses.

Table: Linkages between strategic objectives, interventions and outcomes

Objective	Intervention	Outcome
Objective 1: Build climate resilience and adaptive capacity to respond to climate change risk and vulnerability	Intervention 1: Reduce human, economic, environmental, physical and ecological infrastructure vulnerability and build adaptive capacity	Outcome 1.1: Increased resilience and adaptive capacity achieved in human, economic, environmental, physical and ecological infrastructure
	Intervention 2: Develop a coordinated Climate Services system that provides climate products and services for key climate vulnerable sectors and geographic areas	Outcome 2.1: Climate products and services for key climate vulnerable sectors and geographic areas developed and implemented
Objective 2: Promote the integration of climate change adaptation response into development objectives, policy, planning and implementation	Intervention 3: Develop a vulnerability and resilience methodology framework that integrates biophysical and socio-economic aspects of vulnerability and resilience	Outcome 3.1: A Climate Risk and Vulnerability Assessment Framework developed and implemented across 100% of key adaptation sectors.
	Intervention 4: Facilitate mainstreaming of adaptation responses into sectoral planning and implementation	Outcome 4.1: Effective adaptation planning that covers at least 100% of the South African sectors identified in the NCCAS.
		Outcome 4.2: Achieve a 100% coverage of climate change considerations in sectoral operational plans.
Objective 3: Improve understanding of climate change impacts and capacity to respond to these impacts	Intervention 5: Promote research application, technology development, transfer and adoption to support planning and implementation.	Outcome 5.1: Increased research output and technology uptake to support planning and implementation
	Intervention 6: Build the necessary capacity and awareness for climate change responses.	Outcome 6.1: Capacity building and awareness for climate change response enhanced
Objective 4: Ensure resources and systems are in place to enable implementation of climate change responses	Intervention 7: Establish effective governance and legislative processes to integrate climate change in development planning.	Outcome 7.1: Adaptation governance defined and legislated through the Climate Change Act once approved by parliament.
		Outcome 7.2: Institutional structures for climate change adaptation strengthened.
		Outcome 7.3: Enhanced public-private-civil society collaboration and stewardship.
	Intervention 8: Enable substantial flows of climate change adaptation finance from various sources	Outcome 8.1: Adequate financial resources for national adaptation priorities from national fiscus and international sources.

Objective	Intervention	Outcome
	Intervention 9: Develop and implement an M&E system that tracks implementation of adaptation actions and their effectiveness	Outcome 9.1: A national M&E system developed and implemented

The following provides a summary of the focus areas of importance in the strategy:

Reduce vulnerability and build adaptive capacity

South Africa is already experiencing the negative effects of climate change and is expected to suffer significant consequences in the future. To promote adaptation to these impacts it is necessary to take measures to reduce human and economic vulnerability as well as to reduce the vulnerability of physical and ecological infrastructure to climate change. In addition, it is necessary to build the adaptive capacity of individuals and society to respond to climate change impacts. Since vulnerability to climate change differs depending on gender, age, wealth, social status and other factors, adaptation actions must be targeted in ways that ensure equitable benefits for the individuals and communities that are most vulnerable to climate change. Furthermore, the contributions of vulnerable groups should not be underestimated as their insights and capacities can help to develop actions that are most effective. Existing strategies that focus on the inclusion of vulnerable groups should be drawn upon, such as Department of Forestry, Fisheries and Environment's gender mainstreaming strategy in the environmental sector.

Status quo

South Africa has invested in understanding its climate change vulnerabilities since the late 1990s. From as early as 1999 a set of reports on climate change vulnerability focusing on certain sectors were developed under the programme South African Country Reports on Climate Change. In the early 2000s South Africa developed a national climate change response strategy and some of the metropolitan municipalities and provinces started to develop climate change vulnerability and adaptation strategies. The NCCRP was then published in 2011 and following that work began on the Long-Term Adaptation Scenarios documents which provide important information on adaptation. Since 2012 DFFE has been running the Let's Respond Toolkit programme, which has helped district and local municipalities to develop climate change vulnerability assessments and adaptation strategies.

There are a wide range of adaptation projects that are currently being implemented in South Africa by different stakeholders in different sectors. Some of the existing projects may not be acknowledged as 'climate adaptation projects' but contribute towards building adaptive capacity and reducing vulnerability. Similarly, the adaptation-related sectors that are identified by the NCCRP, are not the only sectors to be affected by climate change, and actions in new emerging adaptation-related sectors are being developed in order to prepare for the impacts of climate change.

The priority adaptation-related sectors for South Africa, as identified in the NCCRP, are water, agriculture and commercial forestry, health, biodiversity and ecosystems, human settlements (urban, rural and coastal), and disaster risk reduction and management. However, it is becoming more apparent that these sectors are not the only ones to be affected by climate change in South Africa. New emerging adaptation-related sectors include energy, infrastructure (including transport), tourism, mining, oceans and coast.

Actions

The actions to achieve this outcome are outlined below. It should be noted that this is not an exhaustive list. There will also be interdependencies and trade-offs between these actions that will need to be explored –

Table: Actions to reduce vulnerability and build adaptive capacity

Actions	Descriptions
Strengthen local organisations to support individuals (male and female) and community adaptation.	Provide support to local organisations to support both individuals (male and female) and communities, especially the vulnerable, to adapt to climate change.
Identify individuals (male and female) and communities at most risk from climate change within municipalities and deliver targeted climate change vulnerability reduction programmes for these individuals and communities.	This will involve the identification of at-risk individuals (male and female) and communities within municipalities. Based on this identification targeted vulnerability reduction programmes can be designed and delivered, addressing issues such as gender inequality and marginalisation which represent underlying causes of vulnerability to climate change
Develop a list of resilience-building projects that can easily be replicated.	This will involve developing a list of recent successful resilience-building programmes and projects that can easily be replicated in other areas or sectors. This action stresses the importance of learning from successfully implemented programmes to identify key elements that have provided best results in resilience-building in order to replicate them in similar environments
Capacitate and operationalise South Africa's National Disaster Management Framework to strengthen proactive climate change adaptive capacity, preparedness, response and recovery.	This will involve assessing gaps and needs with regard to the National Disaster Management Framework to identify elements of the framework that have not yet been achieved. In particular all Disaster Management Centres will need to integrate climate change within their terms of reference.
Equip and capacitate emergency response departments, such as health and fire, to prepare for and manage climate-related disasters.	This will involve continued capacity building of emergency response workers to provide them with the skills to respond to and manage climate change-related incidences. It will also include equipping the emergency response infrastructure.
Invest in knowledge and capacity building for the public, especially vulnerable groups (male and female), to prepare and adapt to climate change.	Develop awareness programmes that focus on making the public aware of the potential risks of climate change and how to practically prepare for these risks Support rural livelihoods through knowledge and capacity building, particularly for women from vulnerable households. This could include capacity in areas like climate-smart and conservation agricultural practices, water-saving practices and building climate resilient structures.
Invest in knowledge and capacity building for climate-resilient rural livelihoods.	Support rural livelihoods through knowledge and capacity building, particularly for women from vulnerable households. This could include capacity in areas like climate-smart and conservation agricultural practices, water-saving practices and building climate resilient structures.
Launch an enhanced climate change public flagship programme to build a healthier, more resilient society.	This will involve the development of an evidence-based white paper on National Climate Change and a Public Flagship Programme as well as establishing key implementation nodes in provinces and municipalities

Climate services

South Africa experiences a wide range of weather and climate-related impacts that are projected to worsen with climate change. These include drought, severe storms, flooding, heat waves and change in the distribution of disease. These impacts pose risks to human lives, the natural environment, infrastructure and the economy.

Different areas, natural systems, sectors and communities will be impacted in different ways, with some being more vulnerable than others. To prepare for these impacts, it is critical that sound information and data on climate change is available, and that predictions and forecasts are disseminated so that informed and appropriate responses and decisions can be made. The term 'climate services' is used to encapsulate the different information, data, forecasting and dissemination systems. Climate services offer science-based information, weather forecasts, climate predictions and climate projections that can empower decision makers to manage the risks and opportunities of climate variability and change.

Status quo

The table that follows highlights some of the climate products and services that have been developed to prepare for different types of climate impacts, including flood, drought, fire, disease and increased heat, as well as the stakeholders involved. It should be noted that this is not an exhaustive list and does not include existing climate products and services in the private sector.

Table: Some examples of climate products and services that have been developed to prepare for different types of climate impacts

Products/ services	Function of the product/ service	System developers
The South African Flash Flood Guidance (SAFFG) system	The system provides guidance on potential flash flood watches and warnings within one to six hours.	South African Weather Service (SAWS)
The South African Flash Flood Guidance (SAFFG) system	The system provides guidance on potential flash flood watches and warnings within one to six hours.	South African Weather Service (SAWS)
Drought Early Warning systems	Provides information on drought conditions based on the interpretation of satellite and climate data.	National Disaster Management Centre (NDMC)
The Drought Monitoring Desk	Provides information on long-range seasonal forecasts, observed rainfall as well as maps of Standardised Precipitation Index (SPI).	SAWS
National Fire Danger Rating System (NFDRS)	The NFDRS provides a measure of the relative seriousness of burning conditions and threat of fire by providing as accurate a measure as possible of the relative seriousness of burning conditions.	Council for Scientific and Industrial Research (CSIR)/ Department of Water and Sanitation (DWS)
The Advanced Fire Information System (AFIS)	System locates fires in near real-time over southern Africa.	CSIR

Actions

Although a number of climate products and services have been implemented, there is still room for improvement. A network to share information and learnings on climate products and services and associated technologies would be particularly useful. It is also important to consider that government is not the only stakeholder that should be targeted with climate-related information and data, and that stakeholders such as businesses, civil society and communities will also benefit from accessing climate information. Actions to improve South Africa's climate products and services systems are highlighted below.

Table: Further climate services actions

Actions	Description
Set up a National Climate Centre in an existing institution	This will involve identifying a suitable institutional home for a National Climate Centre. The National Climate Centre should coordinate the central collation of climate data, information, products and applications, and facilitate climate-related research and development in South Africa. Since there are a number of existing institutions that play an important role in climate services in South Africa and already perform some of the functions associated with the proposed centre there is no need to establish a new institution.
Establish an interactive online Climate Service Platform	This will involve the development of a specially designed website to act as a climate service knowledge portal. It will provide information, research and data stored and archived in the national climate services database and data from various climate service providers. The platform will allow various users to access sectoral climate services or to be directed to service providers who can provide customised climate services or products
Establish a Climate Change Science Advisory Technical Council	This will involve the establishment of an expert advisory group consisting of climate change professionals, climate-related sector professionals, social science professionals from a range of fields, as well as science and technology advisors. This group will provide advice to the National Climate Centre.
Continue and enhance climate observation and monitoring networks	This will involve continued investment in and support for capturing climate observation and monitoring data. It will also involve identifying existing gaps in the monitoring and observation network and addressing these gaps to ensure that national climate data is reliable, comparable, up-to-date and accessible.
Continue to invest in climate change prediction and modelling data	This will involve the continued investment in and support for the development of climate change predictions and modelling.
Develop and continuously update a national climate information and early warning system to address the needs of different sectors	This will involve developing a national climate information and early warning system that can interface with other information systems. A key component of the system will be methods of disseminating information to the stakeholders in an appropriate and timely manner, using a variety of different communication channels. It will also involve identifying appropriate channels for vulnerable groups to overcome the barriers they experience in accessing information.

Climate risk and vulnerability assessment framework

Sector departments need to identify and map risks and vulnerabilities that are relevant to their sectors to use as a basis to develop a climate change response implementation plan. In addition, provinces and municipalities should undertake climate change needs and response assessments based on the vulnerabilities of the respective provinces and municipalities and use this as a basis to develop a climate change response implementation plan.

Status quo

Climate change vulnerability assessments and associated climate change response plans have been developed in South Africa for a number of years by national departments, provinces, municipalities and various entities. All nine provinces in the country have developed risk and vulnerability assessments. In the local sphere of government DFFE has supported all district municipalities to develop a vulnerability assessment and a climate change response plan. Many local municipalities have also conducted their own vulnerability assessments and developed an associated response plan.

Despite the various efforts on vulnerability and response plan development there is no agreed vulnerability and resilience methodology framework to provide guidance to this process. As a result, it is not always possible to compare the results of the assessments or aggregate the results to provide an overall picture of vulnerability and response across sectors and spheres of government in South Africa.

Table: Climate risk and vulnerability assessment actions

Actions	Description
Develop a National Climate Risk and Vulnerability Assessment Framework (NCRVAF)	This will involve developing an overarching adaptation and vulnerability resilience framework that provides guidance on the development of vulnerability assessments and climate change response plans developed by sectors and spheres of government as well as business and civil society. Since there is variability among sectors and geographic areas the framework should not be prescriptive. Rather it should provide flexible, yet structured guidance aimed at ensuring quality of assessments and improved coherence between assessments and plans, as well as allowing for comparisons of the results of the assessments and plans where possible. The framework should also provide a platform to assess trade-offs across sectors to further inform sector strategies and plans. The process to develop the framework should be done in consultation with various sectors, provinces, municipalities, research institutions and other relevant entities. The process should also build on work that has already been done on developing assessments and response plans.
Use the NCRVAF to guide sector assessments	This will involve sector departments using the NCRVAF as guidance when undertaking initial assessments and developing response plans. Sector departments should also use the NCRVAF as guidance when reviewing and revising existing assessments and response plans.
Use the NCRVAF to guide provincial assessments	This will involve provinces using the NCRVAF as guidance when reviewing and revising existing assessments and response plans
Use the NCRVAF to guide local assessments	This will involve municipalities using the NCRVAF as guidance when undertaking initial assessments and developing response plans. Municipalities should also use the NCRVAF as guidance when reviewing and revising existing assessments and response plans.

Adaptation planning and mainstreaming

Climate change is a cross-cutting issue that impacts on different sectors and contexts in different ways. Adapting to climate change therefore cannot be limited to the environmental sector and must be integrated into the planning and implementation processes of the different spheres of government, sectors, business and civil society. Developing standalone climate change strategies at different levels is essential to respond to climate change in South Africa. However, these strategies need to be used as a basis to incorporate climate change adaptation into the different national sector plans, provincial and municipal plans, and private sector strategic plans, to ensure that it will be fully prioritised.

Status quo

All nine provinces have developed climate change response strategies that include climate adaptation interventions. Regarding the local sphere, DFFE and the South African Local Government Association (SALGA) facilitated the Local Government Climate Change Support Programme which resulted in the development of climate change response plans for all the district municipalities in South Africa, with associated adaptation interventions. Many local municipalities have also developed their own climate change response plans using the tools from this Programme. Some provinces and municipalities are in the process of integrating elements of their climate change response strategies into their strategic plans. Regarding specific sectors, many national government departments are currently developing climate change plans for their sectors and in some cases, they are taking steps to integrate these into departmental operational plans. In addition, some private sector businesses have developed climate change response strategies.

Table: Adaptation planning and mainstreaming actions

Action	Description
Draft, approve, and implement updated National Climate Change Sector Plans to include climate change adaptation	This will involve ensuring that key sectors have drafted updated national climate change sector plans. Sector plans identified for inclusion of climate change adaptation interventions include water, agriculture, forestry, fisheries, health, biodiversity and ecosystems, human settlements and disaster risk reduction and management sectors, as well as energy, mining, coast, transportation and infrastructure. These sector plans must be reviewed and published every five years.
Draft, approve, and implement updated provincial climate change adaptation strategies and associated implementation plans	This will involve each province drafting updated climate change strategies that include adaptation responses and associated implementation plans to guide climate response in their province. These strategies and associated implementation plans should be reviewed and updated every five years.
Draft, approve, and implement updated municipal climate change adaptation strategies and associated implementation plans	This will involve each municipality drafting updated climate change strategies that include adaptation responses and drafting associated implementation plans to guide climate response in the respective municipality. Local municipalities should use the district municipality plans as resources. These strategies and associated implementation plans must be reviewed and updated every five years.
Integrate climate change adaptation into Provincial Growth and Development Strategies	This will involve each province ensuring that climate change projects and programmes are reflected in their strategic Provincial Growth and Development Strategies.
Integrate climate change adaptation into provincial sector plans	This will involve ensuring that all priority sectors at provincial level incorporate climate change into their strategic planning documents.

Research

Climate change will have significant physical and socioeconomic impact in South Africa. It is important that decisions made to plan for this are based on access to accurate and current data and a wide range of both social science and physical science research. Investment in high-quality climate modelling data and research on the projected impacts of climate change, among much other research, will help reduce risk and enable the development of more effective actions. Currently there are many institutions involved in climate-related research in South Africa. However, there is a lack of coordination between the different institutions and no central database or platform where climate-related data is shared.

Actions

A wide range of institutions are involved in climate observation, modelling and climate-relevant research in South Africa. These include governmental agencies like the South African Weather Services (SAWS), government departments such as the Department of Science and Innovation (DSI) and academic and research institutions including the University of Cape Town, Rhodes University, the North-West University and the University of the Witwatersrand. Various NGOs and community organisations also contribute to research in climate adaptation.

Table: Research actions

Actions	Description
Develop a research roadmap for climate change adaptation	This will involve developing a roadmap for climate change adaptation research in South Africa, identifying areas where new and additional research is required and recommending priorities for research and development funding. Research on climate change adaptation is not limited to climate science and will require a cross-disciplinary approach. Research should also include social and human sciences specialists such as gender analysts, sociologists and historians. Potential areas of research include the relationship between climate change and rural-urban migration; adopting a regional approach to climate change; the impacts of forestry on water availability in the face of climate change; the vulnerability of the current building stock to climate shock; the adaptive capacity of infrastructure; the gendered impacts of climate change as well as gendered vulnerabilities and capacities.
Continue to invest in research that aims to understand the different impacts of climate change on the environment, economy and society	This will involve continued support for different research institutions that are developing an understanding of the impacts of climate change on the environment, economy and society, as well as the opportunities for different sectors. These include research reports such as the Long -Term Adaptation Scenarios (LTAS) which outline adaptation scenarios for South Africa under projected future climate conditions.
Invest in research on the most effective adaptation responses to different climate change impacts	This will involve continued support for research into the most effective adaptation responses and new technological solutions that can be replicated
Establish a programme to promote research into new climate change adaptation technologies	This will involve establishing a programme to promote research into new climate change adaptation technologies.
Establish a knowledge dissemination programme to encourage research uptake	This will involve establishing a programme to promote the dissemination of new climate change adaptation research knowledge and information on new technologies that have been developed to promote uptake of the research and information.

Awareness and capacity building

The importance of focusing on education in the climate change field is highlighted in the NCCRP. Climate change will impact on multiple sectors and requires systematic interventions to improve the awareness and capacity of a range of stakeholders. Despite the advances made in South Africa since 1994, many adults, particularly women, cannot read and write. It is crucial that these stakeholders are also considered when creating communication and awareness programmes. Stakeholders need to understand the causes, impacts, and key vulnerabilities associated with climate change, as well as how to respond to these vulnerabilities. One of the most effective ways of improving awareness is to mainstream climate change into education and training curricula at different levels, including schools and tertiary institutions. Awareness and capacity building are also particularly important in all three government spheres so that politicians and officials are equipped to guide climate change response in their respective jurisdictions. Since new knowledge is continually generated on the impacts of climate change and appropriate responses, awareness and capacity building is required on an ongoing basis.

Status quo

A wide variety of stakeholders currently provide climate change-related education, training and awareness programmes in South Africa, including NGOs, academic institutions, businesses and government entities. Climate change is also featured in school curricula and tertiary level courses. At the school level, climate change and sustainability has been included in different subjects from Grades 1–12 in the national Curriculum Assessment

Policy Statements (CAPS). Climate change education materials have also been developed for teachers through the Fundisa for Change programme. At the tertiary level, climate change honours and master's degree programmes are offered at many universities. Furthermore, a number of different research institutions and centres have been established in association with universities focusing on different aspects of climate change and sustainability. In the NGO sector, a wide range of local and international NGOs in different parts of the country work in climate change education and awareness. These organisations are diverse, working on different climate change-related sectors and with different stakeholders. A number of these NGOs work directly with the youth. In the business sector, associations, groups and forums play a role in educating business on the possible impacts and opportunities in the sustainability and climate change field and help to promote discussion and knowledge sharing in the private sector.

Table: Awareness and capacity building actions

Actions	Description
Develop and implement an effective communication and outreach programme	This will involve developing a communication strategy that should consider: knowledge sharing events, repositories of information on climate change impacts, climate change forums, resources and translation of climate science into actionable policies and plans. The communication strategy should be inclusive and consider gender, vulnerable groups and those that cannot read and write. Furthermore, the strategy should provide the opportunity for groups to contribute to the co-creation of knowledge in the field and recognise the importance of indigenous knowledge systems. The communication strategy should then be launched and a continuous communication campaign implemented. The content and target audiences should be revised annually based on learnings and feedback. The target audiences should prioritise the most vulnerable groups. Government should work closely with community-based organisations and civil society organisations in the development and implementation of the communication and outreach programme.
Develop and implement a training programme for government officials and politicians	This will involve developing and implementing a training programme for government officials and politicians. Since a number of training initiatives already exist to promote the development of adaptive capacity by government officials and politicians, such as the Let's Respond Toolkit for municipalities and SALGA's training on climate change for councillors, the programme will ensure a unified approach to climate change adaptation training and monitor the impacts of the programme. The programme can be revised annually based on learnings and feedback. It should incorporate training to develop technical capacity within the various spheres of government and key sector institutions that help build climate resilience and develop risk response strategies. In addition, the training programme should aim to build capacity to mainstream climate change adaptation into planning, programmes and new developments or projects throughout all spheres of government.
Establish formally accredited training courses	This will involve establishing one or more formally accredited climate change adaptation training courses for government officials to ensure consistency in training and to support the professional development of participating officials. This action will be implemented by government in partnership with other stakeholders such as research institutions
Develop a Climate Change Adaptation and Environmental Education and Training Programme	This will involve developing a broader climate change adaptation and environmental education training programme for implementation across all sectors of society
Incorporate climate change adaptation into relevant, primary, secondary and tertiary curricula	This will involve incorporating climate change adaptation into relevant primary, secondary and tertiary curricula to mainstream climate change knowledge into education and training. It should form part of the broader framework of education on sustainable development, be interdisciplinary and aim to equip South African citizens to orient society

Actions	Description
	and the economic system towards climate resilience and sustainability. This action will be implemented by government in partnership with research institutions
Incorporate climate change into informal education and learning	Establish reflective learning forums and committees where peer-to-peer learning and sharing of information on climate change adaptation can take place informally amongst different stakeholders

Governance and legislation

South Africa's international climate change commitments, the global sustainability movement as well as changes in climate have resulted in many government sectors and departments, as well as private organisations and communities, implementing climate change adaptation and related projects in South Africa. Despite some coordination within different spheres and sectors, mandates, especially in the government sector, are unclear in current legislation. Communication between different sectors is lacking and there is a risk that organisations are conducting similar work, making use of funds that could be better spent. Adopting an integrated approach to climate change where roles, responsibilities and mandates are clear and where partnerships are promoted will help to ensure that South Africa's climate change adaptation goals are met timeously and efficiently.

Status quo

Climate change adaptation responses are currently being implemented by different spheres of government and other sectors, such as business and research institutions. The current roles and responsibilities of the three spheres of government and non-government entities regarding climate change adaptation are outlined below –

- National government: The Department of Forestry, Fisheries and the Environment (DFFE), a UNFCCC focal point, is the lead department responsible for coordinating the implementation of the NCCAS. Other line function national departments are responsible for integrating climate change response into their sectors.
- Provincial government: Each province has an environmental department that is responsible for leading climate change response. Other line function provincial departments are responsible for integrating climate change response into their sectors.
- Municipalities: Many critical actions required for climate change responses are the responsibility of municipalities. These include the provision of basic services (water, electricity, waste removal and sanitation and sewage infrastructure maintenance), road management, disaster risk management and the provision of safe and healthy human settlements.
- Private sector: Climate change will affect business in several ways, including through potential changes to supply chains and direct climate risks posed to operations and assets. As businesses become more proactive in dealing with climate risk, their insights, experiences and resources will provide significant opportunities to leverage public sector benefits.
- Civil society: Civil society plays a pivotal role in advising on and supporting adaptation initiatives. Civil society groups are directly affected by the risks posed by a changing climate and the opportunities created by adaptation initiatives. Civil society can raise awareness about the need to adapt, facilitate debates and support and monitor local implementation.
- Labour: Labour plays a pivotal role in advising on and supporting adaptation initiatives. Labour groups are directly affected by the risks posed by a changing climate and the opportunities created by adaptation initiatives. Labour played a significant role in redressing past inequities in South Africa and is an influential agent of change and transformation.

- Academia and research: Academia is central to efforts to improve the understanding of climate science, vulnerabilities and the effects of climate change, as well as governance, political science, policy, psychology and communication-related aspects central to a holistic climate change response, and to provide information on appropriate sectoral and community-based responses.
- Community leadership: Community leaders are critical partners in the implementation and awareness of climate change adaptation initiatives.

Table: Examples of governance and legislative action

Actions	Description
Create formal climate change legislation for adaptation	This will involve developing climate change legislation and taking it through the parliamentary process for enactment. This is required as South Africa's rich body of climate resilience and adaptation knowledge, as reflected in policies, strategies and white papers, needs to be translated into a Climate Change Act. This will enable government's commitments to be backed up by legislation
Facilitate the meeting of the Inter- Ministerial Committee on Climate Change	This will involve ensuring that the Inter-Ministerial Committee on Climate Change is set up and meets on a regular basis. The Inter-Ministerial Committee on Climate Change will aim to coordinate climate change efforts across sector departments and spheres of government
Continue to facilitate the meeting of the Intergovernmental Committee on Climate Change (IGCCC)	This will involve ensuring that the IGCCC continues to meet on a regular basis. The IGCCC fosters information exchange, consultation, agreement and support among the spheres of government regarding climate change and government's response to it. As a high-level platform, it brings together representatives from National Treasury and the national departments of environment, forestry and fisheries; agriculture, land and rural development; minerals and energy; health; human settlements, water and sanitation; international relations and cooperation; trade and industry; transport; science and innovation; social development; provincial environment departments and the SALGA.
Establish a functioning Provincial Committee on Climate Change for each province (this can be an existing forum).	This will involve each province establishing a Provincial Committee on Climate Change, managed by the provincial environmental departments. This can be an existing forum such as the provincial disaster management forums that incorporate climate change issues on the agenda. The role of these committees is to coordinate climate change response actions and some provinces have already established such committees. The composition of these committees will be determined by the provincial lead departments. Potential stakeholders could include representatives of relevant provincial departments, political representation, civil society/ business/ academia, and representation from municipalities.
Establish a functioning Municipal Committee on Climate Change for each municipality	This will involve each municipality establishing a Municipal Committee on Climate Change. The role of these committees is to coordinate local climate change response actions and some municipalities have already established committees. The composition of these committees will be determined by the municipal lead departments. Potential stakeholders on could include: representatives from relevant municipal departments, political representation, and civil society/business/academia.

Finance

The projected cost range for the South African adaptation response from 2020 to 2030, under the low mitigation scenario, is between R4.2 billion and R308 billion. For the moderate to high mitigation scenario the project cost range is R34 billion to R298 billion. The wide-ranging projected costs in these scenarios reflects the lack of certainty and data regarding the effects of climate variability, making it difficult to calculate the cost of adaptation. It is clear, however, that substantial finance will be required to implement the NCCAS to achieve meaningful adaptation in South Africa.

Status quo

Adaptation initiatives spread across government departments are often not labelled as adaptation projects. The primary funding for adaptation activities in South Africa is through direct allocations from the national budget via the Medium-Term Expenditure Framework (MTEF) including expenditure on research programmes and activities that directly contribute to building and supporting resilience. The other principal source of public sector finances are public intermediaries. These include the Global Environment Facility (which functions as an operating entity of the financial mechanism of the UNFCCC); Development Finance Institutions (DFIs) such as the Development Bank of Southern Africa (DBSA), the World Bank and the African Development Bank; and Official Development Assistance Institutions and Climate Funds, including the Green Fund, the Green Climate Fund and the Adaptation Fund.

Table: Finance actions

Actions	Description
Carry out a cost-benefit analysis of the NCCAS	This will involve developing a cost-benefit analysis of the NCCAS, initially to determine the full cost of implementing the NCCAS. Thereafter the benefits of the NCCAS will be identified and quantified.
Develop a gender-responsive resource mobilisation strategy	This will involve developing a resource mobilisation strategy through a participatory process with different stakeholders to highlight all activities involved in securing new and additional resources for implementing the strategy. The resource mobilisation strategy will also recommend ways to maximise the use of existing resources and ensure that the most vulnerable groups are included and that they are beneficiaries.
Develop a gender-responsive national climate investment plan	This will involve developing a national climate investment plan, through a participatory process involving different stakeholders, to provide a set of robust and financeable adaptation projects and programmes for consideration by domestic and international funders. The plan will ensure that the most vulnerable groups are included and that they are beneficiaries.
Expand the list of government entities accredited for climate financing	This will involve identifying additional government entities that are appropriate to accredit for climate financing and supporting them through the accreditation process. The throughput of adaptation projects to dedicated multilateral climate funds will be maximised by expanding the list of accredited government entities to include well-capacitated municipalities and provinces.
Build the capacity of local accredited implementing entities to access adaptation finance	This will involve building the capacity of accredited implementing entities to improve their ability to secure finance. This will assist South Africa to maximise the allocation of adaptation finance from dedicated multilateral climate funds.

Monitoring and evaluation

Since the effects of climate change differ across geographies and will shift over time, adaptation actions will work in some locations and time periods, and not in others. A 'learning by doing' approach is therefore needed. This will help South Africa to progressively improve the NCCAS, and as a result, its ability to deal with the inherent uncertainty of climate change science. To implement a 'learning by doing' approach the strategic outcomes of the NCCAS must be monitored and evaluated to understand whether progress has been made towards achieving the strategic interventions. The results of this monitoring and evaluation can then be used to determine if any shifts are required in terms of the strategic outcomes of the NCCAS.

Status quo

The Climate Change Adaptation Monitoring and Evaluation approach for South Africa has been organised into nine Desired Adaptation Outcomes (DAOs). Each is of cross-cutting, cross-sectoral relevance and describes, in a general sense, a desired state that will enhance South Africa's transition towards climate resilience.

Table: Monitoring and evaluation actions

Actions	Description
Establish a M&E system to track progress in achieving the strategic outcomes of the NCCAS	This will involve setting up an effective M&E system to track and assess success in achieving the strategic outcomes of the NCCAS.
Report on success in achieving the strategic outcomes of the NCCAS	This will involve using the information collected in the M&E system to report annually on progress in achieving the strategic outcomes. The report should also highlight key lessons learnt as well as any shifts that may be required to achieve the strategic outcomes of the NCCAS.
Update the NCCAS based on the M&E learnings	This will involve updating the NCCAS every five years based on the learnings that have been developed as a result of the establishment of an M&E system and development of annual reports.
Ensure that M&E information is accessible to stakeholders	This will involve that M&E tracking reports are communicated effectively at a community level in accessible formats

8.1.3.3 Loss and damage reporting tool for South Africa

The Loss and Damage Framework for South Africa guides the process of collecting loss and damage data related to climate disasters or severe weather events through a systematic process to record human and economic loss data arising from meteorological, hydrological, and climatological related disasters. It will also be used to improve the monitoring and evaluation of impacts of weather and climate-related disasters to support and inform climate action aimed at reducing disaster impacts and fulfilling the country's international reporting requirements.

A key outcome of the Loss and Damage framework was the development of a simple Excel-based Loss and Damage tool. This tool is aimed at local, district and metropolitan municipalities and focuses on the most critical elements and data needs in terms of human and economic indicators to perform monitoring and evaluation of impacts. It guides the user through the data entry process using macros and lookup tables and the collected data is stored on separate spreadsheets. This approach ensures that the data is collected accurately, and that data integrity is maintained while still having access to the data for further analysis. The reporting functionality allows the user to view a summarised view of the event and the productive economic loss.

8.1.3.4 Multi-hazard Early Warning System (MH-EWS) Monitoring and Evaluation Framework

The Multi-hazard Early Warning System (MH-EWS) Monitoring and Evaluation Framework highlights key findings of implementing the framework through the use of case studies. The framework was used to develop a list of indicators which address monitoring, observation and forecasting of hazards, and aligned with existing policy, legislation and reporting requirements in South Africa. The indicators are grouped within three elements of effectiveness, namely: (i) 'Efficiency' indicators; (ii) Reliability indicators; and (iii) Impact indicators. The Garden Route District Municipality was used as the first case study to test and refine the indicators in the framework, and eThekwini Municipality was used as the second case study.

The different elements of the framework were integrated into a Microsoft Excel format to serve as a self-contained tool for the monitoring and evaluation of the effectiveness of the MH-EWS and has a built in guidance document. The tool allows the user to capture information related to MH-EWS used for Disaster Risk Reduction and includes key indicators related to the plans and processes in place, the reliability of the MH-EWS and the impact of weather and climate-related disasters. The first step the "municipal data" sheet is used to capture information on the hazard to be assessed and the year of the assessment; the second step, the user will need to source the relevant information for the different indicators that are contained within the tool; and in third step the user will enters an explanation to justify the score that was given to an indicator. The final step of using the tool, the user is able to extract scores on the overall effectiveness of each element of the MH-EWS framework.

8.1.3.5 National Risk and Vulnerability Framework

This National Risk and Vulnerability Framework provides an overarching approach and advice for conducting risk and vulnerability assessments using a variety of approaches and technologies. It aims to provide stakeholders/ decision makers with an integrated diagnostic framework that help them analyse whether and how the dynamics of climate risk are addressed in practical assessment cases, as well as to improve a common approach/ shared responsibility approach in conducting climate risk assessments across all sectors. The framework provides decision-makers with a variety of approaches and tools for evaluating the various components that contribute to critical considerations such as the type of preparation required for a vulnerability assessment, which tool to use, and how to conduct a vulnerability assessment.

8.1.3.6 National Climate Change Adaptation Research Agenda

The National Climate Change Research Agenda (NCCARA) is South Africa's adaptation research roadmap, which serves to guide the research on impacts and vulnerability, adaptation options to deliver "knowledge for action", and to support the uptake of this knowledge in adaptation policy and practice. The research being undertaken is meeting the most pressing adaptation knowledge gaps as identified by stakeholders from government, civil society, academia and research and business, particularly in the context of South Africa's challenging socio-economic and development context and the need to support a socially just transition to a low-carbon, climate-resilient economy.

The NCCARA is directed at South African society as a whole, including the key relevant sectoral institutions, provincial governments, municipalities and non-governmental entities, who include the private sector, the research community and civil society. To effectively make the NCCARA a success, collective effort is required by all parties to mobilise resources and ensure implementation. Thus far, several research interventions have been undertaken with various partners. The research priorities are comprised of a range of thematic areas critical to building South Africa's resilience to the impacts of climate change being water and food security, biodiversity and ecosystems and infrastructure for both human settlements and climate data amongst others.

The NCCARA will be reviewed every five years for alignment with current and emerging research areas. The implementation of the NCCARA is made effective through partnerships with a variety of lead research institutions such as the National Research Foundation (NRF), South African universities, research institutions and South African Environmental Observation Network (SAEON).

8.1.3.7 Climate change adaptation actions

Adaptive Capacity Facility

As part of the Country Strategic Paper (CSP) III (2017-2021), the South African Department of Forestry, Fisheries and the Environment (DFFE) in partnership with the Government of Flanders has developed the "DFFE Adaptive Capacity Facility" (DFFE-ACF or ACF). The overall objective of the Facility is to enhance climate resilience by reducing human vulnerability and building human adaptive capacity through implementation of transformative and systemic climate change responses.

The specific objectives is to enhance knowledge and understanding of systemic and transformative climate change responses by stakeholders in South Africa; with an outcome to enhance climate resilience by reducing human vulnerability and building human adaptive capacity through implementation of transformative and systemic climate change responses.

The key challenge the ACF aims to address is the lack of effective climate change implementation at a local level in South Africa. The Facility is intended to benefit those citizens and communities of South Africa that are most vulnerable to climate change impacts as a result of their exposure to various impacts and/ or their lack of capacity to adapt to these impacts. These vulnerable groups are most reliant on effective institutional adaptation measures that can reduce their exposure to the impacts of climate change and increase their adaptive capacity to more effectively respond to climate change.

8.1.3.8 National Climate Change Adaptation Investment Plan

Adaptation initiatives that are spread across government departments are very often not labelled as adaptation projects. The primary funding for adaptation activities in South Africa is through direct allocations from the national budget via the Medium Term Expenditure Framework (MTEF) including expenditure on research programmes and activities that directly contribute to building and supporting resilience. The other principal source of public sector finances are public intermediaries. Relevant public intermediaries for South Africa include the Global Environment Facility (which functions as an operating entity of the financial mechanism of the UNFCCC); Development Finance Institutions (DFIs) such as the Development Bank of Southern Africa (DBSA), the World Bank and the African Development Bank; and Official Development Assistance Institutions and Climate Funds, for example the Green Fund, the Green Climate Fund and the Adaptation Fund. South Africa's private sector has also invested in adaptation related activities, including sustainable farming practices, building ecological infrastructure and improving water infrastructure and will continue to play a strategic role in leading the identification of investment opportunities for both implementation and funding contributing to economic growth. Civil society and other community groups and NGOs also play a vital role in developing and implementing adaptation projects and programmes, especially for grassroots communities including women. A range of economic and financial instruments exist that are being employed by both private and public investors to support adaptation projects. Additional to the existing economic and financial instruments, the Development of the South African National Climate Change Adaptation Investment Plan will assist in advancing the implementation of the National Adaptation Communication and National Climate Change Adaptation Strategy in partnership will all key sectors of the economy. Through support of the NDC partnership, South Africa will have clear investment areas that will catalyze/ leverage funding for climate change adaptation programs/projects at large scale. The implementation of the various large scale climate change adaptation programs will provide a trajectory into a Climate Resilient South Africa.

8.1.4 Marine fisheries and aquaculture

As a signatory to climate change-specific international agreements, South Africa's then-Department of Agriculture, Forestry and Fisheries (DAFF) effected institutional arrangements resulting in the inclusion of Fisheries as a sector requiring a national development plan. An ad hoc team of scientists within the Branch: Fisheries Management of the Department was appointed to address all climate-change related issues within the sector, forming the Fisheries Climate Change Task Team (FCCTT). The team is currently composed of four scientists from the Chief Directorate: Fisheries Research and Development and two scientists from the Chief Directorate: Marine Aquaculture and Economic Development. In June 2015, an internal workshop was held to assess the vulnerability to climate change of all fisheries falling within the scope of the scientific working groups of the Branch, including the marine aquaculture sector.

The workshop was set up and convened by the FCCTT, as the first step in the process of developing a Climate Change Adaptation and Mitigation Plan (CCAMP) for marine fisheries and aquaculture. Results showed that the sectors most vulnerable to climate change appeared to be the linefish and small pelagic fisheries. A third sector, aquaculture, was selected because of its unique challenges and its potential for growth. Concurrent to the development of CCAMP, several scientists from the Branch and from the then-Department of Environmental Affairs

(DEA) collaborated in writing a book chapter on South Africa in the publication “The impacts of climate change on marine fisheries and aquaculture and their adaptations”. Apparent changes in oceanography off the South African coast, such as increased intensity and variability of coastal upwelling in the last two decades, and increased SSTs off the East Coast, and their potential impact on fisheries for small pelagics, linefish, squid and West Coast rock lobster, as well as the aquaculture industry, were considered. Several adaptation measures were discussed and some specific proposals for identified sectors considered.

In the CCAMP, specific adaptation measures were identified for the fisheries and sectors rated as most vulnerable to climate change (small-scale linefishery, small pelagic fishery, and marine aquaculture). The Branch proceeded with developing a more-detailed CCAMP specifically for the marine-fisheries and marine-aquaculture sectors, through broader discussions at a workshop convened in October 2016. A number of interested and affected parties were invited and were consulted on possible adaptation measures for fisheries already included in the current CCAMP, as well as those not yet considered. The final process was to select and prioritise those adaptation measures for the short, medium and long term. The emission of greenhouse gases (GHGs) by the marine fisheries and marine aquaculture sectors is currently small in comparison to other South African economic sectors. Several measures for reducing GHG emissions in marine capture fisheries can be applied and are discussed in the CCAMP.

A further workshop was held at the Sea Point Research Aquarium from 14 to 16 March 2017 to solicit views from as wide a scientific audience as possible to: (i) increase the amount of information available to the FCCTT to facilitate further development of the Fisheries CCAMP; and (ii) provide a broad geographical and multidisciplinary foundation for the longer-term objective of developing a national research response to the effects of climate change on South Africa’s marine environment and on the industries, communities and individuals dependent on it.

Going forward, the Branch should strengthen its capability to monitor fish stocks effectively through resource surveys and through the continued collection of adequate catch data from commercial and small-scale fishers to assess the size and distribution of resources and to monitor changes in all key parameters of exploited fish populations. Furthermore, the Branch should retain the capacity (or at least access to it) to carry out state-of-the-art mathematical modelling of fish population dynamics using survey estimates of exploited stocks, catch and effort data, and parameters that characterise the marine ecosystem.

Another important requirement is to continue, and expand, research on models that require limited data, since it is likely that the available data for many of the potential new target species will be very limited. The Branch should also collect relevant oceanographic data, and ensure adequate monitoring of oceanographic trends, especially in areas where large changes and major impacts on fisheries are taking place, such as the South Coast and in many inshore zones. Bioclimatic modelling to predict distribution shifts in response to changes in the environment should also be a priority.

The marine aquaculture sector should expand its research on the range of species suitable for the sector, consider predictions of future changes such as temperature and ocean acidification, monitor the occurrence of disease, and carry out additional research relevant to the sector. Creating awareness of climate change is a priority, and climate change should be highlighted through events such as workshops and seminars organised in partnership with all relevant entities.

In terms of policy updates, climate change and response measures should: (i) be included in the Marine Living Resources Act (MLRA); (ii) form part of the fishing Rights allocation process (FRAP); and (iii) be included in other policies such as the Aquaculture Policy Framework for South Africa. Revisions of the MLRA should include the enabling of greater flexibility, since climate change impacts on economically important resources will require rapid impact redress. The draft Policy for Exploratory Fisheries should be finalised and implemented, since opportunities for new fisheries, which could arise from changing distributions of species, ought to be properly and systematically addressed, as should the Inland Fisheries Policy, currently under development. The Small Scale Fisheries Policy makes reference to possible impacts of environmental and climate change on coastal communities but makes no recommendations on how these impacts should be addressed. The Branch should enhance climate change awareness in the Small-Scale Fisher Co-operatives, and promote specific adaptation measures in affected co-operatives. The CCAMP for the marine fisheries and marine aquaculture sectors will be further developed into a more detailed and comprehensive plan for the Branch: Fisheries Management, which will include specific recommendations on implementation. A monitoring and evaluation unit for marine fisheries and marine aquaculture should be set up within the Branch.

8.1.5 Policy trade-offs between taking climate actions

The following section is an edited extract of the 2022 South Africa Country Climate and Development Report and readers are encouraged to read the report for more, in-depth, fully referenced information.

The South Africa Country Climate and Development Report (CCDR), produced by the World Bank Group in close collaboration with the Presidential Climate Commission and other South African counterparts in the public and private sectors, academia, organized labour, and civil society, pays special attention to policy trade-offs between taking climate action, growing the economy, and reducing inequalities. The report provides recommendations to help policy makers prioritize among a range of options, recognizing uncertainties about future climate change impacts and the availability of technologies and financing.

8.1.5.1 Mitigating climate change—the low-carbon transition

The 2022 South Africa Country Climate and Development Report (CCDR) proposes that moving away from coal as the main source of energy would be in the national best interest, delivering substantial local benefits in terms of (i) avoided loadshedding and improved energy security; (ii) economic competitiveness; (iii) reduced air, water, and soil pollution; and (iv) lower greenhouse gases emissions.

The CCDR proposes an analytical framework that is built around three models. The first is a full energy sector model (South Africa TIMES Model (SATIM)) designed to achieve net zero by 2050 in a least-cost manner. It includes a complete description of primary energy sources (coal, liquid fuel, and gas), their transformation, their transmission and distribution, and the final demand by key economic sectors. The second is a computable general equilibrium (CGE) model, the so-called South African General Equilibrium (SAGE) model, that incorporates the impacts derived from the SATIM on the country's main economic variables, especially the level of economic activity and GDP composition. The third is a micro-simulation model that captures the distributional impacts on households and jobs.

Several options for achieving net-zero carbon emissions by 2050 have been developed for the CCDR and combined to explore multiple net-zero scenarios for South Africa. The reference scenario is a pathway that follows the updated NDC targets by 2030 and the government's ambitions for 2050 as presented in its Low-Emission Development Strategy and Just Transition Framework. The net-zero reference scenario assumes a cumulative GHG emissions budget of 9 gigatons (Gt) CO_2-eq over the period 2021–2050, which is aligned with the upper level of the updated NDC until 2030.

8.1.5.2 Adapting to climate change—the resilient transition

The South Africa Country Climate and Development Report proposes that South Africa identifies key areas exposed to climate risk and set out measures to build a more resilient society. This is in view of the fact that climate change negatively affects SA's infrastructure, productivity, human capital, and scarce water resources. The country is vulnerable to rising temperatures and variable precipitation that result in droughts, floods, and heatwaves. This vulnerability undermines the country's ability to achieve its long-term development goals.

Building a resilient economy will require significant investments in the water, road, and agriculture sectors as well as in cities. The CCDR estimates that these investments will amount to about 1.3 percent of SA's GDP per year or R2.4 trillion in net present value between 2022 and 2050. The necessary investments need to be implemented early to lower the country's vulnerability. To reduce these costs, the government could adopt structural reforms to improve the efficiency of public spending and incentivize private sector investments in green and climate-smart projects.

8.1.5.3 Protecting poor and vulnerable people—the just transition

The South Africa Country Climate and Development Report indicates that in order to reconcile development and climate goals while addressing inequality and racial and spatial exclusion, South Africa needs to pay special attention to its most vulnerable people in its efforts to adopt a low-carbon path and build a resilient economy. The country already starts from a disproportionately low base, and higher poverty from an unjust climate transition would exacerbate existing economic, social, and political tensions. It would also make it harder to reach the consensus needed to adopt and urgently implement the necessary reforms.

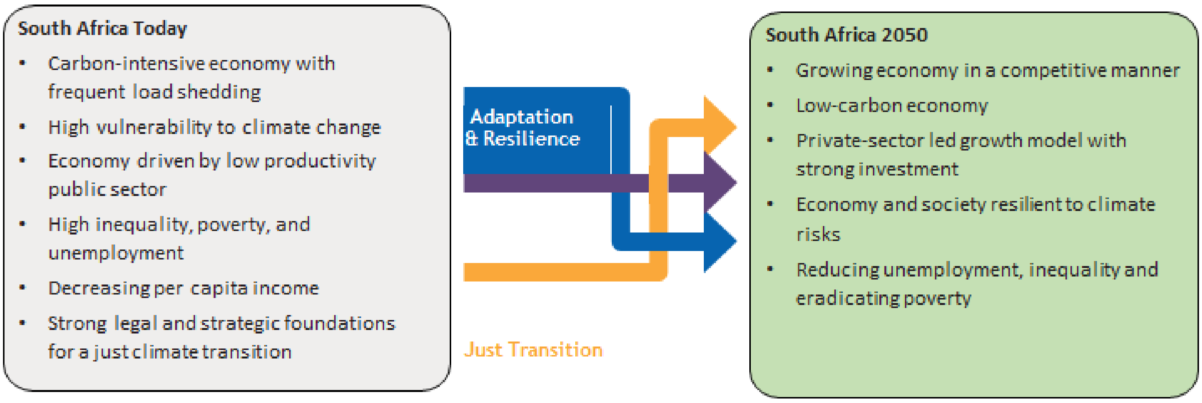


Figure: Aligning South Africa's development paradigms

For each of these transitions, the CCDR identifies actions that are particularly urgent, are most likely to create synergies between development and environmental objectives, and are pro-poor. The combination of these actions led to five priority policy packages being identified that should produce the greatest impacts if properly implemented within six months and the next one to three years. Emphasis is on actions that will maximize synergies across the three interconnected transitions, while minimizing the burden on the most vulnerable groups. Given the government's limited fiscal space and the global public good's dimension of the climate change, special attention will be given to both the domestic private sector and external financing, including in the form of grants and concessional loans, will have an important role to play in these transitions.

8.1.6 Climate change public awareness and education

The following section is an edited extract of South Africa's Climate Change Education and Awareness Survey 2020 report, and readers are encouraged to read the report for more in depth, fully referenced, information on the survey.

Vital to the achievement of South Africa's climate change response objectives, as indicated in the South African Climate Change Response Policy (NCCRP), is the informed participation of all stakeholders in South Africa's climate change response; enabled by enhanced awareness and understanding of climate change causes, impacts and access to information, as a basis for empowered and transformative action by all sectors of society. As part of the efforts to achieve the above policy mandate, the Department of Forestry, Fisheries and the Environment (DFFE) in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) commissioned a study to establish the current level of education and awareness with regard to climate change in South Africa, including understanding attitudes and perceptions of the South African society towards climate change and its relevance in achieving the National Development Plan 2030 aspirations.

8.1.6.1 Public awareness

The literature review study found that the level of climate change awareness was high in developed countries such as the United States of America (USA), the United Kingdom (UK), Japan and Australia and low in developing countries such as those in Latin America, South East Asia and Sub-Saharan Africa including South Africa. However, compared to a survey done more than a decade ago (in 2005) by the Human Science Research Council (HSRC), there was an improvement in climate change awareness of the public since it was only 55% of the respondents (from a sample size of 3164) who reported to had been aware of climate change in South Africa. In the present study, more than 80% of the respondents (from a sample size of 3452) indicated that they were aware of climate change. However, in a climate change survey that was done by Institut de Publique Sondage d'Opinion Secteur (in French) (IPSOS) (involving 23 countries included the United Kingdom (UK), South Africa had a very high proportion (84%), only second to Colombia agreeing to the statement: “If South Africa’s government does not act now to combat climate change, it will be failing the people of South Africa”. The results show that many people are concerned about climate change impacts in South Africa.

The South Africa’s Climate Change Education and Awareness Survey 2020 report reflects that 88% of the respondents across all the provinces reported to have heard about climate change via mediums such as TV, social media, families, schools and the newspapers. This was also manifested through many people indicating to have been either aware of the impact of climate change, noticed or experienced either or a combination of the following: an increase in temperature and alien plants, experienced weather events such as flooding and heatwaves, and weather affecting their production leading to crop failures, malnutrition, sea-level rise, to mention a few.

In terms of the results based on demographics, not many differences were found between urban and rural respondents.

Similarly, gendered responses to some of the attitude, knowledge and practice questions were too small to indicate that either gender requires more attention. However, small difference in gendered responses may be influenced by the high sample in urban areas as most respondents in such areas do not rely on natural based livelihoods contrary to those in rural areas where many people rely on land-based livelihoods such as farming etc. The Western Cape and Gauteng provinces were the provinces where many people were aware of the climate change initiatives.

8.1.6.2 Education

Some climate change experts reported that children attending well-resourced schools in South Africa had a better basic knowledge of climate change than those in poorly resourced schools. While many South African universities offer studies directly related to climate change or were in the process of developing climate change programmes, these mainly happened at postgraduate levels. These universities include the University of Witwatersrand, University of Pretoria (UP), University of Johannesburg (UJ), University of KwaZulu-Natal (UKZN), University of Stellenbosch (SU), University of the Western Cape (UWC) and University of Cape Town (UCT) to name just a few.

The climate change experts suggested that climate change education must be integrated into the national educational system at all school levels as this would ensure that children become aware of climate change from an early stage in their lives.

8.1.6.3 Policies

Climate change experts pointed out that South Africa has good policies but lack of political will hinders the implementation of climate change related policies and also that government departments work in silos. Furthermore, they indicated that public and private sectors are pulling in different directions suggesting the need for proper coordination and collaboration between the public and private sectors. Many respondents from DFFE rated South African government's existing policies across all key sectors as ineffective in addressing climate change issues. These sectors included Water (69%), Energy (77%), Forestry (62%), Biodiversity and Ecosystems (54%), Communication (92%), Agriculture (77%) and Waste Management (62%). The climate change experts indicated that if the country as proposed by the NDP transitions to a low carbon economy, this would greatly contribute towards reducing greenhouse emissions. The experts also suggest investing more resources in climate change, political will at ministerial and government levels, interdisciplinary research led by DFFE and oversight over resources spent on climate change efforts.

8.1.6.4 Science communication and messaging

A multiple communication channel strategy consisting of a variety of communication platforms, both traditional information dissemination methods (such as TV and Radio) and modern (i.e. social media) emanating from the findings of the South Africa's Climate Change Education and Awareness Survey 2020 study has been created. This communication strategy will be used by DFFE and all relevant stakeholders to disseminate climate change awareness and education information across all sections of the society. To effectively communicate climate change information to the public, the communication strategy covers the following five aspects on how messaging can be done to make it more appealing to the public: (i) Message should illustrate local and regional impacts, (ii) Message should be framed as an immediate, current problem, rather than a remote threat, (iii) Message should incorporate health threat elements and extreme weather, (iv) Existing uncertainties should be acknowledged so that the audience retains trust in the speaker, and (v) Message should target specific groups and address the particular barriers to climate action that they face.

8.2 Environmental impact governance - EIAs

The governance of environmental impact management in South Africa relies principally on Environmental Impact Assessments (EIA). The use of EIAs to regulate environmental impact management started in earnest in the 1970s in the United States in response to their National Environmental Protection Act of 1970 with other countries like Australia soon following. During this first decade of EIA the environment was fragmented into discrete components in order to assess specific impacts of actions - such as impacts on air, water and soils. During the 1980s public participation and social aspects of developments were introduced. Scoping was also developed as the tool to identify and focus on the important aspects.

In South Africa, although EIAs were used to some degree on a voluntary basis from the late 1980s, EIA was introduced as a legal requirement in terms of the Environment Conservation Act, 1989 (Act No. 73 of 1989) (ECA). The EIA Regulations promulgated under the Environment Conservation Act (ECA) (Government Notice No. R. 1182 & R. 1183) came into effect on 5 September 1997 and identified listed activities that were subject to the process.

Following the adoption of the 1996 Constitution, the National Environmental Management Act No. 107 of 1998 (NEMA) was enacted to give effect to the environmental right contained in section 24 of the Constitution. Chapter 5 of NEMA, entitled "Integrated Environmental Management" identifies various environmental instruments including environmental management frameworks, strategic environmental assessments, environmental management programmes and, significantly, environmental impact assessments.

In 2006, environmental impact assessment regulations were promulgated in terms of NEMA (the "2006 EIA Regulations"). In terms of the 2006 EIA Regulations activities requiring environmental authorisation before being undertaken were identified. The 2006 EIA Regulations became effective on 2 July 2006. As with the EIA Regulations that preceded them, under the Environment Conservation Act, the 2006 EIA Regulations were the subject of significant judicial attention.

In 2007, government together with the environmental sector agreed that the EIA process required a review after 10 years of implementation. To this end, a 10 Year Review of the Effectiveness and Efficiency of EIA in South Africa was compiled and published in 20018. A key finding was that there was a need to significantly improve both the effectiveness and efficiency of EIAs as regulated by the ECA and NEMA regulations.

On 2 August 2010, the 2006 EIA Regulations were repealed and replaced by new environmental impact assessment regulations – the "2010 EIA Regulations" – which took the findings and recommendations of the 10-year EIA review into account.

In 2014, the so-called 'one environmental system' came into effect which made the NEMA regulated EIA process the only environmental impact management governance process. Up to that point, for example, the environmental impacts of mining were managed through a separate regulatory system. To this end, the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA), the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM: AQA), the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)(NEM: WA), and National Water Act, 1998 (Act No. 36 of 1998) were amended to give effect to the one environmental system. Although this means that the department responsible for mining still regulates the environmental impact of mining activities, it does so use the NEMA EIA process. Furthermore the one environmental system has made the Minister of Environmental Affairs the appeal authority in terms of EIA decisions and assessment timeframes are fixed and synchronised.

With this background, South Africa's High Court emphasized the importance and rightful place of environmental assessment in South African law in the 'HTF Developers versus Minister of Environmental Affairs and Tourism' case as follows –

> *"The principle of environmental assessment as the means of ensuring …equality is the practical cornerstone of the principles of sustainable development and equitable use of our natural resources and environment. Moreover, the principle of environmental assessment is premised upon and interrelated to a precautionary principle, mandating a risk-averse and cautious approach."*

With this, the overall objective of EIA is –

> *to ensure the progressive realisation of the environmental right described in Section 24 of the Constitution of the Republic of South Africa, promote the Section 2 Principles of NEMA, achieve sustainable development as defined in NEMA and relevant case law, and ensure the realisation of section 33 of the Constitution which requires just administrative action.*

The environmental assessment process is used to understand the potential environmental impacts of a development, and to inform environmental decision-making before the development (and more particularly, the listed activities that require environmental authorisation under NEMA) is authorised. The information recorded during the EIA process provides the basis for a decision to grant (with or without conditions) or refuse authorisation in respect of a given application, and with regard to the authorisation of an application, informs the selection of the most appropriate alternative.

“Environment” is widely defined in terms of NEMA and includes both anthropogenic (e.g. human health and socio-economic considerations) and ecological components (e.g. flora and fauna). This broad definition of the term “environment” requires that the EIA process is more holistic in that it takes account of a broader range of considerations than those associated with the natural environment alone. Such an approach does however also reduce the significance of natural environmental aspects. In essence, EIA is a process that must at all times seek to facilitate the attainment of sustainable development through the careful assessment of all relevant considerations so as to appropriately inform environmental decision-making.

EIA is as much based on scientific approaches as it is on legal and administrative procedures. In this regard the process is essentially aimed at achieving the following objectives:

- Short term objectives:
  - provide information for decision-making by officials employed by the competent authority, as well as any appellate authority in due course, in terms of the environmental consequences of proposed activities;
  - promote environmentally sound and sustainable development through the identification of appropriate enhancement and mitigation measures;
  - improve the environmental design of the proposal;
  - ensure that resources are used appropriately and efficiently;
  - identify appropriate measures for mitigating the potential impacts of the proposal; and
  - facilitate informed decision-making, including setting the environmental terms and conditions for implementing the proposal.
- Long-term objectives:
  - protect human health and safety;
  - avoid irreversible changes and serious damage to the environment;
  - safeguard valued resources, natural areas and ecosystem components; and
  - enhance the social aspects of the proposal.

Essentially these objectives reflect international environmental best practice of integrated environmental management.

In the South African context, Chapter 5 of NEMA establishes the principle of Integrated Environmental Management (IEM) as the cornerstone of environmental management.

According to Section 23 of NEMA the general objectives of IEM are to:

- ensure that all decisions that significantly affect the environment are taken in light of the environmental principles in Section 2 of NEMA;
- identify, predict and evaluate the –
- actual and potential impact on the environment, socio-economic conditions and cultural heritage, and
- risks, consequences, alternatives and options for mitigation of activities; in order to minimize negative impacts and maximize benefits and promote compliance with principles of environmental management of Section 2 of NEMA;
- ensure proper consideration of the effect of activities on the environment before commencement;
- ensure adequate and appropriate opportunity for public participation in environmental decision-making;
- ensure that environmental attributes are borne in mind in management and decision-making matters that may impact significantly on the environment; and

- identify and use the best ways of environmental management to ensure that the environment principles in Section 2 of NEMA are introduced.

The following sectors are subject to EIAs due to the potential significance of their environmental impacts and their significance in terms of contribution to the national economy and NDP goals:

- Mining (e.g. open cast, underground, minerals processing, small and large ranging from sand mining to fracking);
- Agriculture (e.g. feedlots, broilers, abattoirs, etc.);
- Energy (e.g. coal fired power stations such, transmission infrastructure, renewable energy projects, etc.);
- Tourism (e.g. access and accommodation infrastructure in national parks, etc.);
- Housing (e.g. high-cost country, golf and lifestyle estates; low cost housing developments; mixed land use developments);
- Bulk Services Infrastructure and Transport (e.g. linear development such as rail and pipelines, etc.); and
- Waste Management (e.g. waste storage, waste processing activities, recycling, etc.).

The skill and competencies that underpin the EIA process include:

- The developer/applicant provides an understanding of the particular development and or sector
- Consultant and EAP provides project management and integrative thinking skills and competencies
- Specialists provide scientific skills and competencies
- Public/civil society provides inputs based on values, experience and local knowledge
- Administrators/officials provide administrative and review skills and competencies
- Judiciary provides judicial skills, oversight and interpretation of legislation

The EIA activities as prescribed in the EIA regulations include Screening, Scoping, assessment and evaluation, PPP, review and appeals.

Reports that contain information that enable the government agencies (known as 'Competent Authorities' to take informed decision about the environmental impact management of specific developments include Scoping and EIA Reports, Basic Assessment Report (BAR) and Environmental Management Plans (EMPs).

In terms of how EIA is expected to achieve its objectives –

- EIA recognises the validity of quantitative and qualitative data, thereby accommodating more subjective elements of impact predictions, values and views as well as objective evidence. EIA is understood to be both value judgement and scientific.
- The state is mandated to authorise and regulate activities, after considering the potential consequences or impacts of these activities on the environment.
- Legislation provides clear procedural and content requirements as the basis for decision making, which requires decisions to be procedurally fair, lawful and reasonable (rational and proportional).
- The decision-making mandate is vested with provincial and national spheres of government where administrative capacity is provided. Skill requirements are prescribed for environmental assessment practitioners (EAPs) in legislation and qualification standards. In terms of skills training, significant progress seems to have been made with personnel in most provinces having sound qualifications, although overall staff shortages and inexperience are highlighted as key challenges.

With respect to how well the EIA process been efficiently implemented, anecdotal evidence suggest that EIA processes are generally conducted within set legal timeframes and that effective frameworks for monitoring procedural efficiency exist in government. However, serious questions are being asked as to what extent the drive for procedural efficiency is eroding the potential benefits of EIA in terms of improving decision making and providing for transparency and participation.

With respect to the quality of EIA reports and processes –

- Report quality has been evaluated over time as well as for different provinces and sectors.
- Overall report quality decreased slightly from the ECA (pre-2006) to the NEMA regime (post 2006).
- Lower quality grades are achieved for dealing with impact identification, alternatives, mitigation and significance.
- Higher quality grades are achieved for dealing with more descriptive and presentational areas of evaluation.

With respect to the economic impact of the EIA process on identified sectors –

- There is no existing literature on the full economic impact of EIA on specific sectors in South Africa.
- Determining the economic impact of EIA is exceedingly difficult from a conceptual and methodological perspective.
- Research suggests that the average direct cost of EIA in South Africa is particularly low compared to international EIA systems.
- As a percentage of total project costs, EIA in South Africa compares with the higher spectrum of international practice. This suggest that a large number of EIAs are being conducted for relatively small-scale projects, which might be placing a notable cost burden on small and medium enterprises.

With respect to how EIA has influenced decision making –

- EIA has significant mandate to positively influence decision making towards sustainable development.
- There is limited empirical research on the extent to which EIA influences decision making with most research focussing on post-decision follow-up. South Africa has made significant strides in law and administrative arrangements to deal with compliance monitoring and follow-up.
- Research emphasises the importance of post decision monitoring and adaptive management to deal with unforeseen impacts.

In terms of the extent to which the EIA process been effective in achieving its objectives towards sustainable development –

- There is limited research available on the extent to which EIA has delivered sustainability and/or more sustainable outcomes.
- There seems to be ignorance amongst both officials and practitioners in respect of the sustainable development mandate and purpose of EIA.
- Research has demonstrated that in the South African context EIA already has a very strong and explicit sustainability mandate which means that the challenge for EIA does not lie with the mandate (or the establishment of appropriate enabling legislation) but rather with giving effect to this mandate in practice.
- Particular challenges in applying sustainability thinking in EIA is related to incorporating longer term thinking and dealing with uncertainty.

The main potential impacts or contributions of EIA are seen to include –

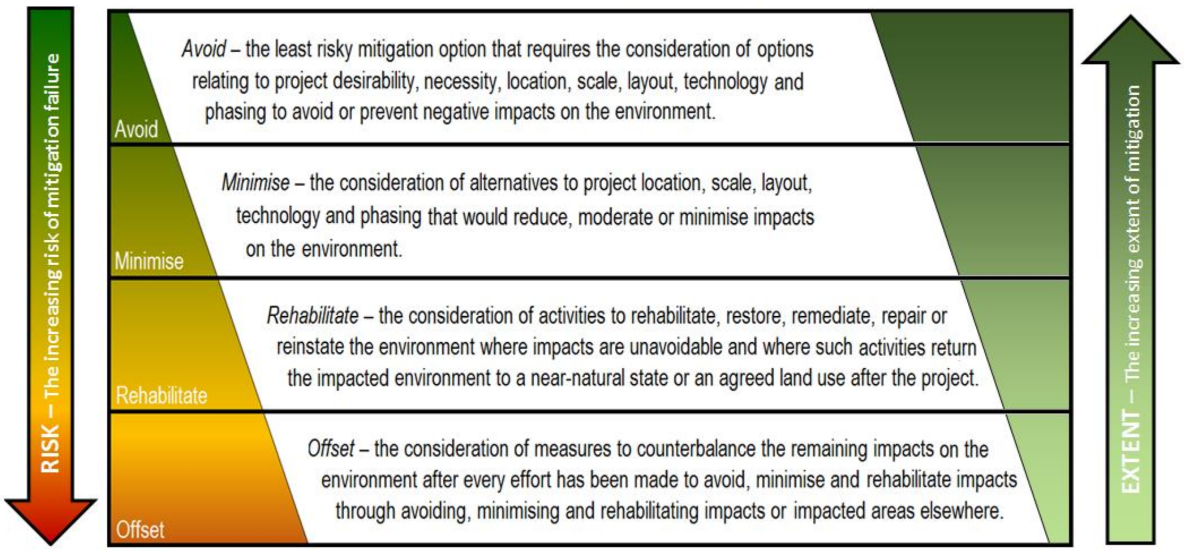
- The promotion of sustainability in decision-making
- The promotion of wellbeing through a safer environment
- The establishment of an environmental assessment profession
- The promotion of public participation
- The increase in environmental awareness
- The reduction in the commencement of unlawful developments
- The reduction in legal interpretation queries – people now better understand the EIA requirements
- The reduction in appeals
- Improvements in granting administratively just decisions
- Improvements in the statistics for all authorisations granted or refused.

8.2.1 Environmental screening tool

The national web based Environmental Screening Tool is a geographically based web-enabled application which allows a developer intending to submit an application for environmental authorisation in terms of the Environmental Impact Assessment (EIA) Regulations to screen their proposed site for any environmental sensitivity. This internationally acknowledged cutting-edge use of spatial information management technology is now an integral component of the South African Environmental Impact Assessment (EIA) processes, offering an innovative, highly effective and user-friendly approach to pre-screening projects for their potential environmental implications.

Designed to enhance the capacity of both regulators and developers to make informed decisions, the National Web-Based Screening Tool seamlessly integrates geographic information, scientific data, and regulatory insights, enabling a visualization of complex spatial relationships and the assessment of potential impacts. In this way, the tool addresses many of the limitations of traditional assessment methods thereby facilitating sustainable development. Importantly, the screening tool facilitates the efficient and effective implementation of the environmental impact mitigation hierarchy (see below) by facilitating impact avoidance decisions even before an EIA application is made – an extremely important development that addresses the perennial problem of bias towards higher risk mitigation actions lower down on the hierarchy.

The Environmental Impact Mitigation Hierarchy



In essence, the EIA applicant opens the tool and locates her proposed site for development on the map of South Africa. Once she has zoomed into the affected area, she is able to draw the proposed footprint of her development on the site. Using over 120 layers of spatial information on environmental sensitivities ranging from high potential agricultural land to vulture occurrence areas, the developer is able to assess and reposition the development footprint with a view to minimising the impact on these sensitivities. The screening tool automatically chooses certain sensitivity layers relevant to specific development types. Once the footprint is confirmed, the screening tool generates a screening report that must be submitted with the EIA application that highlights the impacted sensitivities and provides protocols for specific assessments that must be undertaken based on the screening results.

To explore the capabilities of this innovative tool, everyone is invited to visit https://screening.environment.gov.za and embark on a journey that encapsulates the power of technological innovation in fostering ecological consciousness.

8.3 Forestry

The laws governing forestry management and the sustainability of the forest resources in South Africa are the National Forests Act of 1998 (Act No. 84 of 1998) (NFA) and the National Veld and Forest Fire Act of 1998 (Act No.101 of 1998). The purpose of the National Forests Act is to promote sustainable management and development of forests for the benefit of all. It provides special measures for the protection of certain forests and trees while also promoting the use of forests for environmental, economic, educational, recreational, cultural and health purposes. The Act also provides for the Minister to monitor forests and report on any facts and trends derived from the monitoring.

The purpose of the National Veld and Forest Fire Act on the other hand is to prevent, and combat veld, forest and mountain fires throughout the Republic. It provides for the establishment of voluntary fire management institutions in the form of fire protection associations, establishment of an early warning system and reasonable actions required for fire prevention and firefighting to mitigate the impacts of wildfires in the country. The Act also has reporting obligations in that it requires fire protection associations to report to the Minister on an annual basis on their activities including reporting on fire occurrence statistics.

8.3.1 Compliance and enforcement

The DFFE has deployed various interventions aimed at ensuring compliance with the laws and the enforcement thereof. These include the National Forests Act of 1998 (Act No. 84 of 1998) and the National Veld and Forest Fire Act of 1998 (Act No.101 of 1998), 1998 Compliance and Enforcement Strategy; Licensing guidelines; the Sustainable Forest Development in South Africa White Paper, 1996, and the Principles and Guidelines for Control of Development affecting Natural Forests.

In order to ensure compliance with the provisions of the two pieces of forestry legislation, the DFFE carries out various awareness programmes, although funding poses a serious challenge, inhibiting wider coverage. The Forestry Branch within the DFFE implements awareness raising, through capacity building (internal and external stakeholders of the Department and institutions of higher learning and the Judiciary), meetings with traditional leaders at various communities throughout the country and the annual publication of the National list of Protected Trees and Champion Trees.

Over the past three financial years (2016-2018), approximately 400 stakeholders were trained on the provisions of the Act. The Minister also appointed several individuals outside the Department as Peace Officers. Peace Officers once appointed are granted certain powers and responsibilities such as the power to search and arrest offenders who transgressed on stipulated provisions or those provisions provided for in the legislation concerned.

More than 120 stakeholders were trained on the NFA during the period 2017-2019 including Departmental interns and newly appointed officials in Mpumalanga, Kwazulu-Natal, Eastern Cape Limpopo and National Office; students from the University of Venda and Fort Cox College, Prosecutors and Magistrates (Cape Town); and the Justice College (Pretoria).

The Department also participated in various events and/or organised events in which awareness about forests and other natural resources was raised and awareness documentation distributed. The Department also encourages municipalities to undertake greening programmes such as the annual Arbor City Awards competition whereby a winning municipality receives an award for their effort and excellence in greening projects.

The National Forests Act makes provision for accessing forests for various activities through the licence system. The licences are issued in terms of sections 7, 15 and 23 of the legislation. Section 7 deals with the activities of cutting, disturbing, damaging or destruction of any indigenous tree in a natural forest. Section 15 licences are issued for activities involving the cutting, damaging or removal of any protected tree and the collection, removal, transporting, exporting, purchasing, selling or donating or acquiring in any other manner or disposing of a product derived from a protected tree. Section 23 on the other hand deals with all activities that may be carried out in a state forest with the guidance of forestry tariffs, where applicable. In terms of the national forestry legislation, all indigenous forests are protected and therefore no person may cut, damage, destroy, remove or transport a tree or the product thereof without a licence. Approximately 3500 licences were issued during the period under review (2016-2018) for various activities as provided in the forestry Act.

Despite these compliance measures, there are still a number of non-compliance instances involving individuals and organisations. The department uses various means of enforcement including –

- **Negotiations**: the department discusses failure to comply with the legislation and agrees an arrangement to resolve any infringements. For example, Eskom failed to comply with licence conditions at Masa-Ngwedi, Limpopo, and the department declined to renew their licence and a non-compliance notice was issued to them as a result. The licence was subsequently re-issued after negotiations.
- **Warnings**: various caution notices were issued in the Northern Cape and in Limpopo for failure to comply with the legislation. Warnings are issued depending on the level of the transgression and the services of the South African Police are solicited if the transgression has a huge negative impact.
- **Spot fines**/ J 534: spot fines are issued when the offence is considered major, but the offender admits guilt, and is willing to pay a fine. Spot fines were issued in Limpopo and Northern Cape.
- **Joint Operations**: the Department engages with other sector Departments and conservation boards to conduct operations such as the Phakisa. Joint Operations were conducted in areas such as Tzaneen, Limpopo; Magaliseburg, North West and Lusikisiki Eastern Cape. Arrests, warnings, and fines are issued during the joint operations.
- **Prosecution**: prosecution is chosen as an option if the impact of the transgression is significant in monetary or environment terms. There are various cases that are being litigated including the Nanaga, Al Priva, and Long Beach for contravention of the National Forests Act.

8.3.2 National forest resources assessment

The DFFE is mandated to conduct forest monitoring in terms of Section 6 of the National Forests Act (No. 84 of 1998). In response to the legal mandate to monitor forests, and in response to several other national and international reporting requirements, the Department developed a conceptual framework for a national forest resource assessment. The Department piloted two studies in Bushbuckridge, Mpumalanga and in the Buffalo City

Metropolitan Municipality, Eastern Cape in 2018. The study was meant to test the feasibility of the framework and map out and classify the forest land for the years 2005/6, 2010 and 2015.

The results showed that 96 831.1ha of natural wooded vegetation occurred in Buffalo City, which represented 38.4% of the municipal area. The extent of planted forests (excluding urban tree cover) amounted to 3 593ha; equivalent to 1.42% of the municipal area. Of the settlements recorded for the study period, it appeared that 1.35% had tree cover. All forest cover considered; it appeared that over the decade covered by the study there had been relative stability in the extent of forest. For some individual forest types, however, there had been noticeable trends of change. Whereas the study did not examine forest degradation, the fact that forest extent remained fairly stable does not imply the absence of any degradation trends. From a conservation point of view, the total extent of protected forest cover amounted to 1 908.9ha. Formal protected areas within the municipal borders only accommodated 0.7% of the tree cover. The forest types of Southern Coastal Forest and Buffels Thicket are currently poorly protected and in need of better conservation.

From the perspective of piloting the national forest resource assessment concept, valuable lessons were learned during the course of the study. The overall conclusion was that the proposed conceptual framework is achievable within acceptable limits of accuracy. Building on the learning experiences from the pilot study, it was believed that a national assessment would be viable; provided substantial processing capacity could be established with dedicated human resources. The time frame for conducting such work on a national scale would span several years; probably in excess of five years.

8.3.3 Forestry certification

South Africa still has the highest percentage of certified plantations in the world in terms proportional area. Eighty-two percent (82%), about 1 436 million hectares of commercial (plantation) forestry areas in the country, have achieved the Forest Stewardship Council (FSC) certification. These have Forest Management plans, which consider various factors including social and the environmental factors and are sustainably managed.

Forest management plans are important for sustainable forest management since they indicate sustained supply of forest goods and services. They indicate these are achieved through long-term investment and forest management planning. This often means that management responsibilities for any particular forest will pass over time among individuals, companies and government agencies.

Komatiland Forests was the first plantation to gain FSC certification in South Africa, with the largest and medium-sized corporate growers following suit. Forest management certification includes the definition of forest management practices that meet requirements for best practice in areas including biodiversity, sustainable production of goods and environmental services, minimal chemical use, protection of workers' rights and welfare, local employment, respect for indigenous peoples' rights and forest operations undertaken within the national legal framework following best practices.

39% of plantation FSC certified plantations on Farm Management Unit (FMU) level in Africa is from South Africa and the country represents 66% of the total Chain of Custody in the Continent, representing the level of sustainable forest management. However, none of the Department's more than 65 900 ha plantation estate has received FSC certification. In order to promote sustainable forest management and expand the area of certified forestry areas, South Africa developed a South African National Forestry Certification Standard as part of the South African Forestry Assurance Scheme (SAFAS), which was officially endorsed by the Programme for Endorsement of Forest Certification (PEFC) in November 2018. Subsequently, the National Standard was approved by Programme for Endorsement of Forest Certification.

The National Certification Scheme is based on the Principles, Criteria, Indicators and Standards (PCI&S) for sustainable forest management, which is appropriate for all scales of forestry operations. The PCI&S framework was reviewed during the process of the development of the Standard, and they were used as a basis. The Standard was presented to the National Forests Advisory Council (NFAC), and it was recommended that they be published (gazetted) as regulations. Accordingly, it is the intention of the department to publish the Standard as regulations.

8.3.4 Special programmes: corporate social investments

A number of forestry companies continue to implement projects in and around plantations for the benefit of communities. This social responsibility manifests itself in many forms and helps to improve the lives and conditions of communities, particularly in the deep rural areas of the country where government may not be able to easily intervene. For the period under review (2016 to 2018), the South African Forestry Company Limited (SAFCOL) managing some 187 320 ha of plantation area distributed in the provinces of Limpopo, Mpumalanga and KwaZulu-Natal invested in a number of projects in communities adjacent to their plantations to the value of R22 769 976 benefitting 147 945 community members. In 2016, the Company implemented some 29 projects to the value of R 7 496 590 benefitting 48 591 individuals and communities. The projects included among others construction of the Muzomuhle Old Age Home in the Chief Albert Luthuli Municipality, Mpumalanga; construction of a kitchen at Marhogwane in Bushbuckridge, Mpumalanga; desk manufacturing project in Makhado, Limpopo; charcoal project at Blairmore, Mpumalanga; Construction of Oncweleni hall using timber in KwaZulu-Natal; construction of the Palmridge Multipurpose Hall at Makhambane and renovations of structures in certain localities.

In 2017, the Company continued to assist with social compact projects ranging from construction and renovations of buildings; support for celebrations of events including the Nelson Mandela Day, fire awareness campaigns, skills development programmes, supply of 20 computers to Evane Primary School; provision of educational toys to day care centres and installation of electricity at Ngome Primary School. The amount invested during the period which benefitted 57 075 individuals and communities was R 7 626 497.

The year 2018 saw SAFCOL invest in R 7 646 889 in 31 projects with 42 279 recorded as the number of beneficiaries. The projects supported or embarked on include: continued support to the Desk Manufacturing Project in the Albert Luthuli Municipality, Mpumalanga; construction of Diepdale Youth Centre in the Chief Albert Luthuli Municipality; supply of timber frame classrooms and school desks for Buhlebuyeza Primary school; construction of the kitchen at Dientjie Primary School, Mpumalanga; drilling of borehole for Emhlabaneni, erection of security fences and construction of several ECD Centres; supply of furniture; and running of fire awareness campaigns in Limpopo, Mpumalanga and KwaZulu- Natal.

8.3.5 Re-commissioning of state plantation areas

The re-commissioning of areas that DFFE initially exited in Mpumalanga (4 000 ha) and Western Cape (21 000 ha) will result in a total of 25 000 ha being available for planting. These are the areas which were decommissioned for forestry use in the early 2000s, but government has since rescinded the decision after considering the dire socio-economic impact of the earlier position on poor, rural communities living in and around these plantations. In the Western Cape, forestry operations are already underway having commenced in 2016 after a two- year Service Level Agreement (SLA) for replanting the Vecon areas was entered into between the Department and MTO Forestry. A budget of R18 million was allocated for the year 2016 and a further R24 659 352 was approved for the implementation of the SLA. The process was conducted in the manner that seeks to benefit local communities and stimulate local economic development. It was estimated that through this process, 500 direct and 2 000 indirect jobs will be created (2 500 decent jobs).

As at 31 December 2017, 6 687 ha (53%) had been completed by MTO Forestry whereby 1 067 ha was replanted and 568 ha was subjected to natural regeneration. However, the June 2017 fires that ravaged the Western Cape thwarted these efforts. Most of the seedlings planted by MTO Forestry under the SLA and meant to empower local communities, were destroyed by a series of wildfires. In Mpumalanga, no work had been done on 4 000 ha areas earmarked for re-commissioning as the Department was yet to secure funding.

8.3.6 Forest governance

The DFFE through the Forestry Branch establishes and chairs or co-chairs several forums based on thematic areas of work. These, for example, include the National Forestry Research Forum (Research and Development), Forestry Liaison Forum (commercial forestry matters), the National Veld and Forest Fire Working Group (integrated fire management) and other internal/ departmental structures.

The department participates in the following two councils:

- **National Forests Advisory Council (NFAC)**: a forestry statutory body established in terms of the NFA. The term of office for the NFAC is three years and its main function is to advice the Minister and the Department on all matters pertaining to forestry in the country. The Council has two Committees, namely, Committee on Access and the Committee on Sustainable Forest Management which both report to the Chairperson of the Council. The Department provides Secretariat services to the NFAC.
- **Forest Sector Charter Council (FSCC)**: established to monitor compliance with the obligations of the social partners on the Broad-based Black Economic Empowerment (B-BBEE) Forest Sector Transformation Charter including Government. The social partners to the forest charter include government, labour and business and they have all agreed to certain commitments/ responsibilities aimed at ensuring transformation and development in the forest sector. The FSCC is the custodian of the Charter, and its primary responsibility is to ensure compliance with the charter obligations and to report on the performance of the sector.

The private sector, comprising of individuals, corporations, families and big companies play a major role mainly on commercial plantations businesses. The private sector's role is very important in that it creates the much-needed jobs, invests significantly in research and development and corporate responsibilities for social upliftment.

8.4 Air quality

Intergovernmental coordination and cooperation is crucial to good air quality governance. Government has established several structures to ensure cooperative governance, as required by the Constitution of the Republic of South Africa. The primary functions of these structures is to share air quality information, share experiences, consultation, learn from one another, offer assistance and support to ensure effective and efficient cooperative governance.

The 2017 National Framework for Air Quality Management in South Africa clearly describes the roles and responsibilities of government, industry, and civil society in all air quality management matters in its Chapter 3.

The National Environmental Management: Air Quality Act, 2004 (Act no. 39 of 2004) (NEM: AQA) represents a shift from the historical source-based air pollution control to an air quality management approach that focuses on the receiving environment. Key features of the legislation include:

- Setting ambient air quality targets as goals designed to drive emission reductions.
- Decentralizing air quality management responsibilities.
- Requiring all significant sources to be identified, quantified, and addressed.

- Recognizing source-based (command and control) measures in addition to alternative measures, market incentives and disincentives, voluntary programmes, and education and awareness-raising.
- Promoting cost-optimized mitigation and management measures.
- Stipulating air quality management planning by authorities, and emission reduction and management planning by sources.
- Promoting access to air quality information and public consultation in air quality management processes.

The NEM: AQA is relatively compact and concise despite the complexity of the issues that it regulates. As such, it is often referred to as a 'framework' legislation (that is, legislation providing an outline designed to accommodate further detail over time). This is the result of a decision taken early in the law-reform process to expedite the development and promulgation of the NEM: AQA, and to address the inadequacies of the legislation it replaced (the Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965) (APPA), by focusing on the 'big issues' yet at the same time offering scope for future detail both through the National Framework and regulations. South Africa has adopted the air quality governance system that can be described in terms of a simplified environmental governance cycle. The governance cycle provides a useful framework for achieving continuous improvement over time. An overview of each of the components is defined in the 2012 National Framework for Air Quality Management in South Africa.

Since the promulgation of the NEM: AQA, numerous legislative tools have been put in place to give effect to various provisions of the NEM: AQA. Although these are detailed in full in the NEM: AQA Information Sheet: these include commencement notices; declarations of three air pollution Priority Areas (the Vaal Triangle Air-Shed Priority Area (VTAPA), the Highveld Priority Area (HPA), and the Waterberg-Bojanala Priority Area (WBPA)) and their associated air quality management plans; two National Frameworks for air quality management in the Republic of South Africa, the identification of priority air pollutants and their associated national Ambient Air Quality Standards (NAAQS) for the permissible amount or concentration of each substance in ambient air; the lists of activities requiring an Atmospheric Emission License and the minimum emission standards for each listed activity; regulations on model air pollution control by-laws to be adopted by municipalities; National Dust control regulations; National Greenhouse Gas emission reporting Regulations; the declaration of GHGs as Priority Air Pollutants; National Pollution Prevention Plans Regulations; Regulations prescribing the Format of atmospheric impact reports; the declarations of Small boilers, temporary asphalt plants, small-scale char and small-scale charcoal plants as controlled emitters with related emission standards; Regulations Regarding Air Dispersion Modelling; National Atmospheric Emission Reporting Regulations; Regulations prescribing the atmospheric emission licence Processing fee; Regulations for the procedure and criteria to be followed in the determination of an administrative fine; and Air quality offsets guidelines.

Figure: Standing air quality governance and public engagement forums

Air Quality Management Planning in the Southern African context forms the basis of the commitment to air quality improvement in the country. The NEM: AQA clearly stipulates the concept of effective air quality management planning as a way to achieve acceptable air quality by both government and industry. It recognises the different levels at which air quality must be managed and calls for all stakeholders to actively participate in efforts to safeguard and improve the quality of ambient air. It is for this reason that air quality planning starts at National and goes right through to the Local Municipal level with specific air quality priority areas recognised throughout the country. Air quality management planning is guided by Section 15 of the NEM: AQA which requires each national department or province responsible for preparing an Environmental Implementation Plan (EIP) or Environmental Management Plan (EMP) (in terms of Chapter 3 of the NEMA) to include as part of that plan an, Air Quality Management Plan (AQMP). It also requires Municipalities to include an AQMP in its Integrated Development Plan (IDP) (as required in terms of Chapter 5 of the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000).

These plans map out how the various government departments will:(a) coordinate and harmonize activities to minimize the duplication of procedures and functions, and promote consistency in the exercise of functions; (b) give effect to the principle of cooperative government in Chapter 3 of the Constitution, and enable the minister to monitor the achievement, promotion, and protection of good air quality; (c) improve air quality; (d) identify and reduce the detrimental impact of poor air quality on human health and the environment; (e) address the effects of emissions from the use of fossil-fuels in residential applications; (f) address the effects of emissions from industrial sources; (g) address the effects of emissions from any point or non-point source of air pollution; (h) implement the country's obligations in respect of international agreements (such as climate change and ozone-layer protection); give effect to best practice in air quality management; (j) give effect to the air quality management plan; and (k) comply with requirements that may be prescribed by the minister from time to time.

The last decade has seen an increase in the number and quality of AQMPs that have been developed across the different spheres of government in the country. Six (6) of nine (9) provinces, seven (7) of eight (8) Metropolitan Municipalities, 24 of 45 Districts and 24 of 228 Local Municipalities have got AQMPs.

In terms of Section 18 of the NEM: AQA, the Minister of Environmental Affairs in South Africa has declared three air pollution national priority areas namely; Vaal Triangle Airshed Priority Area (VTAPA) in April 2006, Highveld Priority Area (HPA) in November 2007 and the Waterberg Bojanala Priority Area (WBPA) in June 2012.

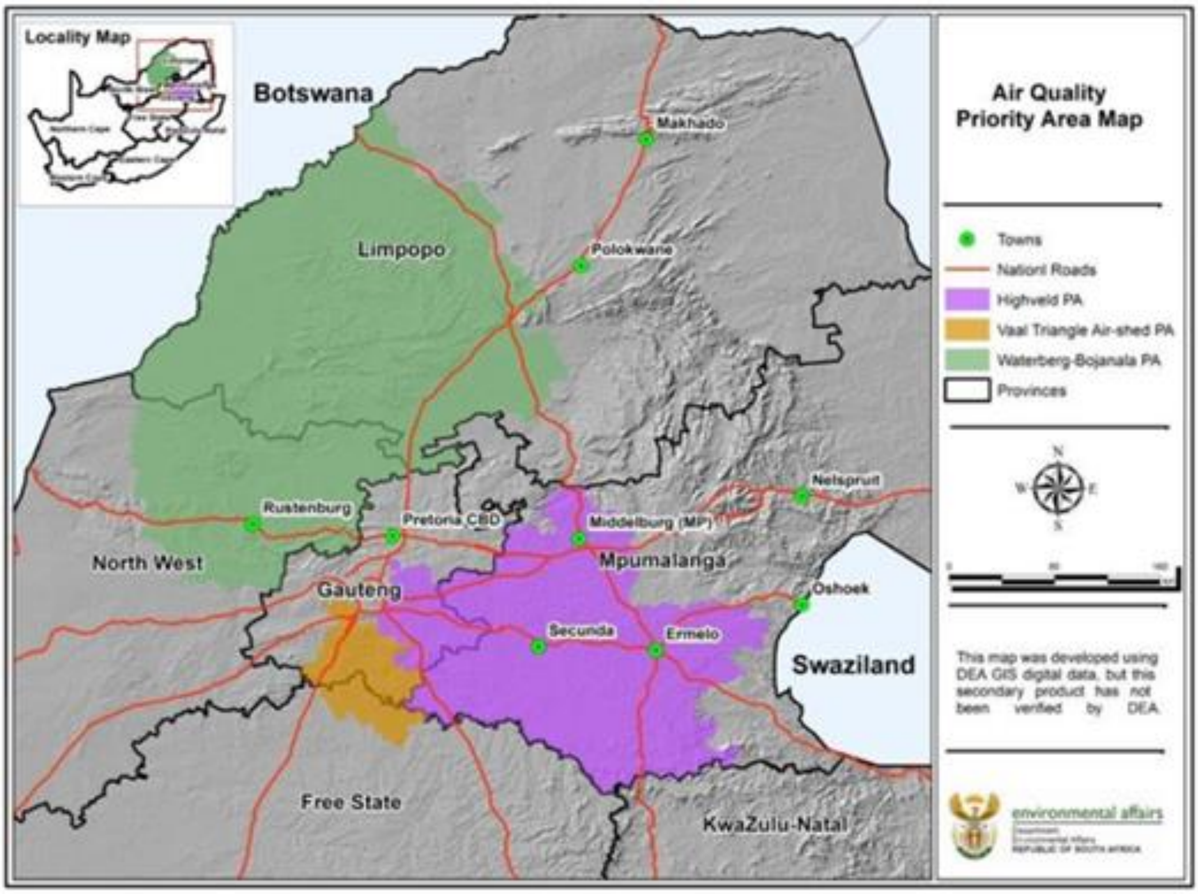


Figure: Formally recognised national air pollution 'hot spots' - the national air quality management Priority Areas

On 1 April 2010, the NEM: AQA came into full effect, repealing the Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965), the "APPA". The management of Registration Certificates issued for scheduled processes under APPA by national government was replaced by the administration of Atmospheric Emission Licenses (AELs) for Listed Activities under the NEMAQA. The AELs are now administered by the relevant metropolitan or district municipalities unless functions are delegated to provincial departments when metropolitan or district municipalities are not fully capacitated. To date, over 1100 AELs have been issued by relevant authorities across the country.

To reduce the administrative burden on licensing authorities and improve service delivery on AEL management, the national department developed the South African Atmospheric Emission Licensing and Inventory Portal (SAAELIP) in 2015. The portal consists of two components, a System for National Atmospheric Emission Licensing (SNAEL) and a National Atmospheric Emissions Inventory System (NAEIS). These systems provide the ability for AELs to be managed seamlessly online from cradle to grave while promoting transparency and access to information to all stakeholders. On SAAELIP, users can process and issue AEL applications, schedule licensing related inspections and track inspection results, manage compliance and emission inventory reporting and facilitate communication between AEL holders and the relevant authority. Since the end of 2018, licensing authorities have been migrating the AELs issued before SAAELIP development, into the online portal.

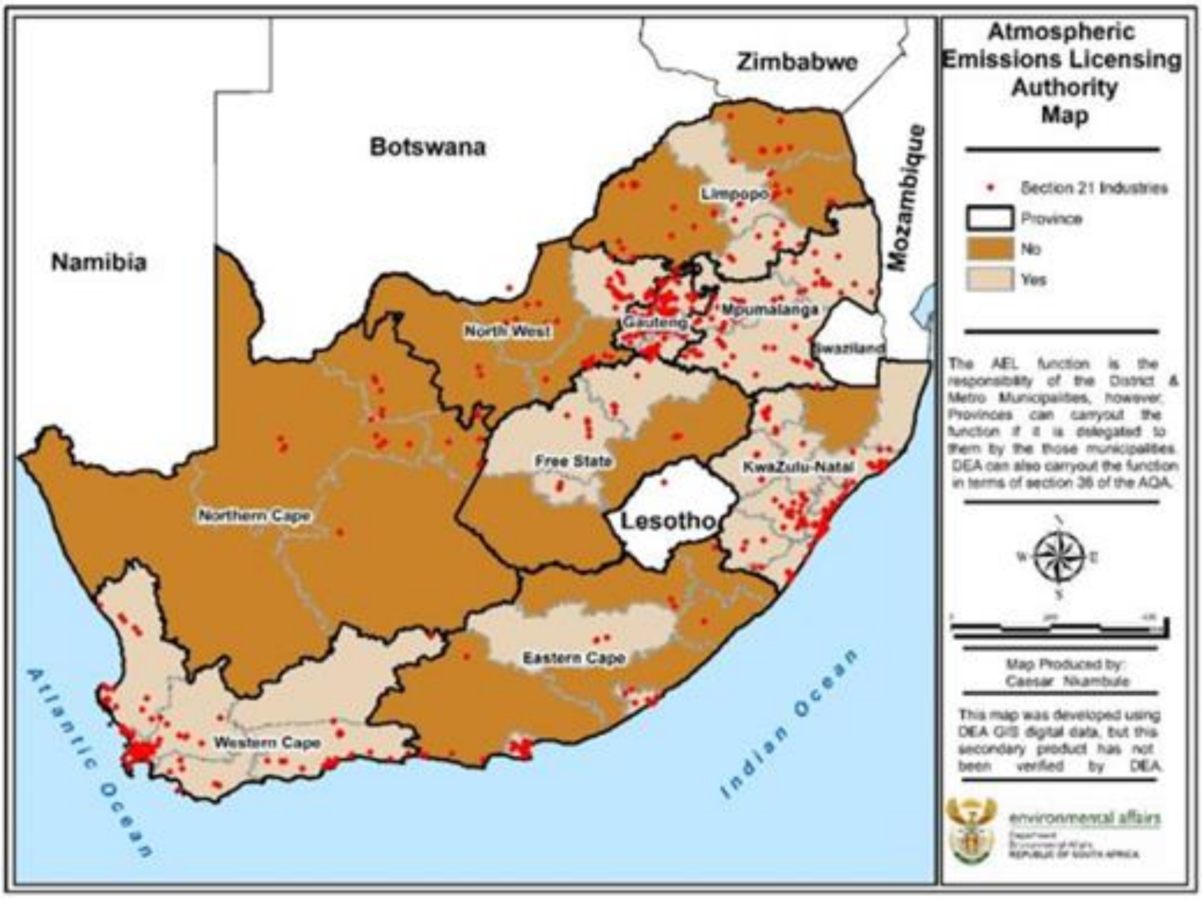


Figure: South Africa's Atmospheric Emission Licensing Authorities

The NEM: AQA is enforced by the Environmental Management Inspectors (EMIs) – the so-called "Green Scorpions". As an example of the compliance and enforcement provisions contained in the NEM: AQA, an AEL may require its holder, on request, to submit a certified statement to the inspector, indicating (i) the licence-holder's compliance monitoring records; (ii) particulars of instances of non-compliance; (iii) the reasons for instances of non-compliance; and (iv) any action taken, or to be taken, to prevent a recurrence of the instance of non-compliance. During the last decade, there has been an intensive training of the EMIs at the local government aimed to enhance the compliance of the AELs and other NEM: AQA requirements. In some Licensing Authorities, the EMIs has been designated and the some are still waiting the designation from their respective MEC.

Information management is a critical component of governance towards continuous improvement in air quality. Therefore, air quality information should be readily accessible, accurate and relevant for informed decision-making. The national department established the South African Air Quality Information System (SAAQIS) in 2010 to provide a common platform for managing and disseminating air quality information across the country (https://saaqis.environment.gov.za/). The information includes air quality related documents, current news items such as new regulations and notice of the release of documents for public comment, contact details of all air quality officers, related scientific publications, and ambient air quality data with the majority of station data being reported to the SAAQIS. It makes data available to stakeholders including the public and provides a mechanism to ensure uniformity in the way air quality data is managed i.e. captured, stored, validated, analysed and reported on in South Africa. At the heart of this system is the dissemination of real-time state-of-air-quality to the public from government monitoring stations.

Finally, the NEM: AQA also ushered in a new era of transparency and participatory governance that was unknown during the APPA period. Communities, NGOs, business and industry have been active and vocal participants in the various air quality management platforms over the years, including the development and oversight of the three national priority area air quality management plans. Notwithstanding the vast amount of work required to generate the above-mentioned laws, regulations, plans and systems, the key question remains – is South Africa's air quality getting better as a result? Although the state of air report Air Quality is indicating an overall improvement in air quality, in many areas of the country our Right to clean healthy air remains largely unrealised, with negative consequences for the health and well-being of the people living and working on those areas.

8.5 Biodiversity

The following section is an edited extract of The National Biodiversity Assessment 2018 report and readers are encouraged to read the report for more in depth, fully referenced, information on the state of South Africa's biodiversity.

The NBSAP-NBF-NBA relationship informs priority actions

South Africa has a well-developed suite of policy and legislation for the management, conservation and sustainable use of biodiversity, including two overarching national tools: the National Biodiversity Strategy and Action Plan (NBSAP) and the National Biodiversity Framework (NBF). These documents, developed through thorough stakeholder consultation, set out South Africa's strategic objectives for managing and conserving biodiversity and are the primary reference points for related priority actions. The National Biodiversity Assessment (NBA) both informs the development of the NBSAP and NBF, and supports their implementation. Together the NBSAP, NBF and NBA provide three key, inter-related anchors for the work of the biodiversity sector in South Africa.

Spatial biodiversity priorities for managing and conserving biodiversity

South Africa's biodiversity is not evenly distributed across the country and when this is combined with limited resources for action, it means that it is essential to prioritise spatially. An important feature of South Africa's biodiversity-related action to the pressures on biodiversity has been spatial planning to identify priority areas in the landscape and seascape for intervention. This is particularly important for the implementation of Strategic Objectives 1 – Management of biodiversity assets, 2 – Investment in ecological infrastructure and 3 – Biodiversity considerations are mainstreamed, of the NBSAP and NBF, which otherwise run the risk of being spread too thin geographically to be effective. The production of many spatial planning tools at the national and sub-national level relies heavily on the spatial data layers and datasets that are compiled and collated for the NBA. Efforts to strengthen foundational data for the NBA thus also supports the development of high-quality spatial biodiversity plans.

Additional priority actions for managing and conserving biodiversity

The NBSAP and NBF highlight a wide range of interventions that are priorities for managing and conserving biodiversity. These are confirmed and reinforced by the findings of the NBA 2018. The key priorities for improving the effectiveness of interventions emerging from this NBA include the need to improve compliance with existing laws, strengthen cross-sectoral planning, strengthen adaptive management, improve implementation of conservation projects and build and maintain capacity. The NBA 2018 technical reports for each realm explain some of these interventions in more detail and articulate additional priority actions resulting from the NBA 2018 findings. There are, however, several general priority actions that support the successful implementation of many of these interventions, and ultimately affect South Africa's ability to meet the NBSAP and NBF goals. These general priorities can be clustered into the following themes:

- Strengthening compliance and enforcement,
- Strengthening cross-sectoral and cross-realm planning,
- Strengthening evaluation for adaptive management,
- Conservation project implementation,
- Maintaining and further strengthening capacity.

8.5.1 Biological invasion

The following section is an edited extract of the Status of Biological Invasions, and their Management in South Africa 2019 report and readers are encouraged to read the report for more, in-depth, fully referenced information on the state of South Africa's biological invasions.

8.5.1.1 Quality of the regulation framework

There have been significant developments regarding the implementation of the regulations governing the management of biological invasions. However, the primary legislation on biological invasions in South Africa (the NEM: BA of 2004; and its associated A&IS Regulations and Lists of 2014 as amended 2016) did not change between January 2017 and December 2019. In February 2018, the late Minister of Environmental Affairs published a notice of intention to amend the regulations and the lists of alien and invasive species. In the notice, the Minister invited the public to submit comments on her intention within 30 days of the date of the notice (the period was extended). The procedure for amending the regulations and the lists was subject to a legal challenge and as of June 2020 the NEM:BA A&IS Regulations and Lists have not been amended. The legal challenge has highlighted the need to clearly document why particular species were listed or are proposed for listing.

It was noted that the process followed in listing species was unclear, and that there was no evidence that the risk of each listed alien species had been properly assessed. The Department of Forestry, Fisheries and Environment (DFFE) requested the South African National Biodiversity Institute (SANBI) to convene a scientific advisory panel that could deal with issues pertaining to the risks posed by alien species. The Alien Species Risk Analysis Review Panel (ASRARP) was then constituted and tasked with reviewing risk analyses underpinning the listing of species under national legislation to ensure that they are scientifically robust.

In an effort to ensure that the evidence underpinning the regulations is transparent, consistent, and in line with international best practice on risk analysis, in collaboration with ASRARP, developed and tested a risk analysis framework tailored for South Africa. To date risk analyses have been completed, as per the published guidelines, primarily by SANBI staff, students, and post-doctoral researchers. As of December 2019, risk analyses for 25 species had been reviewed and approved by ASRARP.

Notably, for 12 of these risk analyses the recommendation does not agree with the current listing category under the NEM:BA A&IS Regulations. There are various reasons for this (e.g. uncertainty as to whether the species is present in South Africa; field evaluations have found the species to be unsuitable targets for eradication; or the effectiveness and need for regulation has been questioned; see Supplementary Material section S5.9 for more details). These risk analyses have been submitted to the DFFE and are intended to be tabled for consideration at an interdepartmental committee tasked with making decisions as to whether and how to list species under the NEM:BA A&IS Regulations. The committee had not, as of mid-2020, been formed. The risk analyses have also not yet been made publicly available.

Separate to the ASRARP process, 128 risk assessments were completed between January 2017 and March 2018 and collated by the DFFE. Most of these concerned alien plant species (104 assessments) and were based on the modified Australian Weed Risk Assessment Protocol. The remainder were done for birds, mammals, reptiles, amphibians, and invertebrates, and used different methods. These documents have not been standardised, subjected to quality control or made publicly available. The process for publishing the 2018 proposed amendments to the lists of invasive species under the A&IS Regulations could not be influenced by ASRARP and the risk analysis process, as these were not in place when the proposed amendments were being developed. The process for publishing the 2018 amendments was illuminated in the court papers in the matter between Fly-fishers Association of Southern Africa Minister of Environmental Affairs and others. Evaluations of the risks posed by eleven of the listed alien species or candidates for listing were conducted as part of the process and were reviewed by international experts.

There are various aspects of the regulations that are problematic. These include some errors and inconsistencies, mechanisms to implement parts of the regulations are missing, and there are few explicit mechanisms to facilitate intergovernmental collaboration. In addition, there is still no guiding policy governing biological invasions in South Africa. A concern about faultless liability in NEM:BA and the A&IS Regulations was raised and argued that liability for the breach of the duty of care on landowners to manage invasive species on their land can be faultless. The liability is faultless when the presence of invasive species on their land is not of their own making; i.e. when the species spread to the property by means other than the actions of the landowner. They further point out that faultless liability provisions are often seen as being unfair or unjust and are vulnerable to constitutional challenge. Enforcement agencies are usually reluctant to enforce such provisions. It is also noteworthy that neither NEM:BA nor the A&IS Regulations make provision for the imposition of administrative fines or penalties on those who have contravened or failed to comply with the provisions of NEM:BA dealing with the management of alien and invasive species or the A&IS Regulations. Administrative penalties are monetary penalties that are imposed by an authorised enforcement agency on a person for contravening the provisions of an Act. The imposition of an administrative penalty does not require a conviction in a criminal court, but merely a preceding fair administrative process. They have been effectively employed in the UK and by the Competition Tribunal in South Africa.

8.5.1.2 Money spent

The Department of Forestry, Fisheries and Environment's Natural Resource Management programmes continue to spend a significant amount of money on controlling biological invasions, well over a billion ZAR per year. However, while the absolute annual spending by the department has stayed fairly constant over the period 2012–2019, in real terms this represents a decline. The expenditure is, however, an underestimate, as it does not consider funds allocated to the control of invasive species by, for example, other government departments, national and provincial conservation bodies, metros and municipalities, NGOs, and the private sector. With respect to spending on individual species, information supplied by a range of implementing agencies indicated that at least 237 invasive species were targeted for management. The spending per species is highly skewed – 45 percent of the money was spent on controlling black wattle (*Acacia mearnsii*), and 77.2 percent of all money spent was directed at only ten species.

8.5.1.3 Planning coverage

There has been no change to the proportion of pathways of introduction with management plans in place~ (80%). There has been no attempt to prioritise pathways for management, and consequently no formal management plans for pathways have been developed by the Department of Forestry, Fisheries and the Environment (DFFE). Although ballast water management plans have been drafted for some South African ports, they appear not to have been implemented. In order to manage the species that are transported on the hulls of ships, the Transnet Ports Authority plans to introduce in-water hull cleaning, however, it appears that this has not yet been put into practice.

As highlighted in the 2017 report, section 75(5) of NEM:BA empowers the Minister to establish a body to co-ordinate species-specific management plans, but no evidence was found that such a body had been established. No species have dedicated management plans in place. Those listed in the 2017 report for pompom weed (*Campuloclinium macrocephalum*) and parthenium weed (*Parthenium hysterophorus*), and for taxa in the genera *Acacia* and *Prosopis*, and in the family *Cactaceae* are yet to be formally approved.

Species-specific eradication management plans have been prepared for some species, but none have yet been formally approved, though it is not clear what the process for this is. In addition, the quality of the plans has not yet been assessed. A detailed plan for the eradication of house mouse (Mus musculus) from Marion Island has also recently been developed. Since the 2017 report, 25 new site management plans covering 648 294 hectares have been submitted, increasing the proportion of sites covered by management plans to 4.5% of the country. Plans for the Maloti Drakensberg Conservation and Development Area (312 105 hectares), Buffalo City Metropolitan Municipality (250 000 hectares), and uMdoni Local Municipality (23 800 hectares) constitute the largest additions. Three site management plans were submitted by private landowners, two of which were submitted pursuant to the issuing of pre-directives on the relevant landowners.

The site management plans were assessed using the guidelines outlined in the 2017 report. The majority (84%) of the new plans were assessed as partially adequate. Three plans were found to be adequate, and one was inadequate. Most site management plans identified the alien plant species that were present, detailed general measures that can be taken for their control, and described invaded sites. However, few of the plans linked the measures to a specific timeframe and budget or reviewed the efficacy of previous control efforts.

8.5.1.4 Pathways treated

There has been no change to the proportion of pathways requiring management that are being managed (77%). Inspection operations by the Department of Forestry, Fisheries and Environment at OR Tambo International Airport have been expanded and now cover a greater number of locations including the passenger terminals, cargo terminal, and mail centre. Environmental management inspectors use the 'Life scanner' application to assist with identifying species at ports of entry, and in cases where the inspector cannot identify the taxon, a DNA analysis (performed off-site at a laboratory) is used to assess whether there is compliance. This analysis can take some time and in instances of compliance the imported specimens are only released to their owner once the results are returned.

This also leads to a delay in seizures and arrests. However, a new tool, the labin-a-box, which was recently developed, might in future enable inspectors to perform a DNA analysis at the port of entry, and reduce the time required to assess compliance. During the 2017/2018 and 2018/2019 financial years the DALRRD inspected more than 180 000 animal and plant product import permits, and 3658 animal and plant imports. Additionally, over 12 000 plant import samples were tested for quarantine pests by Plant Inspection Services.

8.5.1.5 Species treated

Without formal species-specific plans in place, it is not possible to evaluate the degree to which management is targeting the species that need to be treated. Of the 556 listed invasive taxa, 189 taxa (34%) were subjected to some form of management in 2018 and 2019. By comparison, 136 taxa (24%) were reported to be subject to regular management in the 2017 report. It is possible that, for some taxa, the need for further management interventions might have been assessed and deemed to be not needed.

A number of new species-specific control interventions have been reported. The application of treatments to remove invasive freshwater fishes has been very promising, and there are several notable success stories where native biodiversity has recovered within a few years of treatment. These projects involved a range of stakeholders and rigorous monitoring to assess whether there was any adverse impact of the treatment.

This suggests that this technique is viable in South Africa. Four new biological control agents of invasive plants were released in South Africa during 2017–2019 and three were released in 2016 that were not reported on in the 2017 report. These were released against the following targets: Bailey's wattle (*Acacia baileyana*) and green wattle (*A. decurrens*) (also attacks silver wattle (*A. dealbata*) and pearl acacia (*A. podalyriifolia*)), Madeira vine (*Anredera cordifolia*), dense water weed (*Egeria densa*), lantana (*Lantana camara*), Australian albizia (*Paraserianthes lophantha*), Mexican sunflower (*Tithonia diversifolia*), and white-flowered wandering Jew (*Tradescantia fluminensis*). No new biological control agents were released against invasive animals or fungi.

8.5.1.6 Site treated

A number of new site-specific control interventions have been identified. In relation to private land, a person who is the owner of land on which a listed alien species occurs has a duty of care in relation to those species. They are required to notify the competent authority of the occurrence of such invasive species on their land; to take steps to control and eradicate the listed alien species and to prevent it from spreading; and to take all the steps required to prevent or minimise harm caused by the invasive species to biodiversity.

In terms of regulation 13 of the A&IS Regulations, the Department of Forestry, Fisheries and Environment (DFFE) is obligated to establish and maintain registers of notifications received from landowners and directives served on landowners for non-compliance with NEM:BA and the A&IS Regulations and to provide the DFFE and South African National Biodiversity Institute (SANBI) with copies of those registers. SANBI has not been provided with any copies of such registers by the DFFE. It is therefore unclear if any notices were received from landowners since the 2017 report. However, details of directives and pre-directives issued in terms of the A&IS Regulations are recorded in the Department's overall environmental compliance and enforcement registers.

Information on the full number of pre-compliance notices, compliance notices, pre-directives or directives that have been issued subsequent to those reported in the 2017 report were not made available. The type of properties served with notices and directives for restricted activities with listed alien and invasive animal species were mainly private landowners and nurseries. Enforcement action was also taken against some organs of state, such as municipalities, national departments, and management authorities of protected areas. Over the period 2017–2019, six non-compliance cases against private landowners were handed over to the National Prosecuting Authority (NPA) for criminal prosecution. The NPA has secured one criminal conviction, while the other five cases are still pending.

8.5.2 Management effectiveness of provincial reserves

The following section is an edited extract of the State of Provincial Reserves in South Africa 2023 report, and readers are encouraged to read the report for more, in-depth, fully referenced information on the state of provincial nature reserves in South Africa, the challenges affecting management efficacy within these reserves, and opportunities to address these challenges.

The researchers analysed Management Effectiveness Tracking Tool (METT-SA) reports to determine which provincial reserves in South Africa with high conservation value are not currently being managed effectively. Provincial reserves were rated using the biodiversity resource indicator extracted from the METT reports (acknowledging that METT reports are intended to assess changes over time rather than comparing between reserves). In principle, the low-scoring (management score) reserves with a high conservation value should be the highest priority for implementing strategies to improve management effectiveness. The team discovered that many nature reserves are not effectively managed due to various driving factors. It was found that the state of management was mirrored by infrastructure dilapidation and poor road maintenance. Despite this, many of these poorly managed reserves retained their potential as eco- and nature-based tourism attractions.

The researchers also distributed an online survey to obtain expert opinions on the state of provincial reserves in the country and gain insights into the threats and challenges management faces. Based on expert survey responses, the top three challenges affecting management effectiveness were capacity, poor management skills, and a lack of budget.

Lastly, the researchers interviewed provincial reserve managers, conservation practitioners well-versed in park management, and relevant non-government representatives to better understand the challenges facing provincial reserve management. Capacity, poor management skills, and a lack of budget were challenges noted from the interviews as well.

The State of Provincial Reserves in South Africa 2023 report also highlights examples of provincial reserves that require urgent support and attention based on survey and interview responses. The report further recommend the following –

- Provincial reserves with low METT scores should be prioritised for initial engagement to explore opportunities for improving their management effectiveness. Critically, this includes recruiting qualified, skilled, and experienced managers and staff members;
- Urgent measures are required to refurbish infrastructure and significantly improve management effectiveness to realise the full tourism potential of these areas; and
- Partnerships and collaborations should be explored as a co-management option for provincial reserves. Mechanisms to consider include partnerships with the private sector, nongovernment organisations, community involvement, and the use of volunteers. Such partnerships may catalyse funding opportunities to provide technical support, build capacity, and provide other benefits.

8.6 Environmental compliance and enforcement

The following section is an edited extract of the National Environmental Compliance and Enforcement Report, 2021/22 and readers are encouraged to read the report for more, in-depth, fully referenced, information on national environmental compliance and enforcement.

The 2021/22 financial year marks the 15th year in which the Department of Forestry, Fisheries and the Environment has collaborated with its provincial and local counterparts and statutory bodies to develop the National Environmental Compliance and Enforcement Report (NECER); a joint publication that aims to provide an overview of environmental compliance and enforcement activities undertaken by the various environmental authorities over the period of a financial year. The NECER is aimed at a broad spectrum of stakeholders, including a range of private, public and community-based institutions. In this respect, the report seeks to fulfil some of the information requirements of regulators, the regulated, the general public and other interested organisations. The report is designed to meet this objective by providing:

- the general public with an overview of the measures being taken by the environmental compliance and enforcement sector to give effect to section 24 of the Constitution;
- the community-based/ non-governmental organisations with information related to specific compliance and enforcement activities being taken in respect of a certain sectors or facilities;
- the national, provincial and local environmental authorities with an overall perspective of their compliance and enforcement performance, both in relation to previous financial years, as well as in relation to their counterparts; and

- a deterrent effect to would-be offenders who realise there are dire consequences for those who choose to flout environmental laws.

8.6.1 Compliance monitoring inspections

Conducting compliance monitoring inspections to ascertain whether or not the regulated community is complying with the relevant legislative provisions, as well as with authorisations, licences and permits issued in terms of this legislation, play a critical role in ensuring continued compliance. Without effective compliance monitoring, non-compliance may go undetected and thus the necessary enforcement action in the case of non-compliance would, in many cases, not be pursued. The following tables highlight blue, green and brown compliance inspections conducted during the 2021/22 financial year. It is important to note that a single facility may require a number of environmental authorisations, licences or permits. Compliance with each and every authorisation, licence and permit held by a facility, including with each condition thereof, must be ascertained. It is critical that this initial or baseline inspection is then followed up with further inspections so that any improvement or deterioration in the level of environmental compliance by that facility may be assessed.

Compliance inspections per type/ non-compliances detected/ enforcement required: Brown, Green and Blue

Brown						
Institution	Facilities Inspected	Pro-active	Reactive	Inspection Report finalized	Number of non-compliances	Number requiring Enforcement action
Limpopo DEDET	274	201	73	263	-	153
Western Cape DEADP	393	113	210	393	279	195
Mpumalanga DARDLEA	100	8	92	91	-	68
Northern Cape DENC	59	-	59	15	-	-
Gauteng DARD	294	269	25	293	545	488
Free State DESTEA	8	3	5	8	16	-
KwaZulu-Natal EDTEA	599	414	185	567	654	204
North West DEDECT	159	68	91	125	486	33
DFFE	197	116	81	152	1023	47
Eastern Cape DEDEA	62	-	62	55	326	7
Water and Sanitation	62	62	-	62	-	9
Grand Total	2207	1254	850	2024	3329	1204

Green						
Institution	Facilities Inspected	Pro-active	Reactive	Inspection Report finalised	Number of non-compliances	Number requiring Enforcement action
Cape Nature	184	32	152	184	52	-
Limpopo DEDET	413	92	321	402	194	20
Northern Cape DENC	62	60	2	16	11	-
Free State DESTEA	525	16	506	398	-	-
Isimangaliso	57	2	55	30	6	50
North West DEDECT	290	246	44	288	5	-
DFFE	86	80	6	79	14	76
Eastern Cape DEDEA	22	22	-	22	10	6
MTPA	63	63	-	63	-	-
Water and Sanitation	17	-	17	15	531	16
Grand Total	1719	568	1103	1497	823	168

Blue						
Institution	Facilities Inspected	Pro-active	Reactive	Inspection Report finalised	Number of non-compliances	Number requiring Enforcement action
Kwazulu-Natal EDTEA	2	-	2	2	2	2
North West DEDECT	1	1	-	1	1	-
DFFE	55	24	31	13	118	26
Water and Sanitation	187	175	-	171	514	31
Grand Total	245	200	33	187	635	59

8.6.2 Overall national enforcement statistics

The below infographic highlights the summary of the overall national enforcement statistics as outlined in the National Compliance and Enforcement Report 2021/22 reflecting the dockets registered, number of admissions to guilt fines issued, section 24G fines paid, number of criminal records, plea and sentencing agreements, total number of arrests made, acquittals, number of convictions and administration notices issued by the Department of Forestry, Fisheries and the Environment.

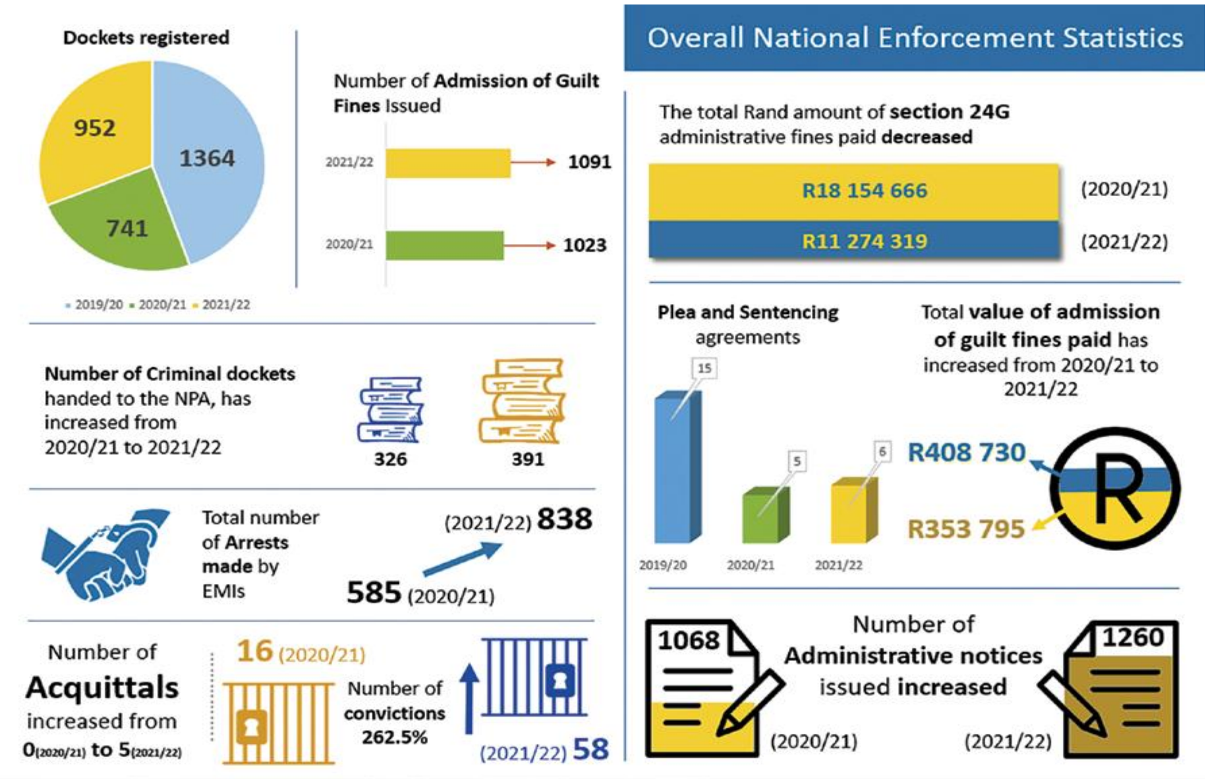


Figure: Summary of overall national enforcement statistics 1 April 2021 to 30 March 2022

8.6.3 Overall national compliance statistics

The below infographic highlights the summary of the overall national compliance statistics as outlined in the National Compliance and Enforcement Report 2021/22 reflecting the number of facilities inspected, proactive inspections conducted, reactive inspections, non-compliance detected by the Department of Forestry, Fisheries and the Environment.

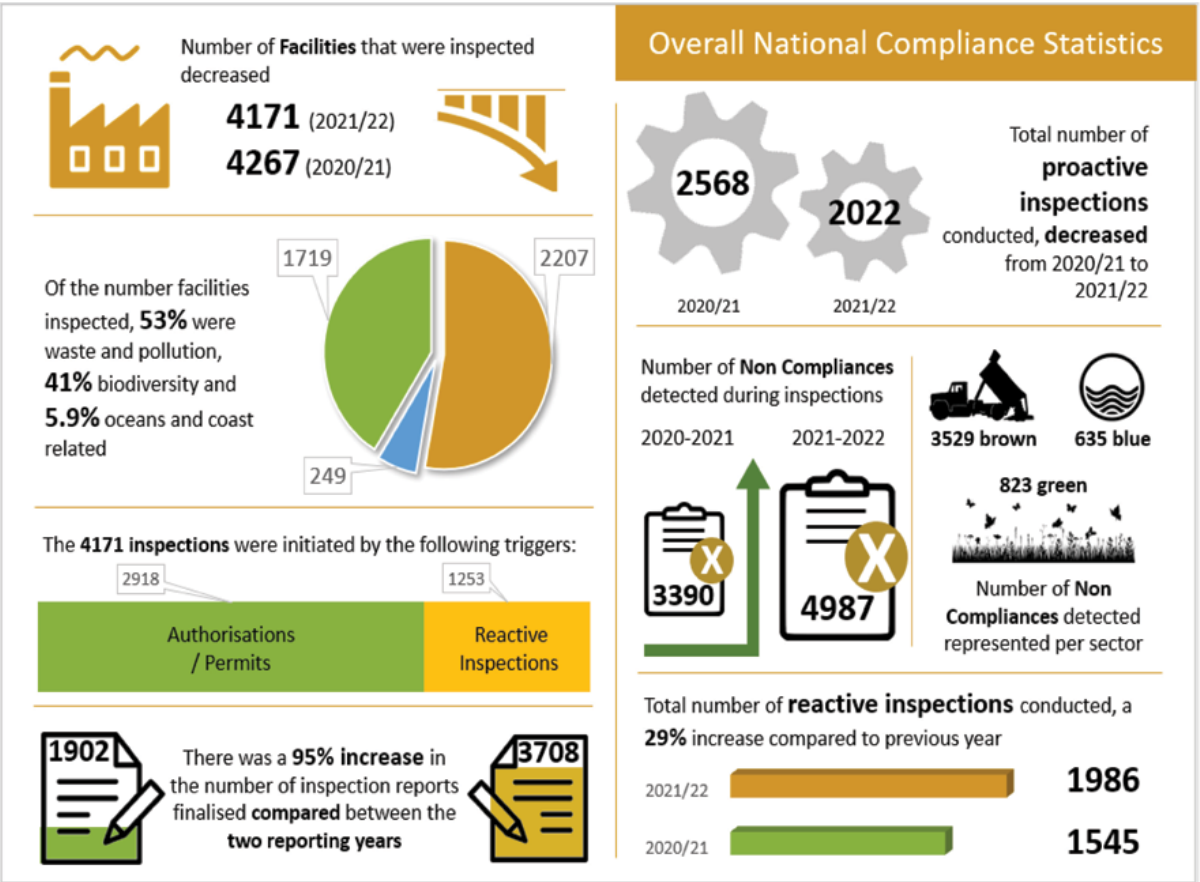


Figure: Summary of overall national compliance statistics 1 April 2021 to 30 March 2022

8.7 Oceans and coasts

Shortly before the first democratic elections in 1994, the Department Forestry, Fisheries and the Environment embarked on an inclusive policy formulation process that would transform the way Integrated Coastal Management (ICM) was conceptualised and implemented in South Africa. During the first phase of this process an independent facilitator was appointed to enter into bilateral discussions with key stakeholders, including the then extra-parliamentary groupings, such as the ANC. The first few workshops focused on gaining agreement on the process to be followed and the "rules of the game". It was agreed that the development of a Coastal Management Policy should be inclusive and participatory, holistic and interdisciplinary, and be based on robust scientific information. With support from DFID in the United Kingdom, a participatory policy formulation process was initiated that culminated in the publication of the Coastal White Paper in 2000. This policy process was characterised by active engagement of government, private sector and civil society stakeholders and called for a people-centred, holistic and integrated approach to coastal governance.

The policy process was overseen by a Policy Committee comprising representatives from government and civil society, while a project management team was appointed to oversee the management of the policy formulation process including research activities, workshops with experts, an extensive public consultation process, capacity development and training as well as the translation of the various inputs into a coastal policy document. This approach was guided by new developments in the ICM international arena as well as imperatives in the new South African Constitution, that requires redress, participation in decision-making, promotion of equity and social justice, co-operative governance and "securing ecologically sustainable development and use of natural resources while promoting justifiable economic and social development" see the Environmental Right. The vision for the coast, as articulated in the Coastal White Paper, captures the spirit of this new approach to ICM and the expectations of all stakeholders involved in the process. The final Coastal White Paper was promulgated in 2000 and received significant media attention and support from key political players. This document contained a clear set of principles, goals and objectives as well as Plan of Action to implement the policy. Key to taking the process forward was the development of a legal and institutional framework to give effect to the Coastal White Paper. Other elements of the Plan included: 1) development and implementation of awareness raising, training and education programmes; 2) determination of information needs in relation to monitoring, information and decision-support systems and research; and 3) identification of projects to address priority issues and implementation of local demonstration projects.

The approach to ICM articulated in the Coastal White Paper required the development of a new Coastal Management Act. Consultants were consequently appointed to prepare a draft Bill. Although the first draft of a Coastal Management Bill was submitted to the Department of Environmental Affairs and Tourism (DEAT) in 2001, the process of finalising this Bill took eight years and involved several iterations before being finally adopted by parliament in 2008. There were two key reasons for the delay in promulgating this Act. First, during this time there were many laws, including several environmental laws, going through the parliamentary process and finalisation of the ICM Bill was not considered an immediate priority. Second, there were different interpretations of the White Paper principles especially with regard to public participation, co-operative governance, accountability and responsibility and how these should be articulated in the Bill. DEAT was concerned that the inclusion of these principles in the ICM Bill, would frustrate effective coastal management and insisted on their removal from the Bill and included greater decision-making powers at the national level. These differences of opinion, as well as numerous public comments received on the various iterations of the Bill, led to a protracted law-making process that culminated in the promulgation of the National Environmental Management: Integrated Coastal Management Act No. 24 of 2008 (ICM Act) in 2008.

The Objects of the Act, provide a very clear indication of a fundamental paradigm shift to ICM requiring: 1) determination of the coastal zone; 2) co-ordinated and integrated management of the coastal zone based on the principles of co-operative governance; 3) protection, extension and enhancement of the status of coastal public property to be held in trust by the state on behalf of all South Africans; 4) securing equitable access to the opportunities and benefits of [coastal public property]; and 5) giving effect to South Africa's international obligations in terms of international law regarding coastal management and the marine environment. What is noticeable about the ICM Act is the focus on the public nature of the coast, the intention to extend and enhance equitable access to the coastal commons, while simultaneously protecting the ecological integrity of the coast. Governance under this new paradigm requires co-ordination and integration across all sectors and role-players as well as co-operation across all spheres of government.

An innovative provision in the ICM Act is that it clarifies what comprises the coastal zone, as well as the purpose and legal status of these zones and articulates the responsibilities of different spheres of government in managing the different components of the coast. A key progressive feature of the ICM Act is thus the clarification of what comprises coastal public property (CPP) and the mechanisms for declaring and extending such property to give effect to objects of the Act. The declaration and extension of coastal public property confirms government's commitment to improve public access to coastal areas, to secure the natural functioning of coastal processes and protect people, property and economic activities from coastal risks. The ICM Amendment Act no. 36 of 2014 see the ICM Act Information Sheet further strengthened this provision by including a section that clarifies the purpose of CPP. While the Act vests ownership of CPP in the people of South Africa, the state is required to act as the custodian of this space for present and future generations. It stresses that "coastal public property is inalienable and cannot be sold, attached or acquired by prescription…" while committing the state to … "ensure that coastal public property is used, managed, protected, conserved and enhanced in the interests of the whole community". To ensure access is enhanced, municipalities have been tasked with the identification and declaration of coastal access land, through for example the declaration of public servitudes on land adjacent to CPP in their areas of jurisdiction which should then be incorporated into municipal zoning schemes and other local planning documents (e.g. Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs)). While the emphasis is on enhancing public access to CPP, this access must be undertaken with due care of the environment, and should not affect the rights of other users, or hinder the state in the course of performing their functions. In order to ensure improved access to, and along the coast, the ICM Amendment Act no. 36 of 2014 empowered the provincial Members of Executive Councils (MECs – provincial environmental "Ministers") and the national environmental Minister to intervene if necessary. In addition, the national Minister has the power to extend CPP by incorporating additional parcels of coastal state land into CPP. Clearly, regarding the coast as a national asset and enhancing access to the coast for all the people of South Africa are foundational principles of this Act.

Further mechanisms in the ICM Act to protect and enhance the status of CPP include the establishment of a coastal protection zone (CPZ) (generally 100 m landward of the high water mark (HWM) in urban areas and 1000 m in rural areas, but also inclusive of dynamic coastal areas, coastal protected areas and private properties under the HWM which is designed to ensure protection of sensitive coastal environments as well as protection of people and property from risks and hazards. The establishment of coastal management lines to, amongst others, protect property and public safety and the CPZ, and to preserve the aesthetic value of the coastal zone is a further mechanism to protect vulnerable socio-ecological systems from natural hazards and inappropriate human intervention. A further innovative mechanism is the provision for the declaration of special management areas (SMAs) - those areas requiring alternative management approaches such as local coastal areas where management by local communities would be appropriate.

Another progressive and innovative provision in the Act is the development and implementation of Coastal Management Programmes (CMPs) - giving effect to the goals and objectives in the Coastal White Paper concerned with coastal planning and development. CMPs are intended to provide policy direction and a clear framework for promoting and achieving integrated and effective coastal management. The ICM Act requires CMPs to be developed by all spheres of government within four years of promulgation of the Act. The Act sets out what components must be included in the CMP, including a vision, objectives as well as priorities and strategies to achieve the objectives, performance indicators, norms and standards as well as the clarification of roles and responsibilities of different governance actors to enable co-operative governance. Furthermore, the ICM Act requires alignment between the CMPs and other national programmes and plans (e.g. National Biodiversity Framework, National Estuarine Management Protocol), provincial plans (e.g. Provincial Growth and Development Strategies) and local plans (e.g. IDPs). In addition, local land-use schemes must conform to local CMPs.

The ICM Act also deals with the integrated management of estuaries and the publication of a National Estuarine Management Protocol to guide development of estuarine management plans. This is a particularly important inclusion in the Act given the value of estuaries and the fact that there are approximately 250 - 300 functional estuaries in South Africa, depending on what criteria are used. Prior to the ICM Act the responsibility for estuarine management was unclear and uncoordinated, and decisions regarding use and development of estuarine resources and environments were taken by different sector departments (e.g. water, fisheries, agriculture) or by the relevant provincial planning and conservation departments. According to the ICM Act, estuaries are an integral part of the coastal zone and "must be managed in a co-ordinated and efficient manner and in accordance with a National Estuarine Management Protocol". This Protocol was gazetted in 2013 and guidelines for the development and implementation of estuarine management plans (EMPs) were published in 2015. A key requirement of this Protocol is the involvement of the public in the development of EMPs.

In terms of ensuring the protection of the coastal environment, the ICM Act contains provisions that require adoption of the “duty of care”, “avoidance of adverse impacts” and “remediation of environmental damage” principles. It requires the application of the National Environmental Management Act No. 107 of 1989 (NEMA) provisions that deals with the “duty of care” and “remediation of environmental damage” but extends these to include activities that may cause significant pollution and degradation of the coastal environment. If the Minister or MEC considers an activity or proposed activity to be harmful to the environment, he or she may issue a coastal protection notice prohibiting the action or may require steps to be taken to protect the environment or conduct an environmental impact assessment to be undertaken. In urgent cases where there is an immediate risk to the public, property or a potentially significant harm to the environment, the Minister or MEC may issue a verbal directive to stop an activity (followed by a subsequent notice). Furthermore, the Minister or MEC may issue written notices requiring the repair or removal of structures that are inappropriately located, in a state of disrepair, abandoned or have been developed in contravention of the ICM Act or other relevant law. This provision has far-reaching implications for the many residential structures, holiday cottages, informal structures and infrastructure that have been developed in the coastal zone without proper planning permission.

The ICM Act established an integrated regime for regulation of the disposal of effluent and waste into estuaries and the sea, including prohibiting incineration at sea and restricting dumping at sea in accordance with international best practice. In addition, it calls for a review of all coastal and estuarine effluent discharges within five years of the promulgation of the ICM Act. The Coastal White Paper proposed a National ICM coordinating structure and this was subsequently incorporated as the National Coastal Committee (NCC) in the ICM Act. In terms of the Act, the main purpose of the NCC was to promote integration of coastal management concerns and objectives and advance effective co-operative governance by co-ordinating the effective implementation of the Act. However, the department of environment’s concerns about delays and possible conflicts associated with civil society’s involvement in the multi-stakeholder fora, led to a decision not to appoint a NCC. Instead, it was decided that the existing Minister and MECs co-ordinating structures (MINMEC), Mintech and Mintech Working Groups would fulfil this function. In practice this meant that Working Group 8 (the “Oceans and Coasts Working Group” of Mintech) would function as an unofficial “NCC”. A proposal to scrap the NCC was consequently included in the ICM Amendments Bill, but this was not supported during the parliamentary process. This means that the national Minister of Environmental Affairs must still appoint a NCC and determine their powers. The ICM Act does not stipulate a time frame for this. As the NCC has not yet been appointed, there is currently no annual report submitted to the Minister and tabled in parliament as envisaged in the ICM Act. During the Coastal White Paper formulation process, Provincial Coastal Co-ordinators were appointed to support stakeholder engagement and assist with implementation of aspects of the Coastal White Paper Action Plan, including implementation of the Sustainable Coastal Livelihoods Programme (SCLP). Since the promulgation of the ICM Act in 2008, the Premiers of all coastal provinces have designated lead agencies for ICM and MECs responsible for environmental matters have appointed Provincial Coastal Committees (PCCs). While PCCs had been established in all provinces by 2016, the operational efficiency and effectiveness of these committees are highly variable across the provinces and depend on leadership, capacity, resources and the length of time established. One of the main functions of these committees has been to provide a forum where activities impacting on the coast and new development proposals, plans, and programmes can be discussed and recommendations made. Furthermore, the forum provides a space where challenges to implementing the provisions of the Act can be explored and knowledge and views of coastal managers and other stakeholders can be shared.

Although not mandatory, establishment of local coastal committees was considered desirable to promote ICM at the local level and facilitate co-operative governance. The ICM Act empowers municipalities to establish such committees, but in practice very few local coastal committees have been established and only the larger coastal metropolitan areas, and some district municipalities, have made progress with developing local coastal management programmes. Lack of capacity and resources and too many other priorities were identified by local authorities as the major challenges to implementing requirements of the ICM Act.

With respect to giving effect to the Coastal White Paper and provisions in the ICM Act, significant progress has clearly been made. This section focuses on progress with respect to implementing some of the progressive provisions described above. Firstly, with respect to delineating a geographical area that comprises coastal public property, the national Department Forestry, Fisheries and the Environment has been engaged in an audit of all state owned land in the coastal zone over the past few years. This has been a difficult exercise due to the fact that the Department of Public Works (the custodians of state land and assets) has an incomplete record of state owned land and in some cases the status of land ownership is unclear. In order to clarify ownership, the state needs to undertake a systematic coast-wide process of verification of all the parcels of public land (e.g. under control of parastatals, commonage in municipal areas, etc.) and private properties. This process has started in the Western Cape Province and will be expanded to the other three coastal provinces over the next few years. Furthermore, the allocation of parcels of valuable state property for public use is not necessarily supported by all governance actors who regard such public land as a means of generating much needed revenue from rates and taxes. Some parastatals have sold or developed such land to boost their coffers, even though it is not their core business.

Despite these constraints, a Coastal Viewer has been developed which spatially represents a number of datasets relating to the coast, indicating the extent of coastal public property and the boundaries of this area is being prepared, but there are gaps in the data relating state land, admiralty reserve and mining activities that are currently being addressed. The purpose of this exercise is to clarify the extent of CPP and enable a strategic approach to expanding the coastal estate, as well as providing a baseline from which to determine appropriate coastal access opportunities. In addition, it will also serve as a buffer zone to coastal erosion associated with sea level rise. Consequently, very little progress has been made in terms of extending CPP and incorporating parcels of private and public land into this public zone. Research on progress on enhancing access to the coast since 1994 suggests that limited progress has been made in this regard. In fact, access to the coast is being curtailed in some areas by private landowners and developers of gated estates and residential golf estates through erecting fences, booms and gates that restrict public access to the coast, often illegally. Promoting exclusive use and access to coastal areas remains a selling point for many developers and undermines the intention of the law. Enhancing access to extensive parts of the Northern Cape coast, in areas that are currently, or were previously mined (but have now been decommissioned), also remains unresolved. Similarly, in terms of improving physical access to CPP, and declaring public access servitudes that can facilitate such access in perpetuity, and publishing by-laws to give effect to such access land, most local authorities have not met their obligations in terms of the ICM Act. To address this shortcoming, additional powers have been granted to MEC's and the Minister of Environment, Forestry and Fisheries in terms of the NEM: ICM Amendment Act, 2014 (Act No. 36 of 2014) to identify and declare such coastal access land. Furthermore, the practicalities of securing coastal access land for designation as public access servitudes is proving difficult. This is due in part to the many competing demands for coastal land, the Constitutional right that protects private property, and the lack of clarity with regard to negotiating such access on communal property.

However, a National Coastal Access Strategy as well as a Guide for the Designation and Management of Coastal Access in South Africa have recently been produced to provide strategic guidance to provincial and local authorities to enable the establishment and maintenance of coastal access in South Africa. In addition, the ICM Amendment

Act has simplified the process of establishing coastal access servitudes. The importance of enhancing and securing public access to the coast is a central feature of the ICM Act because of the key role that the coast and its resources can play in the transformation and development of the South African economy and society.

The main objectives of this strategy are thus to:

- Improve pedestrian access above the HWM;
- Improve infrastructure for access;
- Prevent exclusive use;
- Address conflicting rights between public interest, private property owners and communal and traditional users; and
- Minimise adverse impacts on the environment.

While these DEA publications provide guidance on enhancing coastal access and designating coastal access points and land, there are a number of priority actions that need to be undertaken by provincial lead agencies and local authorities (e.g. conducting inventories and assessments of the state of coastal access) before this process will show results. Thus while outputs in terms of strategies and guidelines have been produced, a significant amount of work is still required to gather information, identify potential access points and access land, formalise these in terms of the ICM Act, and put in place management, monitoring and reporting procedures to give effect to these provisions. In terms of protecting the coast, the ICM Act established a default Coastal Protection Zone (CPZ), but the vision was to follow a public process to refine this CPZ taking account of environmental sensitivities, socio-economic and other factors. While some of the larger coastal metropolitan areas (i.e. Cape Town and eThekwini) have made progress with refining the coastal protection zones and several local authorities have appointed consultants to determine set-back lines (now "management lines"), in general these requirements of the ICM Act have not been comprehensively implemented by most provinces and especially the smaller coastal municipalities. Local authorities indicated that they were overburdened with other responsibilities and lacked resources and capacity to tackle ICM functions. In terms of demarcating coastal management lines, one of the challenges has been concerns regarding the methodology employed to determine set-backs which has largely been a technical exercise based on biophysical factors with little consideration of socio-economic issues. Furthermore, in some coastal areas there has been strong opposition by local coastal communities and private land owners to this legal requirement, arguing that it impacts on property values and the local economy and that the views of local communities have not been adequately sought. With respect to special management areas, no such areas have been established largely due to lack of best practice examples in South Africa of where alternative management approaches are working successfully, and cost-implications. However, the Department has embarked on a process to develop guidelines that will assist in the process to identify, assess and apply for the designation of a special management area.

In terms of improving co-ordination and integration of planning in the coastal zone and addressing the spatial legacy of Apartheid, the Department Forestry, Fisheries and the Environment has recently published the National Coastal Management Programme (NCMP) of South Africa which provides a policy directive and framework for ICM. This framework articulates a set of components (e.g. vision and objectives, delineation of coastal boundaries etc.) and processes that must be adopted within the CMP and proposes an iterative and adaptive approach to planning and management. Hence these CMPs are reviewed and modified every five years. The NCMP also sets out a framework for enabling co-operative governance recognising that formal coastal management institutions must work collaboratively with other government institutions as well as business, civil society, research and professional institutions. Practical tools and clearer guidance regarding which legal provisions can be harnessed to advance the objects of the Act, have been captured in the form of management objectives and associated actions for the nine priority areas of the NCMP to ensure that tangible implementation outputs are achieved over the lifespan of any particular CMP.

Over the last four years, progress has been made with developing provincial CMPs and the Eastern and Western Cape have gazetted their CMPs (2013 and 2016 respectively). The KwaZulu-Natal and Northern Cape provinces both have draft CMPs which should be finalised and adopted in the 2019/2020 financial year. A few of the more capacitated municipalities have embarked on a process to develop local CMPs, mostly with assistance of consultants. However, limited progress has been made in terms of integrating local CMPs into other local planning instruments such as the IDPs, SDFs and zoning schemes. The practical realities facing local municipalities in terms of socio-economic development pressures, human capacity and resource constraints mean that CMPs are not regarded as a high priority for most coastal municipalities.

Progress has been made in terms of acting against illegal developments in the coastal zone. Surveillance and action against illegal structures along the Wild Coast of the Eastern Cape has resulted in excess of 75 structures and partially completed structures being removed using a combination of laws and often following lengthy court proceedings. This includes holiday cottages and informal structures built along the coast without formal planning permission and without payment of rental, rates or taxes to the relevant authorities. Similarly, in KwaZulu-Natal the iSimangaliso Wetland Park Authority have also removed a small number of illegal developments. To speed up this process the ICM Act now allows for the issuing of coastal protection notices, coastal access notices and repair and removal notices. This task is far from completed with the lack of resources and capacity identified as key constraints. Nevertheless, these bold steps by government signal a commitment to protect the coast, especially CPP, for current and future generations. However, cooperation across all relevant departments and spheres of government is needed for this vision to be realised.

The development of estuarine management plans (EMPs) has been progressing steadily since 2008, when the conservation agency in the Cape Province under the auspices of the Cape Action Plan for the Environment's (C.A.P.E.) Regional Estuarine Management Programme appointed consultants to develop management plans for priority estuaries through funding obtained from the Global Environmental Facility (GEF). Thereafter, other ICM and conservation agencies have appointed consultants to prepare EMPs for selected estuaries. Several of these EMPs were prepared prior to the promulgation of the National Estuarine Management Protocol. The Protocol provides guidance regarding components that must be included in the plan, the process required to develop the plan as well as institutional arrangements to facilitate its implementation. To date, approximately 50 Estuarine Management Plans have been prepared, with 2 National EMPs and 2 Provincial EMPs having been approved by the Minister. Further, in some areas, EMPs have taken several years to complete due to concerns of coastal stakeholders regarding the consultation process and contents of draft EMPs. In addition, implementation has been delayed due to the need to ensure consistency with the Protocol and obtain formal endorsement from the relevant provincial MECs.

In terms of institutional arrangements for implementing the EMPs, the roles and responsibilities of different spheres of government are still being clarified through forums and committees that exist in the various provinces and districts. For example, in the Western Cape, several estuary management forums have been set up in the past, in terms of the C.A.P.E. programme and meet on a quarterly basis. These forums, although limited in terms of decision-making powers, play an important role in terms of co-ordinating activities of various governance actors (e.g. Department of Water Affairs, District municipality, local authority, local communities, surrounding farmers) involved in estuary management, including facilitating the sharing of information, providing a platform to raise issues and concerns, and jointly exploring solutions to problems. According to the Protocol, the municipal and/or

Provincial Coastal Committees, will be responsible for monitoring the implementation of EMPs and reporting on progress but these institutional details are still being clarified. However, there are concerns about the capacity and resources of local government to undertake these tasks and are currently undergoing an assessment of capability to fulfil the multitude of environmental mandates through the Department of Cooperative Governance and Traditional Affairs and the South African Local Government Association.

Since 1994, a number of awareness raising campaigns, educational initiatives and training programmes have been implemented. A key focus of these activities has been to raise awareness amongst coastal managers and other stakeholders about the value of the coast, the principles and approaches underpinning the Coastal White Paper and the requirements of the ICM Act. General public awareness programmes such as Coastwatch, Working for the Coast (WftC) and the Blue Flag beach campaign as well as public participation in the International Coastal Clean-up campaign have contributed to enhancing understanding of the importance of the coast and instilling a sense of responsibility amongst the public. Various educational materials have been produced targeting schools, NGOs and coastal management authorities (e.g. CoastCare Factsheets, A User-friendly Guide to the ICM Act of South Africa and several training courses for coastal managers have been implemented by the Department Forestry, Fisheries and the Environment and coastal provinces, and by universities and NGOs (e.g. UCT offered several professional short courses on ICM during the 1990s and the International Oceans Institute (IOI) currently offers an annual course on oceans and coastal management). In addition, through the coastal poverty alleviation initiatives, namely the Working for the Coast (WftC) Programme (previously CoastCare) (part of government's Expanded Public Works Programme), and the Sustainable Coastal Livelihoods Programme (SCLP), jobs were created and training and skills development courses were offered. As part of the WftC Programme over 40 000 people have received general ICM awareness training while several thousand have participated in skills development training, and are now better positioned to find alternative work.

Furthermore, the Department Forestry, Fisheries and the Environment released a National Strategy for Coastal Awareness, Education and Training for South Africa that aims to provide a framework for identification, development and implementation of a range of awareness raising, training and education initiatives. The aim is to promote a more co-ordinated and effective approach to ICM through raising awareness of the value of the coast, enhancing understanding of the ICM Act and strengthening management and governance capacity. Objectives to achieve these aims include providing internships, learnerships and bursaries for staff and students to build capacity of future managers, develop coastal learning materials for the school curriculum, and building partnerships with industry, NGOs and tertiary education and research institutions to support ICM education and training efforts. The NCMP stresses the importance of Awareness, Education and Training and while it can be argued that the Department Forestry, Fisheries and the Environment is in the process of developing programmes and initiatives to operationalise this strategy and implement this priority, the reality is that at the time of writing funding for these activities within the Department Forestry, Fisheries and the Environment budget was limited and no dedicated human resources had been assigned to this task. It would appear as if the priority focus given to awareness education and training immediately after the release of the Coastal White Paper has lost significant momentum and one can only hope that this crucial element will be afforded more priority in years to come.

As one of the responses within the NCMP to address the impacts of climate change, the National Coastal Assessment represents an important step for sustainable development in South Africa: contributing to the United Nations Agenda 2030 Sustainable Development Goals, the African Union Agenda 2063, The National Development Plan 2030 and the Implementation of South Africa's Coastal Management legislation and international obligations. The National Coastal Assessment focuses on identifying those areas of the coast that are most vulnerable to the effects of climate change and natural processes that have been exacerbated by human impacts, whilst simultaneously accounting for the needs of the public in terms of protection from these impacts and ensuring the safety of people and property along the coast. The benefits of this study, as well as the valuable decision making tools that will arise from the findings of the study, include:

- A better understanding of the specific effects on people, property and livelihoods along the coast;
- Improved decision-making on appropriate strategies and plans of action to ensure the protection of the environment, public safety, socio-economic prosperity and sustainable development;
- Enhanced ability to provide meaningful awareness to the public on the impacts of climate change on the lives and livelihoods;
- Facilitate better development planning along the coast, considering the trade-offs when making decisions on the maintenance of existing state infrastructure in vulnerable areas, as well as the development and placement of new state infrastructure to ensure the best use of state assets and expenditure;
- Provide valuable advice and guidance to coastal provinces and municipalities for taking action in implementing operational activities and exercising good governance along the coast.

8.7.1 Oceans and coastal research

The oceans constitute the largest component of the Earth's system and play a crucial role in stabilising climate and supporting life on earth and human well-being. However, as indicated by the United Nations' First World Ocean Assessment (released in 2016), much of the world's ocean is already severely degraded, with changes and losses in the structure, function and benefits from marine systems. Furthermore, with projected climate changes and human population growth, stressors on the ocean will intensify, not only in localised coastal regions with high human population densities, but also at a global scale. Thus, the Decade of Ocean Sciences for Sustainable Development (2021–2030) was proclaimed by the United Nations to support efforts to reverse the cycle of decline in ocean health and create improved conditions for sustainable development of ocean economies while conserving the ecosystem. In this decade, all countries are therefore urged to maintain and increase science investments in describing and understanding the ocean and the role it plays in the planet system.

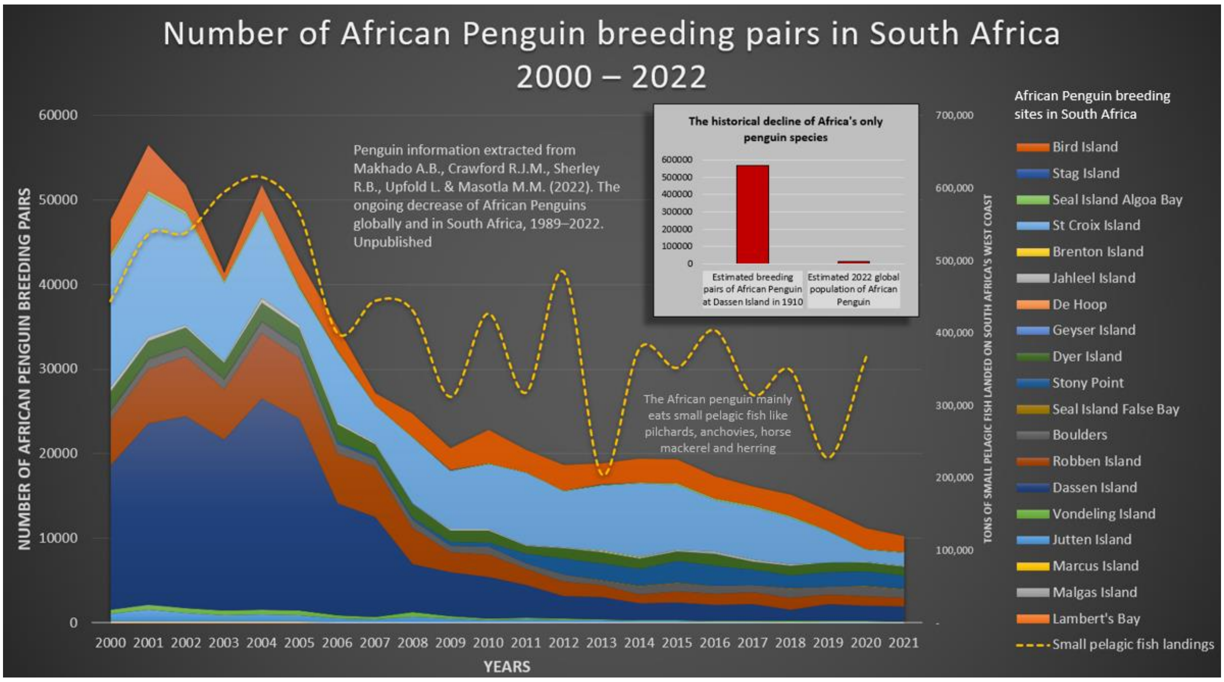
The Oceans and Coasts Annual Science Report (ASR), 2021, presents evidence of South Africa's ongoing investment in this regard. The 33 contributions (termed report cards) herein, report on research, monitoring and related activities of the Department of Forestry, Fisheries and the Environment's Chief Directorate: Oceans and Coastal Research (OC Research), in support of the Departmental mandate of conserving and managing South Africa's coastal and marine environment. The various science programmes of OC Research focus on a number of fundamental physical, chemical and biological aspects of oceans and coasts (including estuaries) and are guided by a medium- to long-term ecological research and monitoring plan that was developed for the period 2016–2030. This plan is focused mainly on describing and documenting marine and coastal biodiversity and complex ecosystem functioning and processes, to support the Department's ocean mandate.

Thus, the data and information products generated from the research and monitoring activities must ultimately be useful for informing managers and policy makers. Underlying the plan is the understanding that the most valuable scientific data collections or observations are those taken within a long-term context. However, within a framework of long-term programmatic work aimed at providing continuous or sustained observations (monitoring) and descriptions of key aspects of the marine environment, some shorter-term research elements are conducted as projects. Such projects allow for deeper understanding of marine ecosystems and processes. It is against this backdrop of continuous applied shallow and deep ocean science that staff are able to provide immediate and relevant management advice and recommendations. Such management advice is required on a range of historical issues such as fishing or shipping and new and emerging issues such as seismic surveys or where to place the increasing number of undersea internet cables.

8.7.1.1 *Monitoring programmes – The African penguin*

The population of the African penguin *Spheniscus demersus*, which is endemic to South Africa and Namibia, has declined substantially in the past 100 years, with the decline reaching precipitous proportions in the present century. Since 2010, the International Union for Conservation of Nature (IUCN) has classified the species as Endangered.

Of concern is that despite the implementation of several actions in terms of South Africa's Biodiversity Management Plan for the African Penguin, the population has continued to decline, albeit at a slower rate.



The decline is attributed to various factors including but not limited to availability of forage fish; oil spills, breeding habitat modification; extreme weathers and diseases.

The Department has gazetted a draft new Management Plan (2022) for the species to strengthen previously implemented actions; address emerging stressors such as marine traffic, ship-to-ship bunkering and petroleum exploration; enhance socio-economic benefits; and improve education and awareness. This is coupled with an independent expert international panel to advise on the management of the species.

According to the Report of the International Review Panel Regarding Fishing Closures Adjacent to South Africa's African Penguin Breeding Colonies and Declines in the Penguin Population, 2023, the African penguin, *Spheniscus demersus*, breeds only in Namibia and South Africa, where it is restricted to coastal waters, except over the Agulhas Bank where its preferred prey may occur further offshore.

The population of African penguins breeding in South Africa has been declining rapidly (approximately 8% per annum since 2005) and is consequently at a high risk of extinction in the wild in the coming decades. In this regard, considerable effort has been made by the fishing and conservation sectors in collaboration with government to understand the causes of the decline and how they might be mitigated. The Panel commends South Africa on its world-leading efforts to underpin challenging utilisation-conservation policy decisions with sound science.

Implementation of closures managed within the Island Closure Experiment (ICE) aimed to understand whether reducing fishing around islands with penguin breeding colonies would help to reduce the current rate of decline. This internationally-recognised experiment involved implementing an alternating pattern of closures around four island breeding colonies on the South African west and south coasts. It is now complete and, notwithstanding the difficulties implementing the experiment, has been successful in demonstrating for the west colonies of Dassen and Robben islands (those more intensively studied within the ICE), that excluding fishing around island breeding colonies is likely to reduce the rate of decline in the population to a small extent, mediated through improvements in reproductive success. Excluding purse-seine fishing around island breeding colonies is also likely to have other positive benefits for penguin conservation, such as facilitating higher adult survival, but the ICE was not designed to estimate such effects.

The Panel recognises that closure of purse-seine fisheries around penguin colonies will provide only a part of the measures required to slow or reverse the population decline of African penguins.

There is a trade-off amongst maximising benefits to penguins, minimising the costs to the fishing industry, and having a reliable basis to quantify the effects of closures (including no closures) on the penguin recovery rate. The trade-off among closure options is a policy decision related to conservation, economic and social goals and objectives for South Africa. This report outlines some aspects that could form part of a decision-making framework to identify the closure options that will provide the best outcomes for penguins given some level of cost to the fishing industry.

The effects of alternative fishery closure designs differ amongst the island breeding colonies, in terms of reducing the rate of decline, costs to the fishing industry, and social impacts. Hence, advice related to the effects of possible closure options is presented by island breeding colony, and not simply at the regional or national level; decisions on closures should also be made by colony, taking account of the unique aspects of the fishery and threats at each colony.

The impacts to the fishing industry can be evaluated using an “Opportunity-Based Model” (OBM) that predicts the proportion of the catch of pelagic fish in closure areas that cannot be “replaced” by fishing outside these areas, together with a Social Accounting Matrix (SAM) model that converts “lost catch” into economic impacts (loss of GDP and jobs) on the fishery, suppliers of goods and services to the fishing industry, and the broader economy. The OBM and SAM model can be used to rank closure options in terms of economic effects but the OBM likely overestimates the potential lost opportunities outside the closed area on a given day. The Panel remains concerned about: (i) the lack of information on how the closures impact fishing costs and fishing behaviour; (ii) the ability of the SAM model to adequately attribute impacts at the scale of fishing communities; and (iii) that there are social impacts that are not estimated using the SAM, but are important to consider in any trade-off analysis.

Evidence suggests that catches from within closure areas will be more difficult to replace around Dyer Island and St Croix Island than around the other remaining five colonies with important breeding populations. Evidence also suggests that levels of lost catch can be reduced, if closures around penguin preferred habitats are well designed.

The Panel identified (in this report) recommendations related to future monitoring of penguin colonies and research to understand the effects of closures on the change in penguin numbers and costs to the fishing industry and local communities.

Further attempts were made to identify consensus closure options among the fishing and conservation sectors during the Panel meeting and ongoing efforts to identify such options are encouraged, particularly as closures may need to be adjusted given the results of future monitoring.

The Panel strongly encouraged continued communication, and collaboration, with transparency of research data and analyses, as a means to build trust and strengthen these discussions. Working collaboratively will further enhance the effectiveness and social acceptability of management measures and decisions aimed at mitigating the decline of the African penguin.

8.7.1.2 Research highlights

Highlights of the latest 2022 Oceans and Coasts Annual Science Report include, but are not limited to (i) the detection of a three-week-long early retroflection of the Agulhas Current in May 2022; (ii) the establishment of a new plankton survey across the entire south Atlantic Ocean; and (iii) a recent recovery in the global Cape cormorant breeding population - in stark contrast to the African penguin which continues its downward trend. Key 'science to policy' topics include the need for foundational science to investigate the potential effects of seismic surveys on marine ecosystems, and a recent evaluation of the governance and management of South Africa's Marine Protected Area (MPA) network.

Cape cormorants

According to the 2022 Annual Science Report, Cape cormorants (*Phalacrocorax capensis)* are endemic to the Benguela ecosystem, where they breed at numerous localities between Ilha dos Tigres in southern Angola, and Algoa Bay on South Africa's south coast. Historically, the breeding population was limited to South Africa and Namibia. The global breeding population of Cape cormorants decreased from ca. 275,000 pairs in 1978/79 to ca. 100,000 pairs in 2005/06, before recovering to ca. 190,000 pairs in 2020/21. In this period, numbers of breeding pairs in Namibia decreased by approximately 65% from ca. 143,000 pairs in 1978/79 to ca. 50,000 pairs in 2020/21. Similarly, the numbers in South Africa decreased by approximately 83%, from ca. 104,000 pairs to ca. 18,000 pairs. In both Namibia and South Africa, there were recent increases in the numbers of breeding pairs, with numbers in South Africa having reached a nadir in 2008/09, and Namibia in 2017/18. However, the recovery of the global population was mainly attributable to a substantial numerical increase at Ilha dos Tigres in southern Angola, which was first colonised in the 1990s. At Ilha dos Tigres, the population increased from ca. 2,600 pairs in 2005/06 to 95,000 pairs in 2020/21, showing a 92% increase in the annual growth rate. Whereas Cape cormorants were historically most abundant in Namibia with 62% of the breeding population, and the rest of the population occurred in South Africa, these countries now account for only 26% and 23% of the global population, respectively. Currently, >50% of the population breed in Angola, meaning that there has been a substantial northwards shift in the distribution of the breeding population.

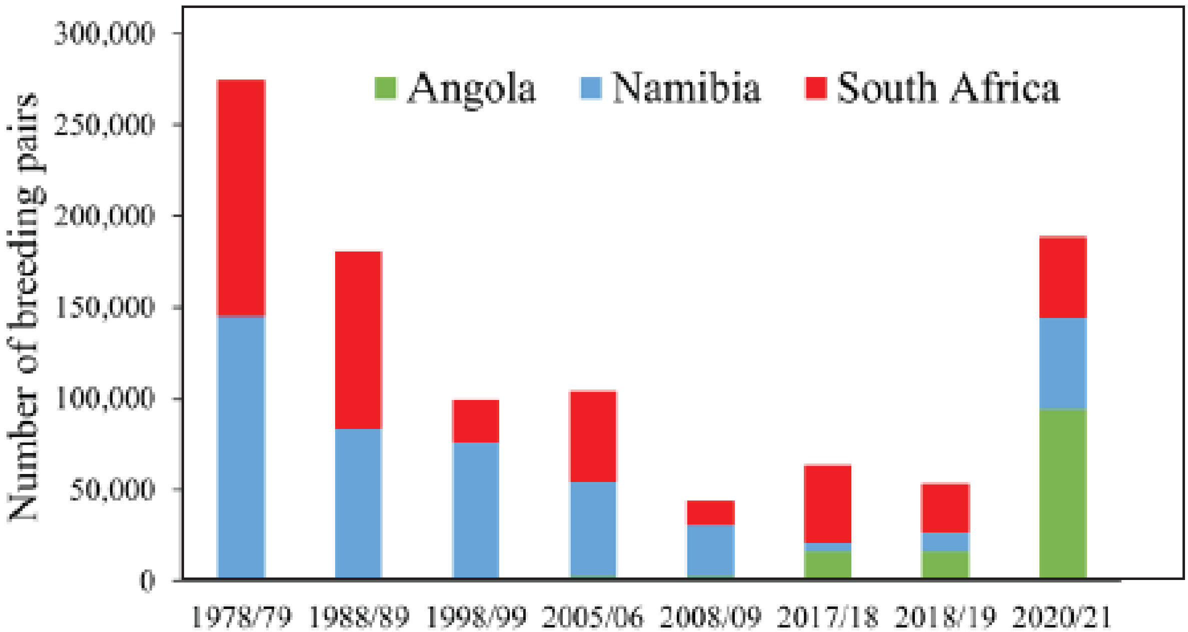


Figure: Numbers of Cape cormorants breeding in Angola, Namibia and South Africa, between 1978 and 2020

The declines in South Africa and Namibia have been attributed largely to food scarcity. In South Africa, this is related to an eastward shift in the distributions of forage fish (anchovy *Engraulis capensis* and sardine *Sardinops sagax*), with reduced prey on the west coast where the majority of Cape cormorants occur in the country. Fishing pressure and environmental changes have resulted in low prey availability in the northern Benguela, which largely coincides with Namibia. Besides food scarcity, other stressors such as disease (avian flu has caused mortality of over 25,000 individuals), predation (e.g. by Cape fur seals *Arctocephalus pusillus pusillus*, and kelp gulls *Larus dominicus*), human disturbance, and oil spills have also affected the populations.

The increase of Cape cormorants in southern Angola and their associated northward distributional shift coincided with the shift of Cape fur seals into northern Namibia and southern Angola. Apart from the abundant breeding space afforded by Ilha dos Tigres, the attraction for these important top predator species is almost certainly prey availability in this region. In particular, the horse mackerel *Trachurus capensis* stock in the region has shown recovery, with good fisheries catches reported for northern Namibia and Angola, thus providing an abundant prey resource for these predators. If the recent incline of the Cape cormorant population endures, its Endangered status may be down-listed, globally. Currently, Endangered or Vulnerable status is applicable at national levels for South Africa and Namibia, respectively.

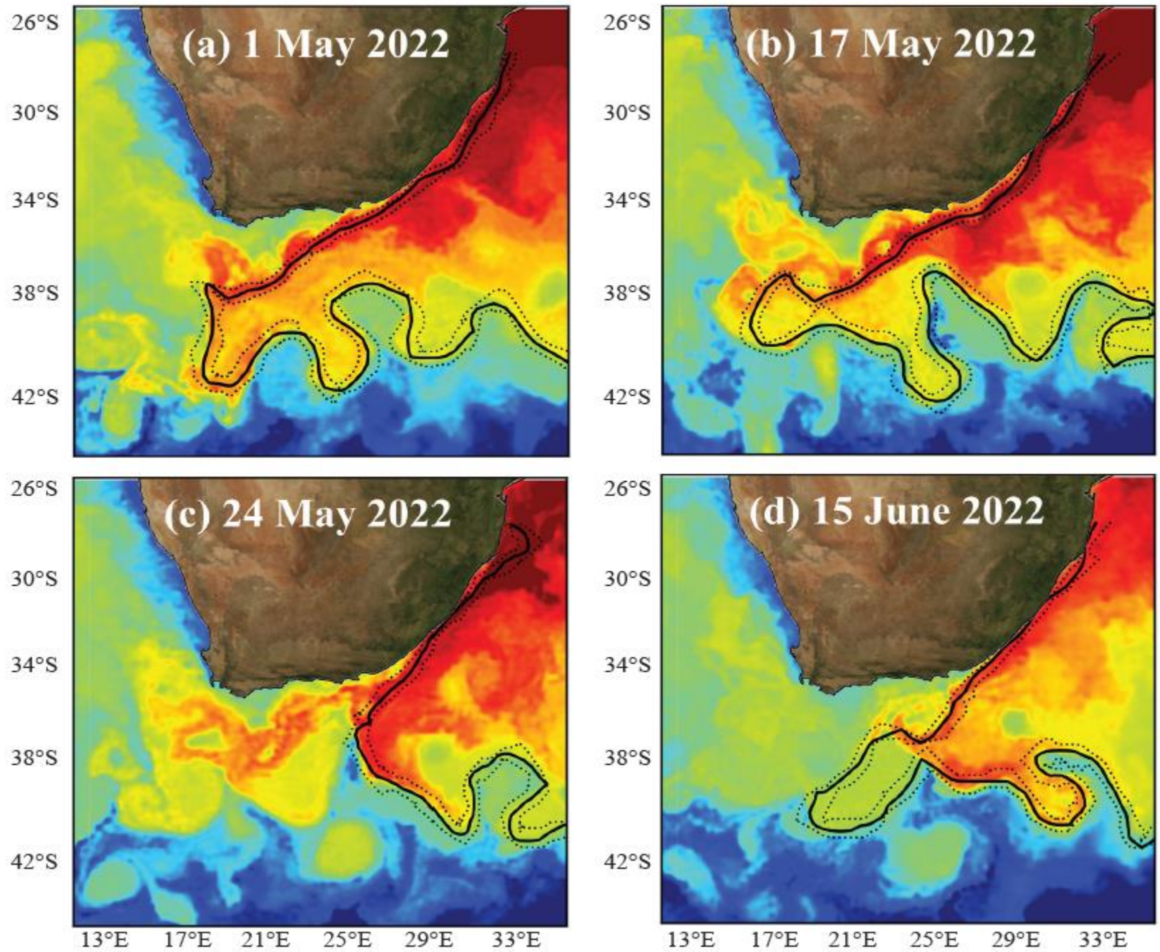


Figure: Location of the Agulhas Current (AC) system, including the core (solid black line) and edges (dotted black lines) of the AC, the Agulhas Retroflection, and the Agulhas Return Current, identified using the LACCE monitoring tool and overlaid onto maps of daily near-real time Sea Surface Temperature. (a) A typical formation of the AC system, (b) the inception of an early retroflection, (c) a fully established early retroflection, and (d) the end of the early retroflection.

An extreme detour of the Agulhas current

The Agulhas Current (AC) is the strongest Western Boundary Current in the Southern Hemisphere. Flowing poleward along the east and south coasts, the Current transports warm, salty water from the Indian Ocean to the Atlantic Ocean, and directly influences regional weather and commercial fisheries for anchovy.

A monitoring tool that uses satellite altimetry data to track the location of the Current detected an early retroflection in May 2022, with the Current changing direction much further east than usual. The effects of this relatively rare and 22-day-long extreme event require further investigation but include potential offshore advection and loss of marine biota from the Agulhas Bank ecosystem.

Coastal water pollution: a snapshot on heavy and trace metals

The Department of Forestry, Fisheries and the Environment with its partners has recently established two projects to monitor pollution at several sites across the Western Cape. Black mussels were tested for trace and heavy metal concentrations, and mussels and sediment samples were tested for microplastics at locations within False Bay, Table Bay and Saldanha Bay.

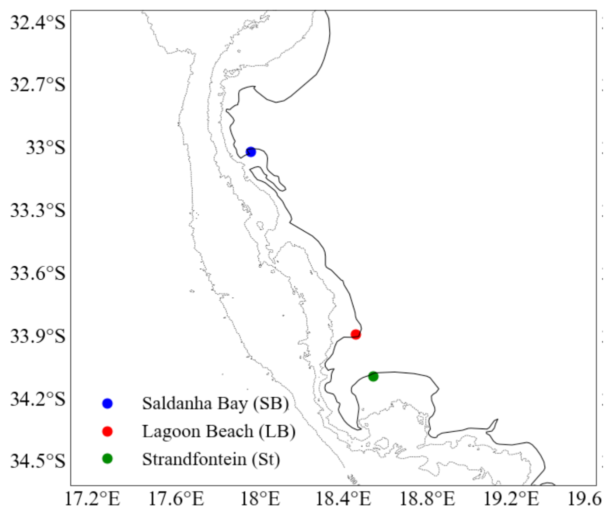


Figure: Map showing the three sampling sites

The discharge of metal pollutants (heavy and trace metals) into the marine environments, where they accumulate and result in toxicity, is a global concern. Metals such as iron (Fe), zinc (Zn) and manganese (Mn) are essential elements but may be toxic to humans if consumed in excess (e.g. in seafood). Mercury (Hg), arsenic (As) and cadmium (Cd) are nonessential elements because of their toxicity, even in trace (small) amounts. Mussels are popular shellfish that are used widely as bio-indicators of trace and heavy metal pollution or toxicity in coastal marine environments.

The metal concentrations were comparable with past recorded values reported for these sites. However, Zn concentrations recorded at Saldanha Bay in early summer and Cd concentrations at all sites were slightly higher than the South African permissible legal limits for these elements in shellfish, (300 µg g-1 and 3 µg g-1, respectively). The sources of such high levels of metal pollutants require further investigation. Monitoring will be continued and eventually extended to other hot-spot sites along the South African coastline, subject to sufficient funding and capacity.

8.7.1.3 Technologies and innovations

On a larger spatial scale, the location of the Agulhas Current's Core and Edges (LACCE) is an OCIMS decision support tool that uses satellite data to monitor the Agulhas Current. LACCE was validated during a voyage to Marion Island in 2022, with in situ measurements of surface temperature and current speed shown to correspond well to LACCE-identified features, including the core and edges, of the Agulhas Current and Agulhas Return Current. A new protocol for the digital image analysis of preserved mesozooplankton was developed and tested. Larger organisms (>0.5 mm) are analysed using the ZooScan, while smaller organisms (<0.5 mm) are analysed using the FlowCam. This method produced better-quality images for organisms in both size ranges and was more representative of all taxa present in the water column. This in-house protocol has been instated as the standard operating procedure to provide a digital archive of zooplankton taxonomic identification for the west coast of South Africa.

8.7.1.4 Training and outreach

The Physical Oceanography group, together with Cape Peninsula University of Technology (CPUT) Marine Science lecturers, hosted an outreach and training event for CPUT Marine Sciences National Diploma learners in the second year of their studies. A wide range of instruments commonly used by physical oceanographers was demonstrated to the learners, exposing them to some of the practical aspects of the technical work and scientific research conducted at the Department of Forestry, Fishieres and the Environment (DFFE), and hopefully stimulating their interest in the marine environment and technologies used in this field.

Figure: Selected photographs highlighting the technical training workshop

Younger learners were targeted during the 'Adopt-a-float' initiative, which aims to inspire and educate students of all ages about global ocean biogeochemistry and climate change. The DFFE Oceans and Coasts Research Physical Oceanography team deployed five profiling biogeochemical floats in the Southern Ocean, each of which was 'adopted', named, and tracked online by a school in the USA.

8.7.2 The Antarctic and Southern Ocean Strategy for South Africa

Cabinet has approved South Africa's Antarctic and Southern Ocean Strategy (ASOS) to provide for the coordination and implementation of the Antarctic Treaties Act, relating to research, conservation, sustainable resource use and environmental management in support of the African agenda. The ASOS was approved by Cabinet on Wednesday, 02 December 2020, the day after the world commemorated Antarctica Day, which marked the 61st anniversary of the signing of the Antarctic Treaty. The Treaty set aside almost 10 percent of the Earth "forever to be used exclusively for peaceful purposes and in the interests of all humanity." Antarctica Day is not only a celebration of this important event, but also serves to highlight how diverse nations continue to work together peacefully using science as a common language for co-operation and stewardship of this global commons.

The South Africa's Southern Ocean and Antarctic Strategy outlines the national interests for the continued participation in the Antarctic Treaty and sets out the vision that "Antarctica and the Southern Ocean are understood, valued, and protected in the interest of South Africa, Africa and the world," which is in line with the founding principles of protecting Antarctica as set out by the original signatories to the Treaty. Antarctica is the coldest, driest, and windiest continent; and is separated from the mainland by the Southern Ocean. The Southern Ocean is the world's most biologically productive ocean and a significant sink for both heat and carbon dioxide, making it critical to the evolution of past, present, and future climate change. The Antarctic Treaty area is thus one of the last remaining jewels of the Earth with minimal anthropogenic influence or impact, and thus ideal outdoor scientific laboratory for all sorts of research, e.g. climate variability, bioprospecting / study of extremophiles (for medicinal – health, food production – agriculture) oceanography, drought and geological sciences.

The Strategy is the product of extensive engagement with key stakeholders, including the key government departments (and their entities) that are partners in the South Africa's National Antarctic Program, namely; the Department of Science and Innovation; Department of International Relations and Coordination; Department of Public Works and Infrastructure; Department of Transport. The Department of Forestry, Fisheries and the Environment also engaged newly identified role players in the space, namely: The Agricultural Research Council, Medical Research Council, Human Science Research Council, and others. In addition, a public notice about the Strategy being open for public comments over a period of 60 days was published in two national newspapers. The strategy outlines an extensive implementation plan over the next five-year (2021-2025) period. Subsequent to the approval by Cabinet for implementation of the strategy, the Department will make the document available through a gazette notice and conduct a series of workshops to inform and engage stakeholders/ role players on its implementation.

8.7.3 The amended National Estuarine Management Protocol

The Department of Forestry, Fisheries and the Environment has published the final amendments to the National Estuarine Management Protocol (the Protocol) in terms of section 53 of the National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008).The amendments address implementation issues and the impact of the 2016 Supreme Court of Appeal judgement in Abbott v Overstrand Municipality, which found that the assignment of functions to municipalities in the existing Protocol presented Constitutional challenges as the assignment should have been done in terms of Integrated Coastal Management Act, and not the Protocol.

To address the unconstitutionality of the Protocol, the Department went through an extensive stakeholder consultation that culminated to an agreement to amend the following paragraphs of the Protocol:

- Paragraph 5: to assign the provincial environmental department as responsible management authorities to develop estuarine management plans and coordinate the implementation of the Environmental Management Plans (EMPs) in consultation with the affected local and district municipalities. Provinces may enter into agreements with municipalities willing to take the function of developing the EMPs in terms of the 156 (4) of the Constitution and continue with the estuarine management function.
- Paragraph 9.1: the approval of the EMP developed by the provincial lead agencies shall be approved by the MEC and where the EMP is developed by the national conservation agency or the Department, it must be approved by the Minister.
- Paragraph 9.2 considers the effective implementation of the EMP by ensuring that once it is approved, it must be integrated to the CMPs, IDP, SDF and Protected Areas Management Plans.

The Department will host a workshop with the responsible management authorities on the implementation of the amended Protocol with respect to the development of EMPs and coordination of implementation thereof.

8.7.4 The coastal vulnerability study

As one of the responses within the National Coastal Management Programme (NCMP)is to address the impacts of climate change. The National Coastal Assessment and Coastal Vulnerability Study represents an important step for sustainable development in South Africa: contributing to the United Nations Agenda 2030 Sustainable Development Goals, the African Union Agenda 2063, The National Development Plan 2030 and the Implementation of South Africa's Coastal Management legislation and international obligations. The National Coastal Assessment focuses on identifying those areas of the coast that are most vulnerable to the effects of climate change and natural processes that have been exacerbated by human impacts, whilst simultaneously accounting for the needs of the public in terms of protection from these impacts and ensuring the safety of people and property along the coast. The benefits of this study, as well as the valuable decision making tools that will arise from the findings of the study, include:

- A better understanding of the specific effects on people, property and livelihoods along the coast;
- Improved decision-making on appropriate strategies and plans of action to ensure the protection of the environment, public safety, socio-economic prosperity and sustainable development;
- Enhanced ability to provide meaningful awareness to the public on the impacts of climate change on the lives and livelihoods;
- Facilitate better development planning along the coast, taking into account the trade-offs when making decisions on the maintenance of existing state infrastructure in vulnerable areas, as well as the development and placement of new state infrastructure to ensure the best use of state assets and expenditure;
- Provide valuable advice and guidance to coastal provinces and municipalities for taking action in implementing operational activities and exercising good governance along the coast.

Currently, approximately 60 percent of the world's 39 metropolises, with populations exceeding 5 million people, are located within 100km of the coastline. These include 12 of the world's 16 cities with populations greater than 10 million. Apart from providing a wealth of natural resources and opportunities for livelihoods and economies, the proximity to the ocean also poses a major threat to humans in form of flooding and erosion as a result of storm events, cyclones, spring tides and tsunamis. Climate change, with an expected increase in storm frequency and severity, as well as projected sea level rise and population increase in the coastal zone, further exacerbates the expected damage to infrastructure and the vulnerability of coastal population through coastal flooding and land loss.

Contemporary coastal management aims to integrate coastal human activities, the integrity of the natural biological environment and the natural dynamics of the physical coast, with an increasing emphasis on future climate change scenarios and population trends. However, the lack of a clear understanding of exact and locally explicit consequences frequently hampers the development of climate change adaptation actions, especially at a scale suitable for implementation at a local level. In order to provide high-level guidance to this challenge, the South African Department of Forestry, Fisheries and the Environment (DFFE) has published the National Climate Change Adaptation Strategy (NCCSA). This strategy (NCCAS) acts as a common reference point for climate change adaptation efforts in South Africa, and provides a platform upon which national climate change adaptation objectives for the country can be articulated so as to provide overarching guidance to all sectors of the economy. The National Coastal Management Programme highlighted significant knowledge gaps in coastal adaptation responses to climate change. As such, DFFE is conducting a national coastal climate change vulnerability assessment and developing a decision support tool that can provide a spatially explicit information baseline for climate change responses for all levels of government.

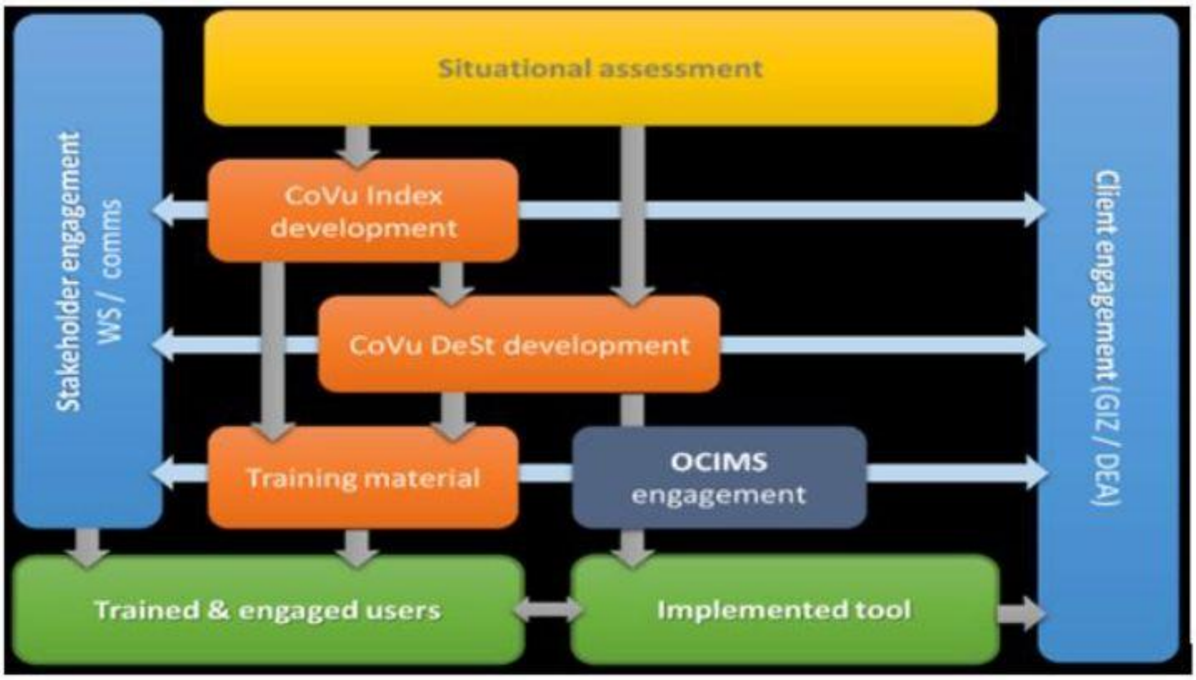


Figure: Overview of the National Coastal Spatial Vulnerability Index (CoVu Index) project for South Africa's coastline and estuaries for physical hazards attributable to climate change

In April 2019, a technical project was initiated to develop a National Coastal Spatial Vulnerability Index (CoVu Index) for South Africa's coastline and estuaries for physical hazards attributable to climate change, such as sea level rise, flooding, erosion or storm events. The resulting Coastal Flood and Erosion Indices are to be embedded in a Decision Support Tool (DeST) to allow coastal managers to interact with the CoVu indices – on a nationally aligned and locally relevant scale – within respective relevant management contexts and to enable decision making on adaptation options and strategies. The project was structured in several interrelated phases and core activities (see below graph).

Based on the outcome of the situational assessment, the coastal flood and erosion vulnerability indices were developed, and the CoVu DeST was designed to package these indices for stakeholder use. Concurrent to these activities, training material for the correct use of the DeST was developed, in order to ensure the optimal usage of the DeST beyond the duration of this project. Further, engagement with DFFE's Oceans and Coasts Information Management System (OCIMS) was undertaken. OCIMS is envisaged as one of the potential platforms to house and use the derived indices and the DeST for future applications. The final envisaged outputs and outcomes of this project are intended for local government officials that are trained in the usage and interpretation of the developed vulnerability indices and tools, and an implemented DeST for improved planning and decision making.

8.7.5 Marine spatial planning

According to National Data and Information Report for Marine Spatial Planning, 2021 as a response, and as part of the Operation Phakisa: Oceans Economy initiative which seeks to unlock the economic potential of South Africa's oceans, South Africa is now implementing marine spatial planning as an approach to improving the rational planning, management and governance of the ocean space and marine resources over which it has jurisdiction. The marine spatial planning entails sustainable ocean development planning. It is a planning approach for marine areas which more coherently organizes the use of space with the aim to guide single-sector decision-making and provide for comprehensive, integrated and complementary planning and management.

South Africa defines marine spatial planning as the governance process of collaboratively assessing and managing the spatial and temporal distribution of human activities to achieve economic, social and ecological objectives.

For South Africa, marine spatial planning offers a practical way to address both specific challenges and select appropriate management strategies to maintain a good status of ecosystem health that will, in turn, facilitate the advancement of national economic and socio-cultural development. Marine spatial planning is an emerging process that is being implemented by an increasing number of countries including South Africa, which is among the first countries on the African continent pursuing marine spatial planning.

8.7.5.1 Marine environmental monitoring and research

As a maritime nation with responsibility for about twice as much ocean as land, South Africa has a long history of marine monitoring and research. Monitoring and research activities are carried out throughout the South African coastline, in the marine area and on and around the Prince Edward Islands.

A number of organizations are involved in monitoring and research relating to the marine environment. Public authorities include but are not limited to the Department of Forestry Fisheries and the Environment (DFFE) and its associated parastatal, the South African National Biodiversity Institute (SANBI). Further marine research focused entities include the South African Environmental Observation Network (SAEON) and the South African Institute for Aquatic Biodiversity (SAIAB). There are further provincial authorities engaged in marine monitoring and research such as Cape Nature or Ezemvelo KZN Wildlife.

The Department of Science and Innovation (DSI) provides core funding to research entities such as academic affiliated institutions which include a number of universities such as the Nelson Mandela University that hosts the country's first dedicated ocean sciences campus. The National Research Foundation (NRF) promotes marine related research, including through the joint DSI-NRF South African Research Chairs Initiative (SARChI). It is designed to attract and retain excellence in research and innovation at South African public universities through the establishment of Research Chairs on emerging topics. The Council for Scientific and Industrial Research (CSIR) undertakes research activities on behalf of public authorities and other clients.

Civil society organizations also carry out marine monitoring and research activities, and include the South African Associate for Marine Biological Research (SAAMBR) and its Oceanographic Research Institute (ORI).

South Africa cooperates with a number of international partners such as the Norwegian Institute for Marine Research (IMR) or the Alfred-Wegener-Institute for Polar and Marine Research in Germany.

8.8 Water

8.8.1 National drought management

8.8.1.1 The national drought management plan

Drought is a recurring hazard event that causes hardship to many livelihoods and economic sectors in southern Africa. Climate change projections of a warmer climate might result in increased dry periods of higher intensity. In spite of the large number of people affected, there is still no capacity to accurately predict when the next drought will happen and how severe it will be. South Africa has a well-developed economy with a strong agricultural sector and the citizens in South Africa are largely protected from the most critical effects of drought such as water and food shortages.

With this, the National Drought Management Plan was prepared by the Department of Forestry, Fisheries and Environment and other sector departments, entities, etc. outlining key performance areas and enablers to deal drought phenomena in the country.

The drought plan is based on the National Disaster Management Framework and consist of the following four Key Performance Areas (KPA's) –

- KPA 1: Integrated institutional capacity for drought management;
- KPA 2: Drought risk assessment;
- KPA 3: Drought risk reduction; and
- KPA 4: Response and recovery.

Integrated institutional and organisational capacity for drought management

The Key Performance Area 1 deals with the different institutions responsible for drought management at all levels and also how to ensure coordinated action and implementation. It provides guidelines for joint action and implementation for all stakeholders, inclusive of government, the private sector and individuals.

National Organizational arrangements

The primary responsibility for the implementation of the Disaster Management Act (Act 57 of 2002) lies with the Department of Provincial Government and Traditional Affairs (COGTA). The respective Provincial Disaster Management Centres (PDMC) together with the District Disaster Management Centres are therefore pivotal in the coordination and implementation of the Act within the Province. Drought management is complex with different line departments responsible for drought management at different sectors. It is important to recognise the mandate of the different disaster management centres to coordinate; NDMC at national level, PDMC's at provincial level and DDMC at district level.

All the above-mentioned sector department plans overlap with each other and consultation and collaboration with all line departments are essential. Other organizations that is pivotal in drought management are: South African Weather Service (SAWS), the South African Satellite Agency (SASA), Research and supporting organizations such as: National Research Foundation (NRF), Agricultural Research Council (ARC), Water Research Council (WRC), Council of Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), South African Environmental Observation Network (SAEON), South African National Parks (SANParks), Human Sciences Research Council (HSRC), Universities, Municipalities, Water Users Organizations (WUO) and Eskom.

Drought risk assessment

The main objective of Key Performance Area 2 is to establish a uniform approach to assessing and monitoring drought risks that will inform drought risk reduction and drought response management by provincial organs of state and other role players. The first step in the development of a drought management plan is the drought risk assessment. Scientific drought risk assessment should be conducted at national, provincial level and also at micro level (District level at least) 4. Drought risk assessment is not a once-off activity with the purpose of identifying priorities and sensitive indicators; it is a continuous process that includes monitoring and evaluation of drought risk indicators.

Drought risk is a function of the frequency of occurrence and the severity and duration of dry conditions and the vulnerability and capacity to manage dry periods, of the affected sectors. Following the notion that risk assessment starts by evaluating the hazard and its corresponding vulnerabilities and manageability's, potential impacts across drought types.

Drought risk reduction

Drought risk reduction encompasses all actions that reduce the risk of dry periods or droughts to (i) communities, (ii) municipalities, (iii) business, (iv) mining, (v) industry, (vi) the energy sector, (vii) farming enterprises, (viii) livelihoods, (ix) tourism, (x) food security or (xi) the economy at large. Strategies or activities should include (i) prevention, (ii) mitigation, (iii) adaptation, (iv) avoidance, (v) adjustment, or (vi) consumption smoothing through insurance etc.

Most effort and funding should be allocated to risk reduction strategies. As a general rule one can expect a seven- to ten-fold saving on capital expenditure on risk reduction instead on relief and recovery. "The main objective of Key Performance Area 3 is to ensure that all drought management stakeholders develop and implement integrated drought risk management plans and risk reduction programmes in accordance with approved guidelines."

The focus of drought risk reduction is the prevention and mitigation of the potentially devastating impacts of drought. This should be achieved mainly through the application of good water management practices in all sectors. Drought risk management is the responsibility of each (i) individual, (ii) farmer, (iii) business, (iv) mine, (v) water management authority, (vi) municipality, (vii) land owner or any organization affected by water supply. Business, communities, municipalities, farmers and others should adapt to their local climatic conditions and ensure adequate adaptation and coping mechanisms. Resilience should be enhanced through the timely application of risk reduction measures such as insurance, water saving mechanisms, water management by-laws, and reserve inputs for dry periods and implementation of climate-smart conservation agriculture (CSCA). CSCA address food security climate changes and the restoration of natural resources. CSCA rest on five pillars namely (i) sustainable increase in agricultural productivity and income, (ii) sustainable use and restoration of natural resources, (iii) adapt and build resilience to climate change, (iv) reduce and or remove greenhouse gas emissions where possible, and (v) ensuring and providing a decent livelihood for those who work the land. Extension services play a critical role in the transfer of knowledge about drought management in the farming sector.

Response, relief and recovery

Response, relief and recovery are important activities during dry periods and droughts. Planning and development of contingency plans are essential for timely and efficient relief actions. Pre-approved contingency plans are a pre-requisite for efficient relief actions. All role players must pre-approve contingency plans; that includes Treasury at all government levels.

The different indicators and thresholds will play an important role in the activation of contingency plans. Plans must be designed in such a way that the plan can be activated with immediate effect once a certain threshold is reached for specific indicators; that includes activation of funding for pre-arranged activities as agreed upon in the contingency plan.

The main objectives of Key Performance Area 4 are to ensure effective and appropriate drought response and relief by:

- Implementing a uniform approach to the dissemination of early warnings;
- Providing an economic safety net for the agricultural sector to avert or reduce the potential negative drought impacts on the regional economy and prevent the out-migration of farmers from the agricultural sector;
- Implementing immediate integrated and appropriate response and relief measures when significant drought occurs or is threatening to occur; and

- Implementing differentiating indicator thresholds that consider the unique circumstances of the different agricultural systems.

National and Provincial Government has a responsibility to provide safety nets in the form of relief and recovery support after extreme exogenous shocks such as drought. Most of South Africa is a semi-arid to arid area with relatively low rainfall coupled with regular dry periods. Municipalities, communities, industry, mining, tourism and the farming sector should therefore adapt water use and production practices to climatic conditions and should take pro-active measures themselves to mitigate the impacts of drought. Regular dry periods within category D0, D1 and D2 drought should be dealt with by the respective sectors themselves. The affected sectors may apply for drought support once the thresholds for D3 drought is reached according to the national drought classification system. Different line departments and municipalities should develop its own sector and geographic specific drought plans. Indicators are not the same for all sectors; for example, the 3-month SPI during October, November, December might have a catastrophic impact on maize production, which is the staple food in SA. On the other hand, it might not impact on the drought was beyond the control of local municipalities or farmers.

Steps to be followed during drought period and manifestation

Drought disaster declaration

The Disaster Management Act (Act 57 of 2002) provides for the declaration of disasters through national, provincial and local government. When a dry period develops into a drought and municipalities, the farming sector, the PDoARD, or other stakeholder's highlight the need for a drought declaration, the Provincial Interdepartmental Drought Committee (PDTT) (Provincial Drought Task Team) should be activated and they should adhere to the following:

- Initiate efforts to assess the current and potential magnitude and severity of the drought
- Inform all relevant departments of the findings and potential impact
- Alert all disaster management role-players in the province who might be of assistance and affected
- Ensure in collaboration with COGTA, DHSWS and SALGA that municipalities in affected areas implemented water saving mechanisms
- Ensure, in collaboration with PDoARD and the PDMC through the structures of organized agriculture, that affected farmers have reduced stock numbers in time.

The involvement of local government or extension services in a province's assessment is crucial so as to advise the DAFF, DWS and the NDMC on the scale and extent of the losses caused by droughts. Food prices and food security is directly influenced by drought in the agricultural sector and the DSD should also be involved in almost all droughts. Provincial departments should determine the financial assistance required to normalize the situation. Key determinants will be considered during the assessment, available water for drinking and sanitation, water for industry businesses and tourism, livestock crop and vegetation conditions so as to ascertain whether the drought was beyond the control of local municipalities or farmers.

Drought relief

Drought relief is the joint responsibility of all municipalities, water authorities, national and provincial line departments and the private sector. The Department of Rural Development and Land Reform and provincial departments of agriculture are the lead agents for agricultural drought relief with the organised agriculture organisations such as African Farmers Association of South Africa, and National African Farmers' Union in support. The Land bank and agricultural businesses also played an important role in drought relief. That includes monitoring, record keeping and evaluation of the relief action. The disaster management structures at national, provincial and district level shall coordinate all relief actions.

Drought contingency plan

Contingency plans differ from preparedness and operational plans in that it can be compiled before the flood incident and it also provide an opportunity for exercise. Contingency plans should be pre-approved by all role players – including treasury – and it should be exercised in order to implement efficient deployment and response. An important aspect of contingency plan development is the need of active involvement from the decision makers. Contingency plans should be agreed upon prior to the expected action.

Enablers of drought management framework

Information management and communication

Disaster risk reduction and disaster relief requires up-to-date and reliable information in a format ready for decision-making. Information systems could involve remotely sensed information, GIS, early warnings, demographic information, market information, hazard information, information about coping capacity and many more. Enabler 1 seeks to address the information needs as well as the processing and storage of data. In addition, communication is equally important and this enabler also deals with communication systems.

> *"The main objective of Enabler 1 is to guide the development of a comprehensive information management and communication system and to establish integrated communication links with all drought management role-players".*

Information and the analysis and dissemination of information are key elements in drought management. Information in most cases is based on data gathering and analysis. All role-players should contribute to the process of data gathering and the following guidelines are applicable:

Weather related data

The South African Weather Service is primarily responsible for weather related data and information. The Agricultural Research Council also has access to weather data and both data sets should be combined and made available to the NDMU on a weekly basis. The NDMU will process data and made it available to the relevant role players as required.

The need for rainfall data in each catchment is imperative for future drought declarations and land owners and the private sector should be motivated to participate in the provision of rainfall and other climate data. Modern-day drought early warnings are fairly accurate and are communicated well on most of the national media. The interpretation and implications of dry periods and pending droughts, however, are not well communicated and the NDMU can play a vital role in this regard.

On-site and on-farm data

On site data and information available to local municipalities, individuals, communities and farmers should be captured and made available to the NDMU. On-site data include (i) localised weather data, (ii) dam levels, (iii) stream flow, (iv) groundwater levels (v) water demand and supply balance, (vi) expected amounts of available water, (vii) condition of water infrastructure. On-farm data are data such as (i) farm level meteorological data, (ii) animal numbers, (iii) farm sizes, (iv) grazing capacity, (vi) veld condition, (vii) planting conditions, (viii) crop condition and (ix) potential production yields.

Data for municipalities should be captured by Municipalities themselves, Department of Cooperative Governance and Traditional Affairs and Department of Water and Sanitation. Municipal level data should be analysed at provincial level and made available to the NDMU.

The extension services and the PDoARD should work jointly to gather, and analyse the farm level data and made that available to the DMU. The monitor farm systems should be computerized in order to ensure up-to-date analysis. Provincial organised agricultural structures can also assist to ensure that all quaternary catchments are represented by at least one monitor or reference farm. Data obtained from the reference farms should be updated regularly in order to ensure up-to-date calculations of SPIs and other indicators.

Data storage and analysis

The National Disaster Management Centre (NDMC), Department of Water and Sanitation, Department of Agriculture, Land Reform and Rural Development and Department of Forestry, Fisheries and Environment are primarily responsible for drought related data gathering and analysis and should provide systems for data storage and analysis. Research institutions and Higher Education Institutions can assist with the analysis of data and the development of systems that automate data analysis.

Data regarding the reference farms should be computerised and automated at provincial level. Consolidated data and information per province should be communicated to the DMU at the NDMC. Meteorological data and remote sensing products from the South African Weather Service, Agricultural Research Council and South African Satellite Agency should be made available for research and early warning.

The DMU at the NDMC should develop the capacity to capture all provincial level data, capture and analyse the data and made it available on a weekly basis to the public and all role players.

Information dissemination and communication

Extension services are primarily responsible for the dissemination of information regarding agricultural related droughts and that should be coupled to a communication strategy. The private sector and organised agriculture should cooperate and provide own resources for increased communication and information dissemination. Municipalities are also responsible to communicate drought related issues to communities within their areas of responsibility.

Education, training, public awareness and research

The main objective of Enabler 2 is to promote a culture of drought adaptation and drought risk avoidance among stakeholders by capacitating role-players through integrated education, training and public awareness programmes that is informed by scientific research. All line departments at national and provincial level and municipal structures together with the private sector are responsible to create awareness for proper water management and droughts. Education, training and public awareness are the cornerstones for drought risk reduction. The different disaster management centres should play a key role in coordinating education, training and awareness programs.

Education and training

Drought risk reduction starts with a water and drought conscious society. Managing water resources also required trained managers and personnel. Education and training in water management and drought risk reduction is the responsibility of each municipality, business, and farming enterprise and government department. All organizations should ensure that personnel working in the water sector or drought risk reduction sector are adequately trained and educated.

Research

A large number of drought related research gaps exist. Continued research should be coordinated and the all government departments, organised business and agriculture and the private sector should mobilize funds and task research institutions such as the Agricultural Research Council, Universities, the Water Research Commission and others to conduct drought related research with an emphasis on climate resilience, adaptation, mitigation, prevention and coping capacity.

Funding arrangements for drought management

The main objective of this Enabler is to establish mechanisms for the funding of drought risk reduction and drought response and relief.

Funding for institutional arguments

Government departments responsible for drought management should cover own costs while the non-governmental individuals or organisations are the joint responsibility of all departments depending on the contribution or involvement to integrated drought management. Private sector and organizations such as organised business and organised agriculture should also contribute to joint actions as per agreement for the direct costs and per diems of non-governmental individuals contributing to the different drought task teams.

Funding for drought risk assessment

The different line departments at national and provincial level are primarily responsible for the funding and development drought risk assessments while district municipalities have the responsibility for district disaster risk assessments. The National Disaster Management Centre (NDMC) and the Provincial DMC's are responsible for coordinating final assessments and guidelines. Drought risk assessment is closely linked to food security and the different departments of agriculture should also involve departments such as DSD during the assessment.

Funding for drought risk reduction

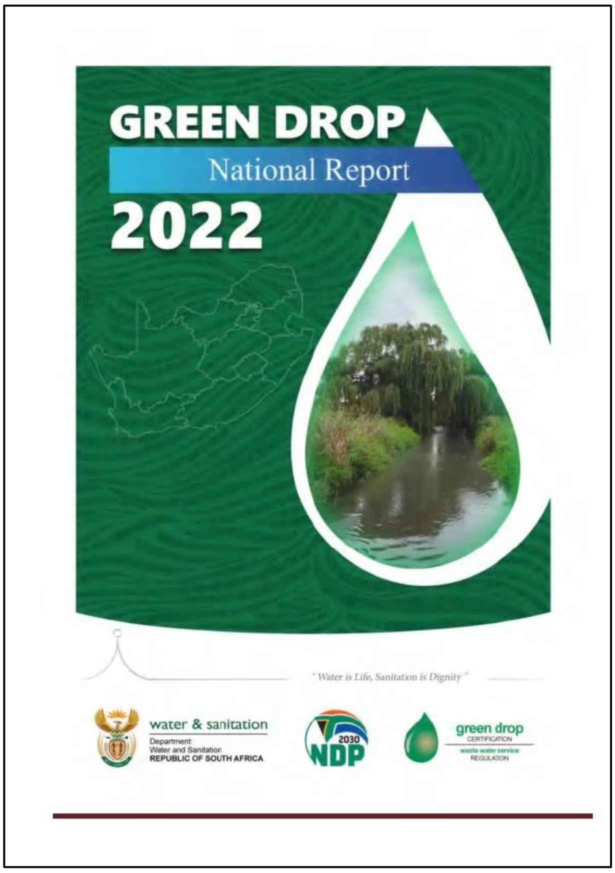
Farmers themselves best support drought risk reduction through the application of good agricultural practices. The primary role of extension services is the transfer of technology and knowledge that should empower farmers to apply sound agricultural practices. The Provincial Department of Agriculture and Rural Development is therefore instrumental in the achievement of increased drought resiliency. Apart from the role of extension, specific targeted programmes and projects also serve as mechanisms to increase awareness and resiliency against droughts.

Funding for disaster relief and response

The affected sector must firstly be able to prove that they did everything within their own capacity to mitigate, manage and cope with dry periods. The different sectors, municipalities and farmers should adapt to climate conditions and continually work with the relevant departments and other research institutions to implement new drought mitigation and avoidance strategies. Under extreme drought conditions, government will provide relief as a safety net.

Municipalities and provinces should first explore own reserves to support vulnerable sectors such as the communal farmers farming on municipal land. If municipalities have no funding, the relevant departments must first utilize own emergency funding to support farmers and only when they can prove that they have no resources of their own, are they allowed to apply for funding from the disaster management structures at provincial and national level.

8.8.2 Green Drop Programme



The Green Drop National Report, 2022 upholds the Minister's commitment to provide the water sector and its stakeholders with ongoing, current, accurate, verified, and relevant information on the status of wastewater services in South Africa. It follows on a series of green drop reports from 2009 to 2013, by providing feedback and progress pertaining to the current status of municipal, public, and selected private and state-owned wastewater facilities.

The green drop programme seeks to induce changes in behaviour of individuals and institutions to facilitate continuous improvement and adoption of best practice management of wastewater networks and treatment systems. Consequently, progressive improvement and excellent performance is recognised and rewarded. The Green Drop National Report, 2022 provides comparative analyses and diagnostics to assist Water Services Institutions (WSIs) to focus on specific areas for improvement and restoring functionality of wastewater infrastructure.

A wastewater system that achieves ≥90 percent green drop score, is regarded as excellent and is then allocated the prestigious green drop status. A system that achieved <31 percent is regarded as a dysfunctional system which would require appropriate interventions.

The Department of Water and Sanitation reported a 100 percent audit coverage of all identified Water Services Institutions for 2022 audit period. The audit covered 144 water services authorities (850 systems), 12 Department of Public Works (DPW) (115 systems) and 5 private- and state-owned organisations (30 systems), totalling 995 wastewater networks and treatment works. The Regulator determined that 23 wastewater systems scored a minimum of 90 percent when measured against the green drop standards and thus qualified for green drop certification. This compares lower than the 60 systems awarded Green Drop Status in 2013 however it is recognised for its inherent value to establish an accurate, current baseline from where improvement can be driven, and excellence be incentivised. The Water Services Institutions that were Green Drop certified include the City of Ekurhuleni, Lesedi Local municipality, iLembe District Municipality, uMgungundlovu District municipality, Witzenberg Local municipality, Bitou local municipality, Drakenstein Local Municipality, City of Cape Town, Saldanha Bay Local municipality, Mosselbay local municipality, and Sasol Sasolburg. A further 30 green drop contender systems were identified with audit scores of <90 percent, but with microbiological- and chemical effluent quality not meeting the Green Drop standard.

The results indicated that the vast majority of rural municipalities struggle to score more than 50 percent; only 5 percent of systems in Free State and Limpopo reached this threshold in comparison of 75 percent of systems in Gauteng. This coincides with the availability of specialist engineering and scientific skills being more prevalent in the urban municipalities.

Only 2 Department of Public Works (DPW) systems received green drop scores of >50 percent (Eastern Cape Port Elizabeth Region), whilst 102 systems scored below 31 percent- this is of considerable concern which demands special attention.

Private- and state-owned systems had 25 of the 30 systems assessed (83 percent) scoring above 50 percent. These results are encouraging, and the Regulator urges the 17 percent to raise their performance above the 50 percent threshold during the next audit season. The national risk ratio provides a risk perspective for treatment plants specifically. The results show an overall risk deteriorated from 2013 to 2021. Municipal plant regressed from 65.4 percent (medium risk) to 70.1 percent (high risk), and Department of Public Works (DPW) plants regressed from 80 percent to 88 percent (critical risk).

All private- and state-owned works are in low- or medium risk positions. The most prominent risks were observed at treatment level, and pointed to works that exceeded their design capacity, dysfunctional processes, and equipment (especially disinfection), lack of flow monitoring, and effluent and sludge non-compliance. This reflects the increased demand placed on existing collection and treatment infrastructure due to expansion driven by population and economic growth.

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

Figure: 2021 Green Drop performance summary

Wastewater systems which failed to achieve the minimum green drop target of 31 percent, are placed under regulatory focus. A total of 334 (39 percent) of municipal wastewater systems were identified to be in a critical state in 2021, compared to 248 (29 percent) in 2013. Municipal systems that are in critical positions are listed from high to low: Limpopo has 78 percent of its systems in critical state, followed by Northern Cape (76 percent), North West (69 percent), Free State (67 percent), Mpumalanga (43 percent), Eastern Cape (39 percent), Gauteng (15 percent), KwaZulu-Natal (14), and Western Cape (11 percent). A total of 102 (89 percent) out of the 115 DPW systems were identified in critical state, compared to 84 percent in 2013. Of the private systems, 1 plant was identified in critical state.

8.8.3 Blue Drop Programme

According to Blue Drop Report 2021, Access to sufficient, safe water is a basic right enshrined by South Africa's Constitution. The Water Services Act (Act 108 of 1997) places the responsibility for provision of water services to Local Government, while the oversight and monitoring duties are delegated to provincial and national government. Incentive-based regulation was introduced in 2008 in the form of the Blue Drop Certification programme, whereby the Department of Water and Sanitation (DWS) measure all aspects contributing to a sustainable Water Services Business, and provision of safe water to the citizens of South Africa. This programme gives prominence to the World Health Organisation's (WHO) water safety planning concept as the basis for a proactive, risk-based approach to drinking water quality management from catchment to consumer. Since then, Department of Water and Sanitation has been monitoring the risk of each water supply system based on performance against blue drop certification criteria. These results create an enabling environment whereby the Water Services Authority (WSA) and DWS identify, prioritise, and implement targeted and specific interventions to improve performance.

The national profile for the country is summarised as follows:

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

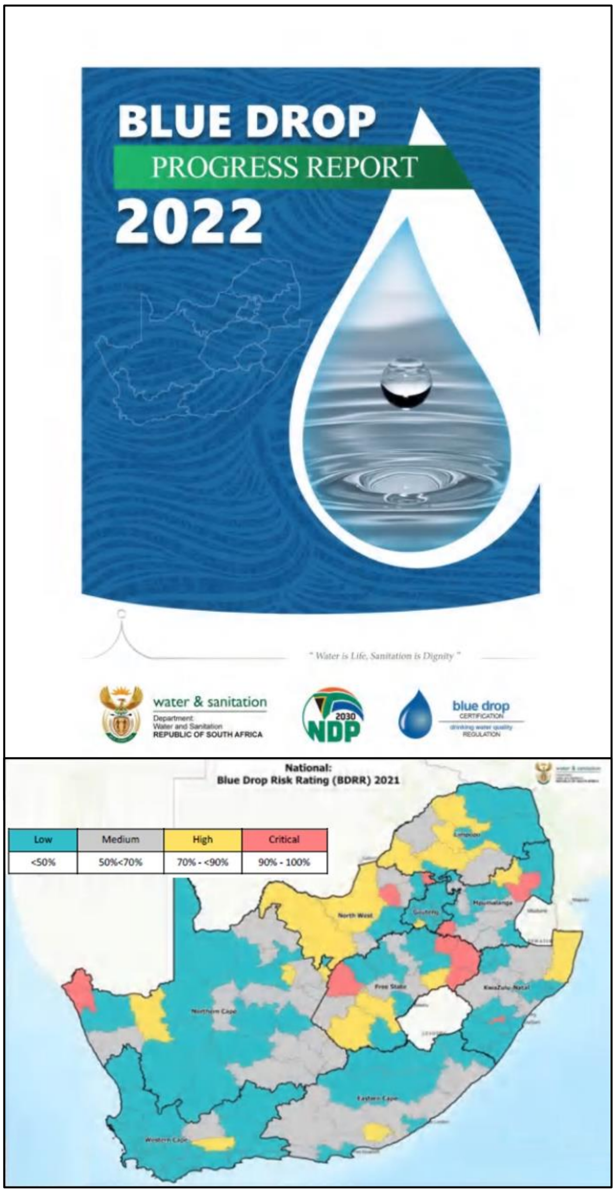


Figure: The 2021 National Blue Drop risk rating profile

8.8.3.1 Risk Indicator A: Design Capacity and Risk Indicator B

The operational capacity in terms of design capacity, are important indicators to determine if the plant can provide sufficient, safe drinking water now and in the near future. Once daily production approaches 90 percent of design capacity, the Water Services Authority (WSA) must plan, budget, and implement projects to increase the capacity of the treatment plant to ensure there is sufficient supply, not only for human consumption, but also for economic activities. The 2021 result indicate 62 percent of treatment plants are small plants with capacity <2 M/d and typically include boreholes and rural systems located in remote areas. In order to address the challenges faced with operation and management of large number of rural schemes located across a large geographical area, WSA's must ensure there is sufficient resources such as staff, chemical supplies, spares, and vehicles to ensure optimal operations of these systems. Analysis of Indicator B could not be conducted due to lack of design capacity information, lack of daily flow meter readings, or incorrect flow data due to lack of calibrated flow meters. WSA's are reminded that installation of flow meters and daily flow recording is a regulatory requirement as per their Water Use License as well as an essential operational tool to ensure delivery of sufficient water at all times.

8.8.3.2 Risk Indicator C: Water Quality Compliance

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

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

The poor water quality compliance results are of serious concern to Department of Water and Sanitation as the majority of supply systems present a potential health risk to consumers. Water Services Authority's (WSA) must investigate the root cause of the failure and implement remedial actions to ensure compliance against limits outlined in SAN S241:2015. Remedial actions include: 'Boil Water' notices issued in systems with sustained microbiological failures; 'Water Quality' Advisories issued in systems with sustained chemical failures for chronic health determinants; and alternative water sources provided to communities until the water is safe for human consumption.

With regards to monitoring compliance, WSA's must ensure there are sufficient microbiological and chemical sampling points as outlined in SANS 241:2015 to verify the safety of water at all points in the distribution network.

8.8.3.3 Risk Indicator D: Technical Skills

Technical skills evaluate the required technical skills to ensure effective operations and maintenance of water treatment plants and distribution networks. In general, technical skills is poor throughout the country with 12 percent of supply system in low-risk category (90-100 percent compliance), 27 percent of supply systems with sufficient number of suitably classified process controllers per shift, 52 percent of supply systems with qualified supervisors, and 28 percent of systems with full maintenance teams in place i.e. civil, mechanical and electrical personnel.

To improve technical skills, Water Services Authority (WSA) must evaluate the performance of each system with regards to process control and determine the operational model which is best suited to ensure effective operations and maintenance of each water supply system. Sufficient budget must be allocated to appoint suitably qualified process control staff to ensure water quality compliance improves through ongoing process optimisation, and qualified maintenance teams to reduce water losses and maintain integrity of the supply system.

8.8.3.4 Risk Indicator E: Water Safety Plans

Water Safety Plans is a measure of risk management procedures as outlined in SANS 241: 2015 and World Health Organisation (WHO) guidelines. The results indicate only 33 percent of supply systems in the country have Water Safety Plans and 9 percent have comprehensive Water Safety Plans with all required components including management approval, risk assessment, a risk-based monitoring program and implementation of corrective measures. As per the water safety planning approach, all water quality risks must be incorporated into a comprehensive Water Safety Plan with clearly outlined mitigating measures to reduce high and medium risks. The Water Services Authority (WSA) must ensure all risks associated with their current scores forms part of the water safety plan with medium and high risks targeted for implementation. It is critical that WSA's allocate sufficient budget and resources for implementation of risks to ensure effective risk management over time.

While Department of Water and Sanitation (DWS) is encouraged by the 48 percent of supply system in the low-risk category, the 34 percent of systems which reside in the high and critical risk categories is of concern to the Department and are placed under regulatory focus. In such cases, a red note is assigned that requires the Water Service Institution (WSI) to submit a detailed corrective action plan within 60 days of publishing of this report. The plan must map the activities, responsible persons, timelines, and expected improvements as outlined in the Regulatory Comment. The plan will be considered against the Regulatory Comment and recommended for approval by a National Regulation Committee. Section 151 of the National Water Act and Section 63 of the Water Services Act are key to developing and submitting these plans as required. Other water supply systems which are in the high-risk category will also be targeted for corrective action plans and municipalities are urged to initiate a process of addressing the regulatory comment as a matter of priority.

In conclusion, Water Services Authority (WSA) must review the performance of each supply system under their authority and interrogate the Blue Drop Risk Rating (BDRR) score as well as the individual risk indicator which make up the BDRR score to identify areas of poor performance. Through effective risk management procedures embodied in the water safety planning approach, the WSA must identify and implement remedial actions to improve the overall risk rating that will lead to effective water services provision and delivery of safe drinking water for all the citizens of South Africa.

Moving forward, the Department is committed to conducting annual Blue (and Green) Drop Assessments, with a full blue drop Assessment planned for 2022 followed by Blue Drop Progress Assessment Tool (BD PAT) assessment in 2023. Through regular cycles of blue drop assessments and BDRR evaluations, an enabling environment is created where both WSA's and DWS identify, prioritise, and implement targeted and specific interventions to improve water services performance in a structured manner based on risk management principles.

8.8.3.5 Blue drop watch report

The Blue Drop Watch Report 2023 is an interim report leading up to the full Blue Drop audit report. It draws attention to the current condition of drinking water infrastructure, treatment processes and water quality, from a technical perspective, by drawing on the audit findings of the field work by Blue Drop inspectors during November 2022 to February 2023. The Blue Drop Watch report is not a Blue Drop audit report, and the latter will only be published mid-2023 once the Department of Water and Sanitation and quality control processes have been satisfied, to ensure accurate and credible reporting of drinking water services. The Watch Report seeks to keep the public and stakeholders updated and informed on the current status of drinking water, to ensure that the necessary interventions are fast-tracked without delay.

Drinking Water Systems

144 Water Services Authorities (WSA) in South Africa provides drinking water for domestic, commercial, and business use via 1186 water supply systems. Integrated Regulation Information System (IRIS) 2023 confirms that 1067 water supply areas are registered, and managed by 144 WSAs, supported by 26 WSPs (including Water Boards). The graph below shows the number of WSA's and supply systems per province that were audited in the Blue Drop audits of 2022 – 2023.

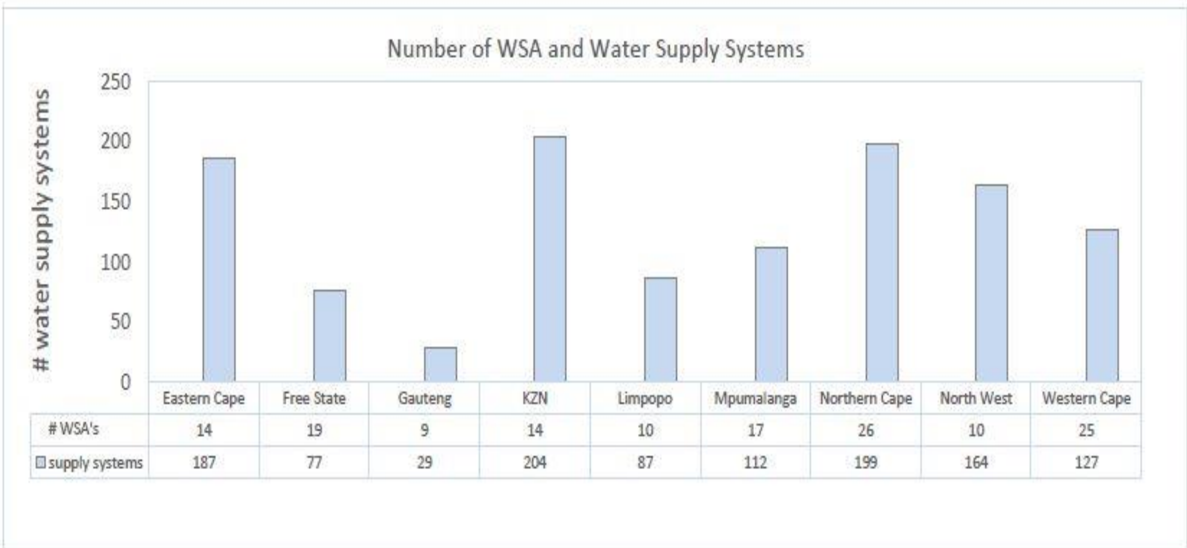


Figure: WSA's and supply systems for 2021 BDPAT assessments

8.8.3.6 Technical site assessment

The intention of a Technical Site Assessment (TSA) is to verify the evidence presented by a Water Services Institution (WSI) during the desktop Blue Drop audit by undertaking a physical inspection of the selected water networks and treatment sites. During the period December 2022 to February 2023, 151 water supply systems were inspected, offering a representative overview of systems owned and operated by municipalities, water boards and water service providers. The assessments covered all 140 municipalities, as well as 27 water boards and bulk water service providers. Detailed TSA reports with photographic evidence and a Very Rough Order of Measurement (VROOM) costs have been generated to assess the condition and status of treatment facilities and gain insight into randomly selected pipe network and pumpstation across the water distribution networks. The following table summarises the TSA scores of the water supply systems that were assessed.

Province	# WSAs	# TSA WSSs	# TSA WTWs-	# WSP/WB (and Names)	Average % TSA
Eastern Cape	14	15	15	1 (Amatola Water)	79%
Free State	19	21	21	4 (Bloem Water)	63%
Gauteng	6*	8	8	3 (Rand Water, Magalies Water)	82%
KwaZulu Natal	14	15	15	7 (Novubu, Zana Manzi, Mhlathuze Water, Umgeni Water, uThukela Water)	71%
Limpopo	10	11	11	6 (Lepelle Water, EXXARO, Magalies Water)	59%
Mpumalanga	16*	17	17	None	69%
Northern Cape	26	27	27	None	58%
North West	10	10	10	1 (Midvaal Water, Magalies Water)	60%
Western Cape	25	27	27	5 (Klein Karoo WSS, WCDM Bulk Water Supplier, Overberg WB)	79%
National totals	**140**	**151**	**151**	**27**	**69%**

Figure: National summary of TSA water supply systems

An average Technical Site Assessment (TSA) of 69% was achieved for the 151 systems assessed, which means that infrastructure and processes are deemed to be '*partially functional with an average performance'*. The best overall performing WSI was located in Gauteng, followed by Western Cape and Eastern Cape. The average TSA score per WSA in South Africa is reflected in the following graph. Gauteng has the highest average TSA score of 82% showing an overall good performance and status of the water system assessed, with the Eastern Cape and Western Cape both attaining average TSA scores of 79%. The remaining provinces are showing performances ranging from an average TSA of 58% to 79%.

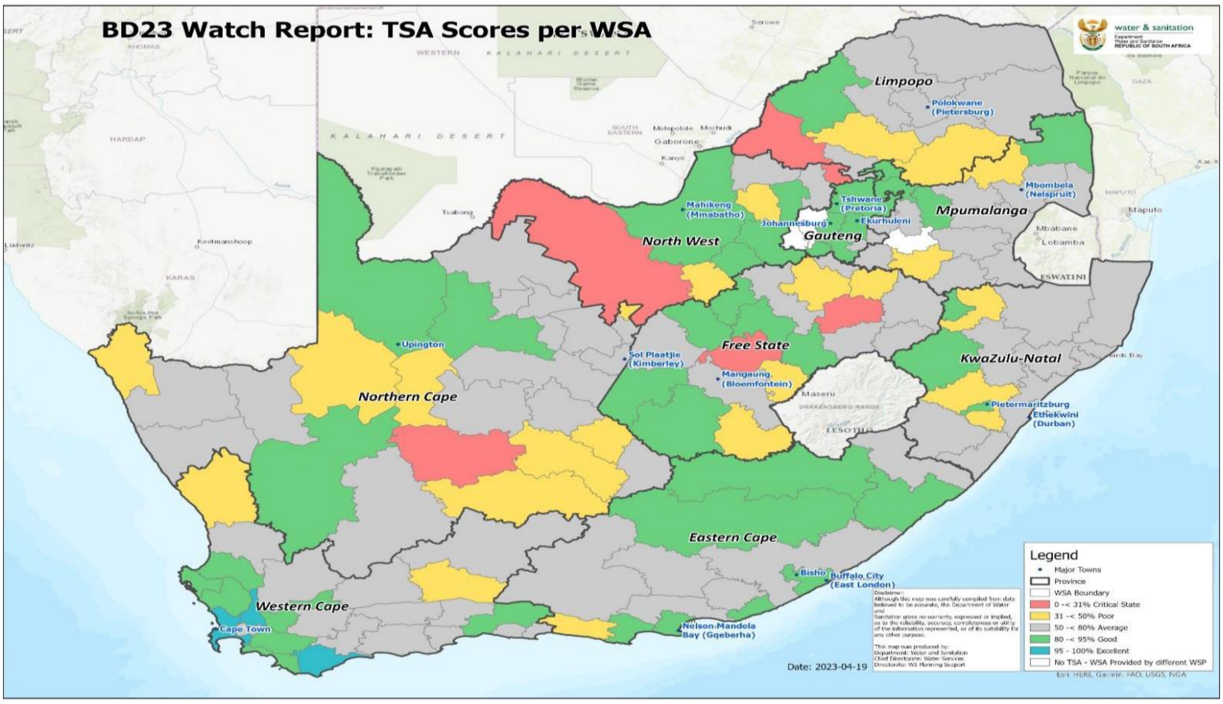


Figure: Average TSA scores for water supply systems across 9 provinces

Water supply systems that achieved ≥50% TSA score are summarised as follows. Standard deviations are shown in brackets to give the reader a sense of the deviation of all systems from the average value.

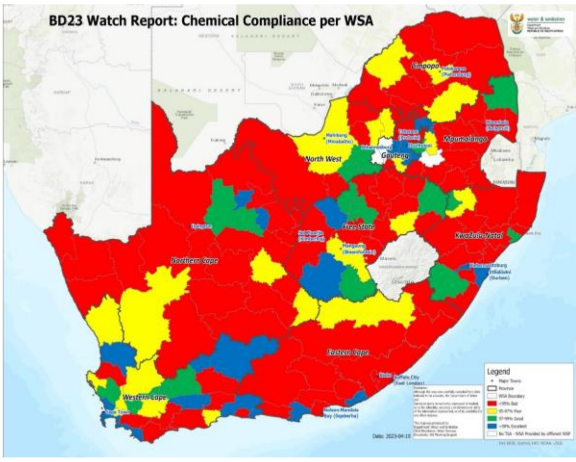
Province	TSA of ≥95-100% [Excellent]		TSA of ≥80-<95% [Good]		TSA of ≥50-<80% [Average]	
	# of WTWs assessed	Average % TSA (±SD)	# of WTWs assessed	Average % TSA (±SD)	# of WTWs assessed	Average % TSA (±SD)
Eastern Cape	None	None	9	86% (6%)	6	67% (12-17%)
Free State	1	95% (0%)	5	83% (2-5%)	9	67% (8-12%)
Gauteng	1	97% (0%)	5	86% (5-8%)	2	63% (10%)
KwaZulu Natal	1	95% (0%)	4	86% (4-6%)	9	64% (14-15%)
Limpopo	None	None	1	86% (0%)	8	63% (13%)
Mpumalanga	None	None	5	87% (3-5%)	10	64% (13-14%)
Northern Cape	None	None	4	88% (6-8%)	15	61% (10-14%)
North West	1	95% (0%)	3	88% (6-7%)	2	59% (1-2%)
Western Cape	4	96% (1-2%)	10	87% (7%)	13	68% (11-18%)
National totals	**8**		**46**		**74**	

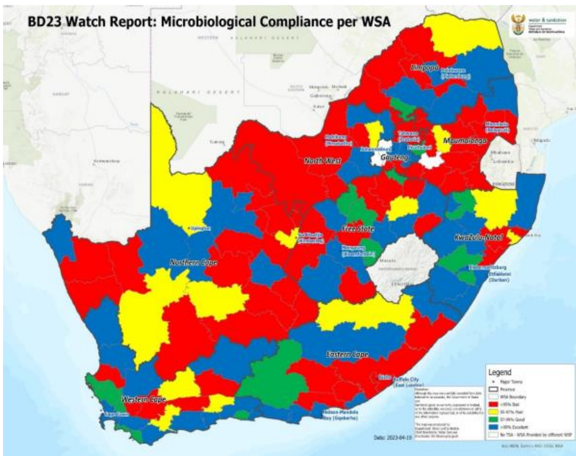
Figure: National summary of the TSA water supply systems in the excellent to average performance categories

Out of a total of 128 systems that fall in the 50-100% bracket, the following performance and condition status was found: 8 systems (6%) in excellent condition, 46 systems (36%) in good condition and 74 systems (58%) in average condition. The systems observed to be in dysfunctional/ critical state based on technical site inspections from the inspection of are 23 systems which are in the poor/critical performance bracket 18 systems (78%) in poor condition and 5 systems (22%) in critical state.

8.8.3.7 Drinking water quality status

Out of 151 treatment plants, 59 systems (39%) achieved excellent microbiological quality and 17 systems (11%) achieved good microbiological quality. A total of 13 systems (9%) have a poor microbiological water quality status and 62 systems (41%) have a bad microbiological water quality status. The water from these 62 systems poses a serious acute health risk to the users. WSAs with poor microbiological water quality status must be monitored to ensure suitable rectification measures are taking to safeguard communities. The direct cause of microbiological failures can be linked to the TSA sub-watch area 7, which has a relatively low contribution to the overall TSA score. Failure to produce water that complies with the SANS E. coli standard can be linked to poor operation, defect infrastructure, incorrect dosing rates, absence of disinfection chemicals, lack of monitoring, or lack of operating and chemistry knowledge. Chemical compliance shows that only 25 systems (17%) achieved excellent water quality and 20 systems (13%) have good water quality, whilst 106 systems (70%) failed to achieve chemical compliance. A concerning 83 systems (55%) and 23 systems (15%) of water treatment plants are in critical state, with bad and poor water quality compliance respectively.





The microbiological compliance per WSA is reflected in the following map. KwaZulu Natal has the highest overall microbiological compliance with 11 of 15 (73.3%) systems with excellent and good status, followed by the Western Cape with 19 of 27 (70.4%) systems and Gauteng with 5 of 8 (62.5%) systems. Similarly, Mpumalanga has the highest overall microbiological non-compliance with 14 of 17 (82.4%) systems with poor and bad status, followed by the Northern Cape with 20 of 27 (74%) systems. The chemical compliance per WSA is reflected in the map below. Gauteng has the highest overall chemical compliance with 5 of 8 (62.5%) systems with excellent and good status, followed by the Western Cape with 11 of 27 (40.7%) systems and KwaZulu Natal with 6 of 15 (40%) systems. Although Gauteng, Western Cape and KwaZulu Natal obtained the highest chemical compliance profile, the Regulator does not regard 40-62% compliance as acceptable. On the non-compliance side, Limpopo has the highest overall chemical non-compliance with 10 of 11 (90.9%) systems with poor and bad status, followed by the Eastern Cape with 13 of 15 (86.7%) systems and Northern Cape with 22 of 27 (81.5%) systems.

8.8.4 Water reconciliation strategies

According to the National State of Water Report, 2022, the objective of the reconciliation strategy within a water supply system is to reconcile or find a balance between the current and future water requirements by implementing appropriate intervention measures to increase the available water, conserve water through water conservation and demand management measures, as well as improve the water quality in the river systems.

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

8.8.4.1 The Integrated Vaal River System Reconciliation Strategy

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

The following options are recommended:

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

8.8.4.2 Mbombela Reconciliation Strategy

The major water requirements within the Mbombela Water Supply System are for irrigation, making up 54 percent of the total Crocodile and Sabie catchment requirements. Sugarcane is the predominant crop in these two catchments. Cross-border flows for the Crocodile and Sabie Rivers have a minimum requirement of 37 million m3/annum, according to the InoMaputo Water Use Agreement to cross the border from South Africa into Mozambique. The Crocodile system provides water to several users along the stretch of the river and downstream of the main dam for the system - Kwena Dam. The yield of the Crocodile River System is influenced directly by the abstraction volumes and location of the water users within the system. The main water resource infrastructure in the Sabie River is the Inyaka Dam which supplies the Sabie and Sand catchments via the Bushbuckridge Transfer Pipeline.

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

- Water Conservation and Water Demand Management (WCWDM);
- Removal of invasive alien plants;
- Surrender irrigation allocations;
- Strict restriction rules on low-priority users; and
- Releases from the Ngodwana Dam.

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

- Water Conservation and Water Demand Management (WCWDM);
- Removal of invasive alien plants;
- Development of groundwater; and
- Additional return flows from treated effluent.

8.8.4.3 Algoa Reconciliation Strategy

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

Urban water use from the Algoa Water Supply System is more than 60% of the total use of the system and is expected to increase. Water use within the Kouga Municipality is 10.0 million m3/a (27.3 Mℓ/d), with an estimated bulk water requirement of 13.0 million m3/a (35.5 Mℓ/d). Of this, 5.85 million m3/a was supplied from the Algoa WSS in 2016/17. The Municipality plans to develop a long-term Water Provision Master Plan to upgrade and rehabilitate bulk infrastructure. In the future, Groundwater from the Humansdorp area will be used by Kouga Local municipality. There is a possibility of the supply of additional Orange River water to the NMBM, instead of more water from the Kromme River sub-system to the Kouga municipality and the proposed power plant.

The following interventions are recommended:

- Further allocation of Orange River water to NMBM

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

- Groundwater supply

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

- Large seawater desalination scheme

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

8.8.4.4 Richards Bay Reconciliation Strategy

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

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

The following interventions are recommended:

- Reducing water demand by introducing WCWDM – King Cetshwayo DM recently (May 2020) started a WCWDM project aiming to reduce water losses in their water supply schemes.
- Remove alien vegetation - removing alien vegetation is a standard intervention measure for saving water in all Reconciliation Strategies and is very important in severely water-stressed catchments.
- Water Reuse - Indirect effluent reuse, whereby treated effluent could be discharged to Lake Mzingazi for indirect potable and industrial reuse. Also, consider the blending of treated effluent at the Mzingazi WTW or artificial recharge to create a barrier to prevent seawater intrusion. Potential uptake of treated effluent by bulk industrial water users close to the Arboretum macerator. Potential users would need to be identified.
- Transfers from Neighbouring Catchments - an increase in the Thukela transfer from Middeldrift be compared with other transfer options (Lower Thukela Coastal pipeline and Umfolozi off-channel storage Dam) at a pre-feasibility level, after which a decision can be made as to the preferred option. However, drought hit the catchment shortly after the completion of the Strategy (2015), and the upgraded Thukela transfer was then selected as an emergency scheme. Construction of the upgrade began, which would increase the size of the existing transfer from 1.2 m^3/s to 2.4 m^3/sd.
- New Dam Construction - a new dam on the Nseleni River. The proposed dam will be located on the Nseleni River, a tributary of the Mhlathuze River just upstream of the Bhejane township, from where water can be released downstream to Lake Nsezi for abstraction.
- The raising of Goedertrouw Dam - the dam can be raised by 2.8 meters which will result in an increase in storage capacity from the existing volume of 301 million m^3 to 336 million m^3. The corresponding increase in yield to the system would be 5.8 million m^3/annum.

8.8.4.5 Water use efficiency

South Africa is the 30th driest country in the world, and many parts of the country are approaching a scenario where the demand outstrips the supply. That is, most of the freshwater resources are fully utilised. A high level of water stress can negatively affect economic development, increasing competition and potential conflict among users, which calls for effective supply and demand management policies and an increase in water-use efficiency. Therefore, Water Use Efficiency is critical in ensuring the sustainability of the freshwater resources. Governments are increasingly collaborating with other stakeholders, including the private sector, to ensure that Water Governance is genuinely inclusive. The fundamental components of good water governance include effective, flexible, and accountable state institutions that can respond to change, along with openness and transparency. Citizens and communities should also be able to voice their opinions and be involved in decision-making. Policy processes must involve participation and multistakeholder engagement.

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

- Sector Bodies such as Business Unity South Africa (BUSA), Minerals Council South Africa, and Agricultural Sector bodies: Provide support to their members to ensure the implementation and reporting of WUE information.
- Water Services Authorities (WSAs): Implementation of WUE programmes and report progress to the Department.
- Industry, Mining, and Power Generation Sector: Implementation of WUE programmes and report progress to DWS.

- Civil Society: Advocating the importance of saving water within their communities.
- Water Research Commission (WRC): Provide Research and Development of tools relating to WUE.

South African Citizens' role in managing water use efficiency

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

8.8.4.6 *Consumption trends*

Integrated Vaal River system

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

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

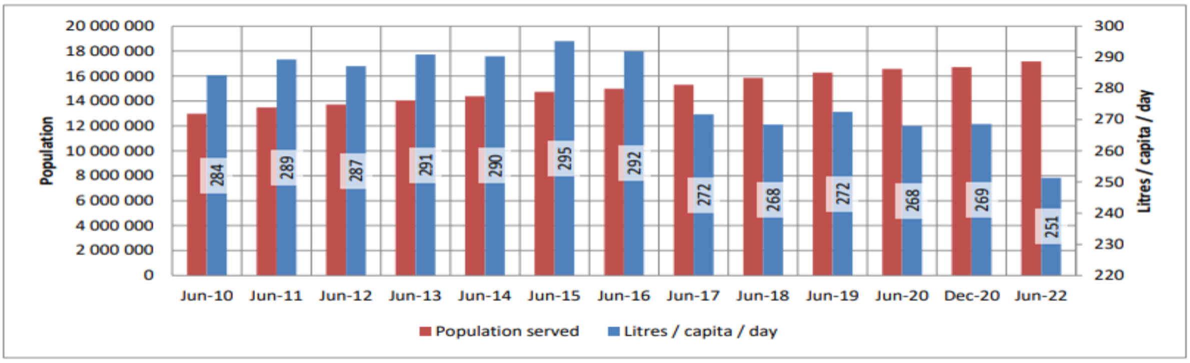


Figure: IVRS per capita consumption trend

Crocodile West River water supply system

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

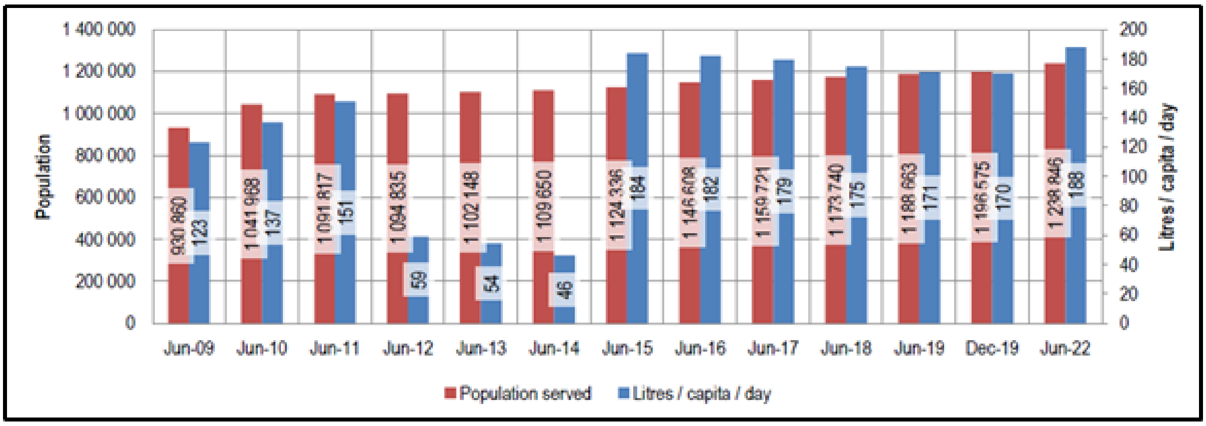


Figure: CWRWSS per capita consumption trend

KwaZulu-Natal coastal metropolitan water supply system

The per capita consumption has been consistently increasing since 2017 when water restrictions were lifted.

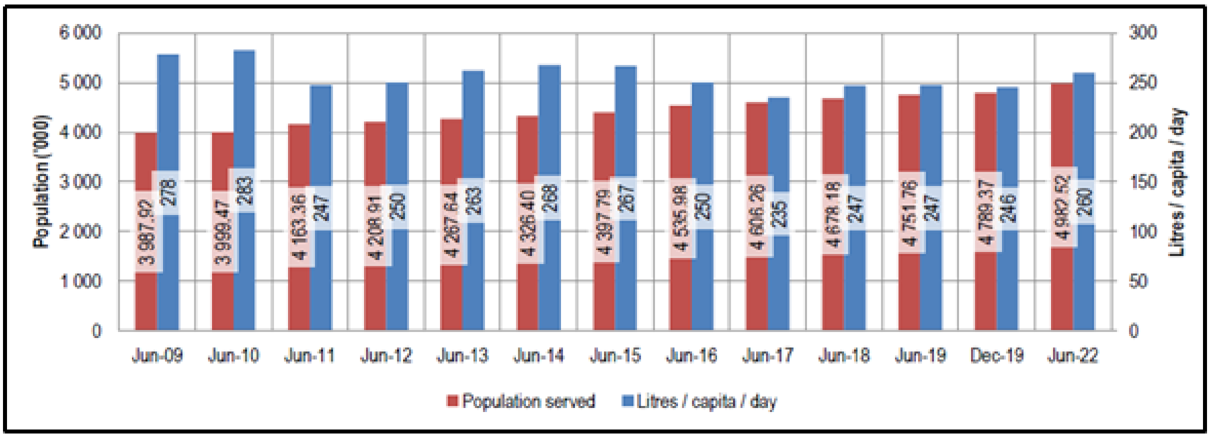


Figure: Coastal metro WSS per capita consumption trend

Western Cape water supply system

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

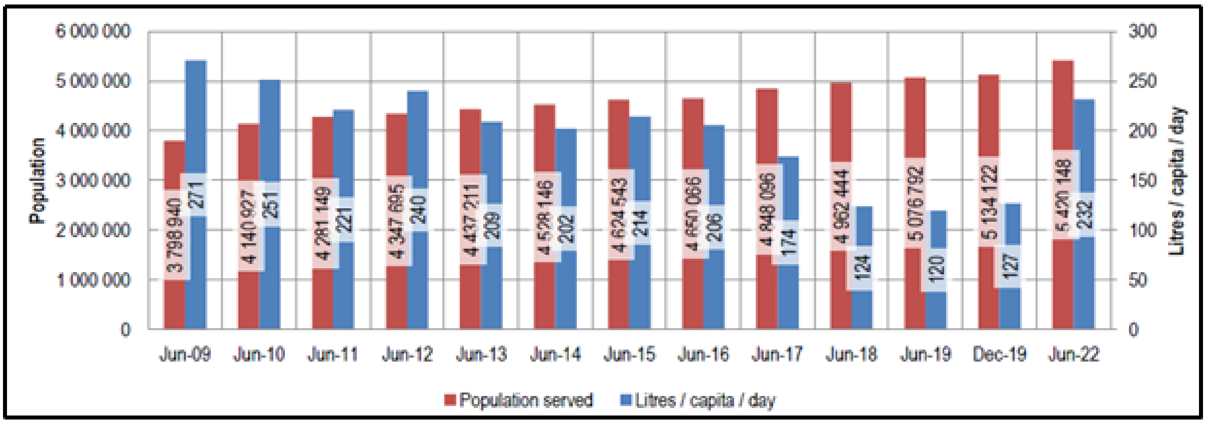


Figure: Western Cape WSS per capita consumption trend

Algoa water supply system

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

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

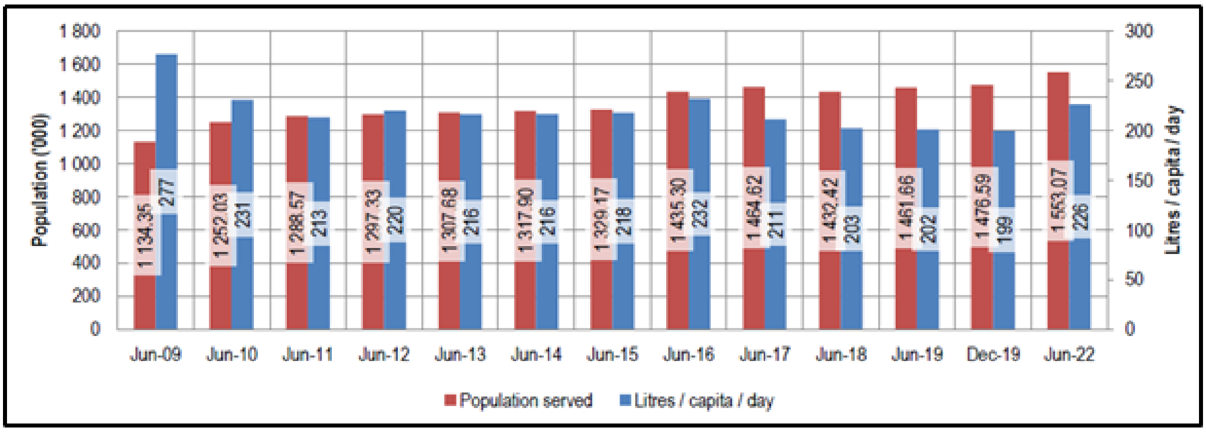


Figure: Algoa WSS per capita consumption trend

Amathole water supply system

The average per capita consumption has been stable over the past few years.

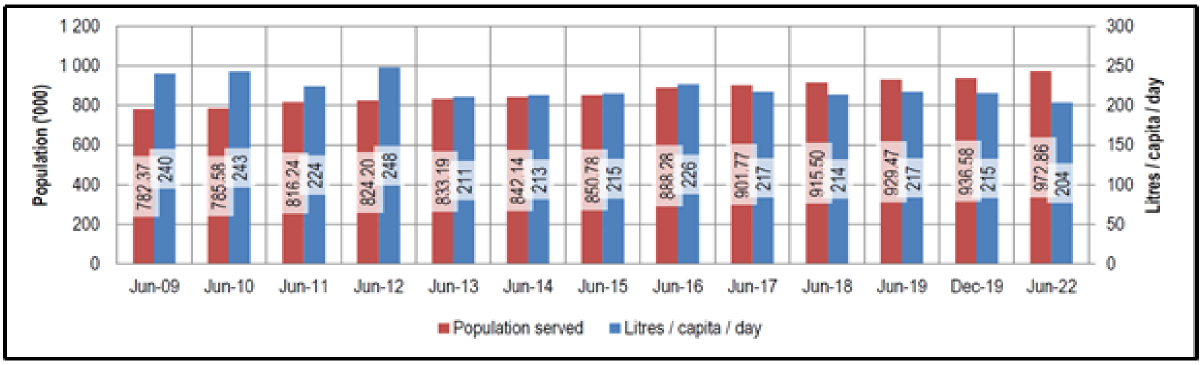


Figure: AmWSS per capita consumption trend

Greater Bloemfontein water supply system

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

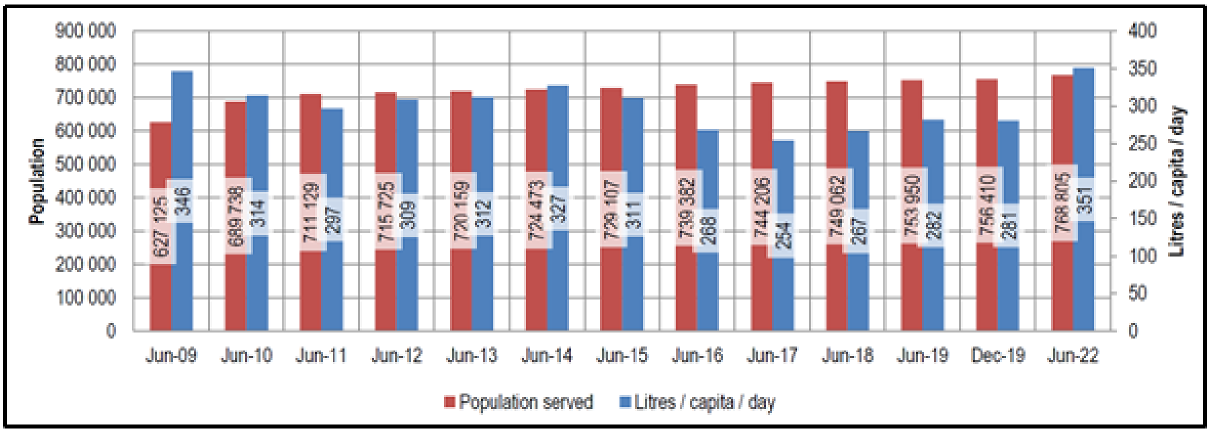


Figure: MMM per capita consumption trend

Olifants river water supply system

The per capita consumption indicates a very low confidence level in the unit consumption decrease over the past five years. The current estimated average consumption is 184 ℓ/c/d.

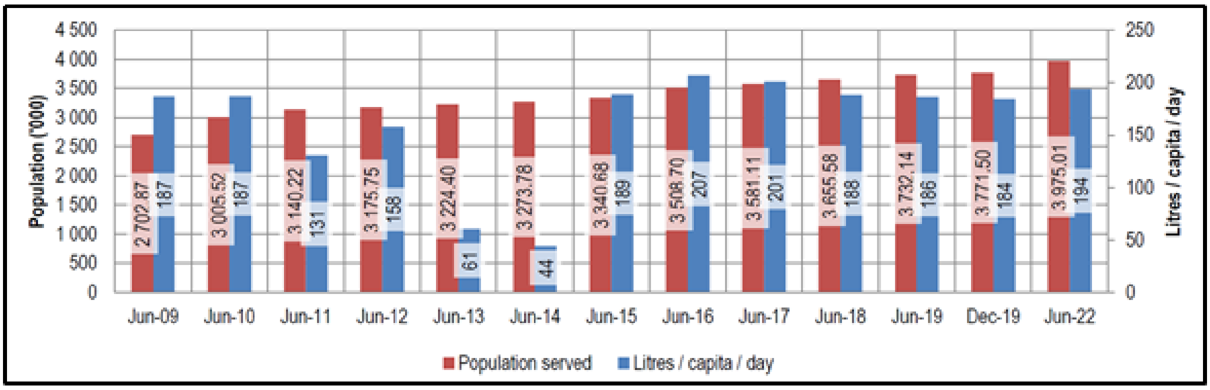


Figure: ORWSS per capita consumption trend

8.8.5 Water resource protection

This section outlines the water resource protection from the National State of Water Report, 2022.

8.8.5.1 *Resource directed measures*

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

8.8.5.2 *Classification of significant water resources*

The water Resource Classification System (WRCS) was formally prescribed through Regulation 810, which was published in the Government Gazette (GG 33541 of 17 September 2010). The classification of water resources represents the first stage in the protection of water resources and determines the quantity and quality of water required for ecosystem functioning as well as maintaining economic activity that relies on a particular water resource. This system prescribes processes to be followed for determining RDMs. This system categorises water resources according to specific water resource classes that represent a management vision of a particular catchment. The water Resource Classification process considers a catchment's social, economic, ecological, and environmental landscape to assess the costs and benefits associated with using versus protecting a water resource. The classification process defines three water resource classes based on the extent of use and the alteration of ecological conditions of water resources from the pre-development state. The Water Resource Classes (WRCs), range from minimally used (Class I) to heavily used (Class III) are ultimately used to describe the desired condition of the resource and the degree to which it can be utilised.

Table: Water resource classification classes

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

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

8.8.5.3 Resource quality objectives

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

(a) Water quantity, pattern, timing, water level, and assurance of instream flow;

(b) Water quality, including the physical, chemical, and biological characteristics of the water;

(c) Character and condition of the instream and riparian habitat; and

(d) Characteristics, condition, and distribution of the aquatic biota.

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

Finalised WRCs and RQOs studies

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

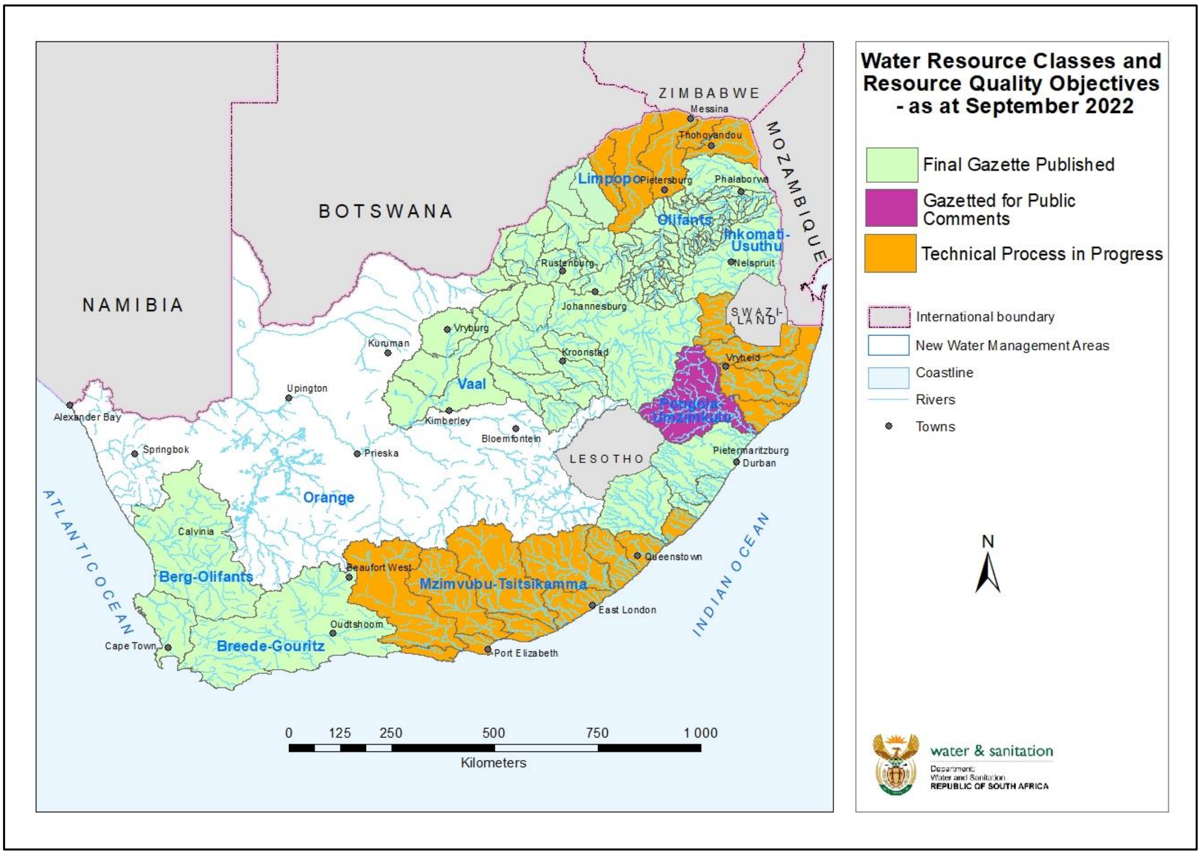


Figure: Overview status of WRC and RQO determination progress post-2010 to September 2022

Table: Overview of study areas with finalised WRCs and RQOs

Study Areas	Status	Government Gazette No.
Olifants-Doorn, Olifants, Upper Vaal, Middle Vaal and Lower Vaal	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 39943 of 22 April 2016
Letaba and Inkomati	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 40531 of 30 December 2016

Study Areas	Status	Government Gazette No.
Mvoti to Mzimkhulu	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 41306 of 08 December 2017
Crocodile (West) and Marico, Mokolo, and Matlabas	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 42775 of 18 October 2019
Breede-Gouritz	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 43726 of 18 September 2020
Mzimvubu	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 43015 of 14 February 2020
Berg	Water Resource classes and associated RQOs have been finalised and gazetted.	GG 43872 of 06 November 2020

WRCs and RQOs determination in progress

The determination of WRCs and RQOs is still in progress in some study areas shown in the table below. In the uThukela Catchment, the finalised WRCs and the associated RQOs are scheduled for publication in March 2023, while the rest of the study areas are currently completing the technical processes.

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

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

Table: Overview of WRCs and RQOs determination processes as of September 2022

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

Luvuvhu	The technical process for the determination of WRCs and associated RQOs commenced in October 2021 and is scheduled to complete in September 2025.	Not yet gazetted
Usuthu to Malthouse	The technical process for the determination of WRCs and associated RQOs commenced in December 2021 and is scheduled to complete in May 2024.	Not yet gazetted

Outstanding Water Resource Classifications and RQOs studies

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

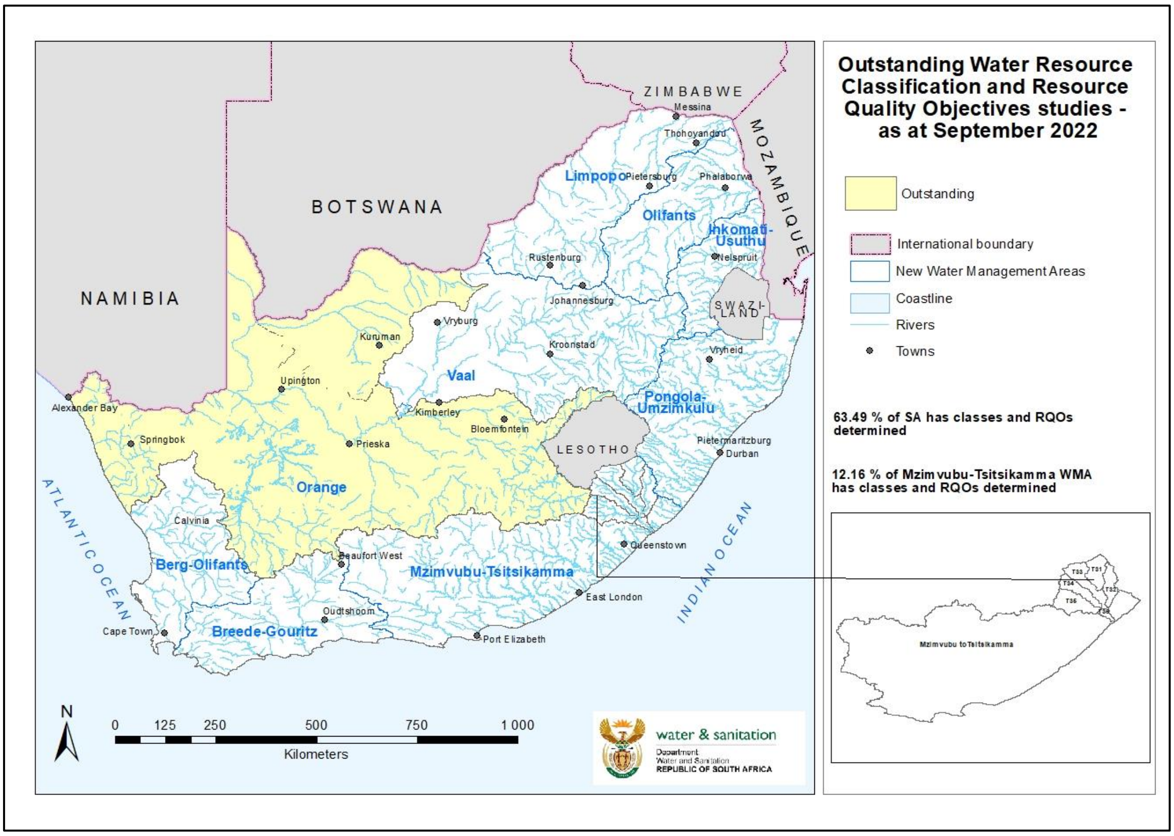


Figure: Outstanding Water Resource Classification and RQOs studies as of September 2022

8.8.5.4 *Determination of the reserve*

The Department has made notable progress in the determination of the Reserve for significant water resources at various levels of confidence ranging from desktop to comprehensive, depending on the type of impact, the magnitude of the impact on water resources, and the quantity and quality of data available to run the models. Reserves for surface water resources (i.e. rivers, wetlands, and estuaries) have been determined at a desktop, rapid, intermediate, and comprehensive level. Similarly, the Reserve for groundwater resources (aquifers) has also been determined at a desktop, rapid, intermediate, and comprehensive level. The Reserve studies for both surface and groundwater conducted thus far have been plotted spatially, and Reserve maps have been developed for South Africa in the maps shown in the figures below. These maps have been made available to the regional offices to assist in the decision-making process for processing Water Use Authorisation applications.

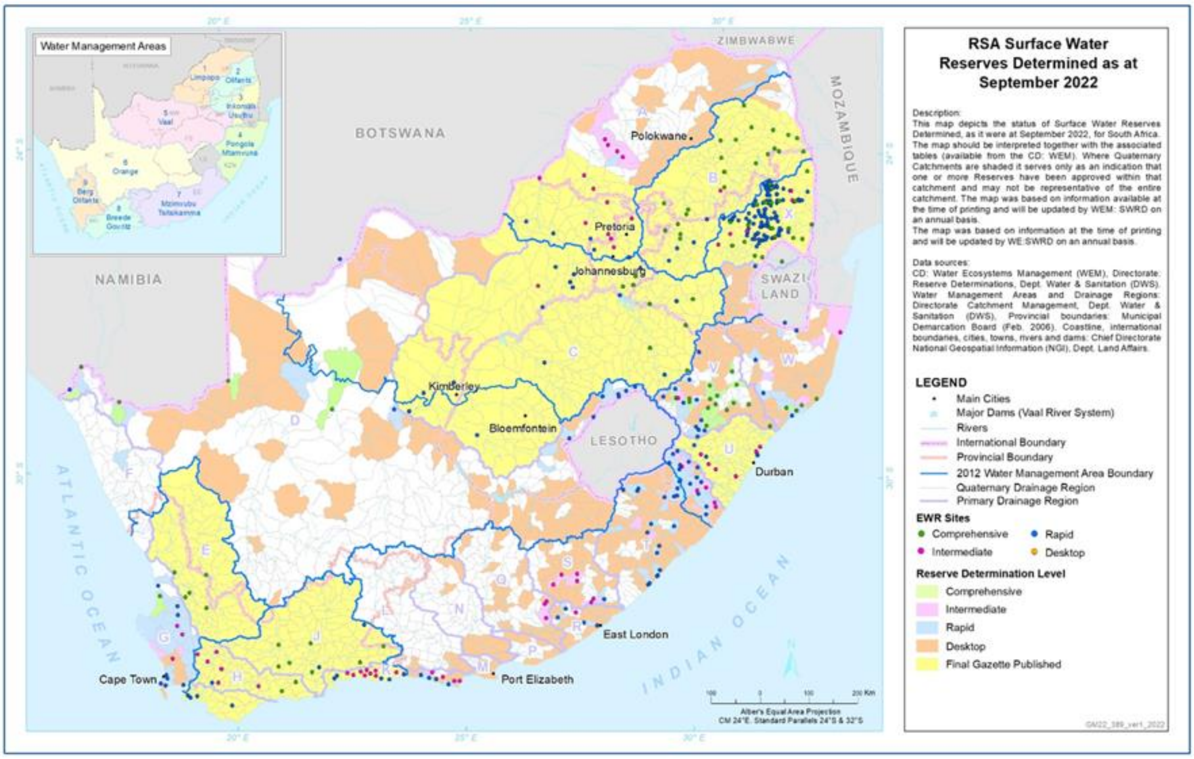


Figure: Surface Water Reserves determined as of September 2022

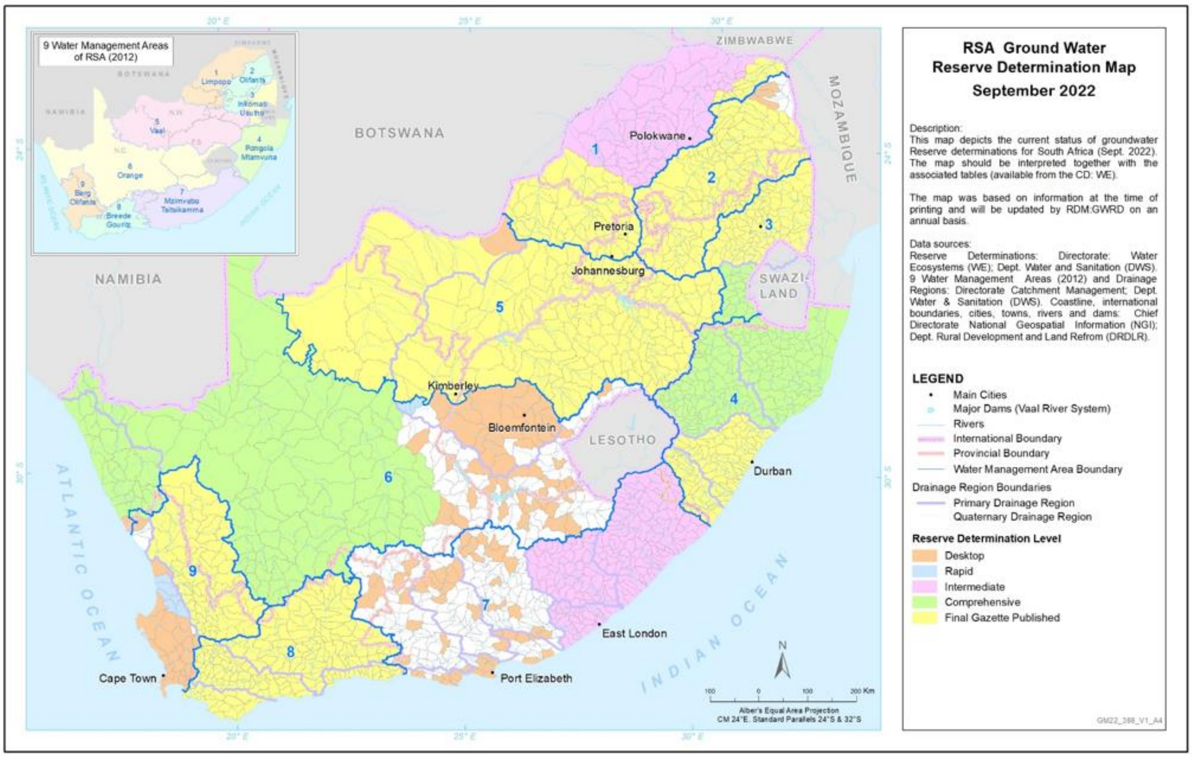


Figure: Groundwater Reserves determined as of September 2022

DWS Progress on Reserve Determination

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

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

Water Management Area	Desktop	Rapid	Intermediate	Comprehensive	Total
Limpopo	0	0	0	0	0
Olifants	0	0	0	0	0
Inkomati-Usuthu	0	0	0	0	0
Pongola-Mzimkhulu	0	0	0	0	0
Vaal	5	0	0	0	5
Orange	1	0	0	0	1
Mzimvubu-Tsitsikamma	13	0	0	0	13
Breede-Gouritz	1	0	0	0	1
Berg-Olifants	0	0	0	0	0
TOTAL	**20**	**0**	**0**	**0**	**20**

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

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

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

8.8.6 Sanitation services

According to the National State of Water Report 2022, the Africa Water Vision 2025: is for *"an Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment."* This shared vision calls for a new way of thinking about water resources management and its use even in sanitation delivery programmes.

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

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

8.8.6.1 *Sanitation technology options used in South African*

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

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

8.8.6.2 *Status of sanitation services*

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

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

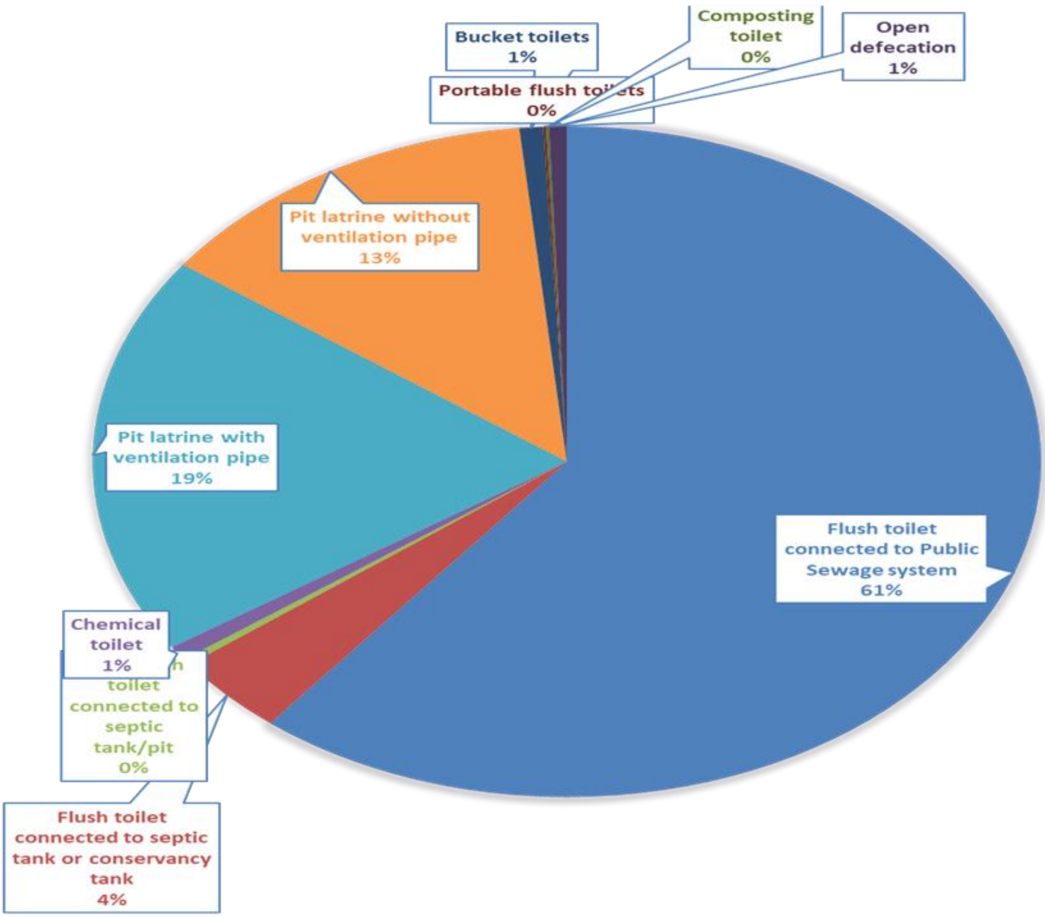


Figure: Sanitation systems used in South Africa

8.8.6.3 *Development of the Faecal Sludge Management (FSM) Strategy*

According to the National State of Water Report, 2022, There are operations and maintenance needs that should be met which necessitate faecal sludge management from the collection, transportation, treatment, safe disposal, or reuse. In the past, the operation and maintenance of onsite sanitation technologies have not been given attention when compared to offsite sanitation systems, which include sewerage networks and Wastewater Treatment Works.

Faecal sludge management technologies

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

Faecal sludge management financing

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

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

8.8.7 Water resource development

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

8.8.7.1 Augmentation projects

Water infrastructure is aging and becoming dysfunctional. Aged infrastructure results in huge water losses and water supply backlogs. Infrastructure renewal lies in the responsibility of the Infrastructure Management Branch within the Department, which is also responsible for the management of Government Water Schemes (GWSs). Table 7-5 reports the progress made on augmentation projects that the Chief Directorate is implementing: Infrastructure Development for the period up to the end of September 2022.

Table: Progress of augmentation projects across the provinces

Province	Project Description	Projects status	Other
Limpopo	Nandoni Dam	Giyani water services project, including the pipeline from Nandoni Dam on progress	Nandoni water purification upgrade, including possible waste-water treatment plant
	Phase 2 of the Olifants River Water Resources Development Project (ORWRDP – 2) involves the development of additional water resource infrastructure consisting of the De Hoop Dam on the Steelpoort River	A BOQ for repairs to the Buffelskloof houses, water supply, and sewage network, and Tshehla Trust furrow has been compiled and is being finalised	

Western Cape	The project for the Raising of Clanwilliam Dam is aimed to provide additional water to improve the assurance of supply for agriculture, provide for water allocations to resource-poor farmers and to address dam safety aspects. The scope of the work includes the raising of the existing dam wall by 13 metres, the relocation of a section of the N7 directly affected by the raised dam wall and the raising of the secondary provincial roads affected by the Full Supply Level	The civil design is complete. Most of the construction drawings are complete and have been formally issued to the Contractor. Construction progress is at 12% completion	Upgrade of Greater Brandvlei Dam Scheme
Gauteng	Lesotho Highlands Phase 2	Lesotho Highlands Phase 2 is in progress	
KZN	uMkomazi Water Project Raising of Hazelmere Dam. The project for the Raising of Hazelmere Dam is aimed to augment the water supply to the KZN North Coast by raising the dam wall by 7 metres to increase the yield of the dam for medium-term supply. The scope of the work includes the construction of a piano key weir on the spillway, the installation of rock anchors, foundation grouting and other minor works	To date, 73 anchors have been installed and stressed. Progress on the dam wall construction is at 97%completion. Work on the intake tower and the left and right flank training wall is complete, and work on the NOC screed and training wall is in progress. The appointment of a private contractor for the construction of the permanent houses is in progress	
Eastern Cape	Ncwabeni off-channel storage dam The project involves the construction of a new concrete faced zoned rockfill dam on the Ncwabeni River, with a multi-level intake tower, an abstraction weir on the Umzimkhulu River and a pump station and pipeline to pump water into the off-channel storage dam	Civil and mechanical designs independent of geotechnical investigations and surveys are continuing. The preliminary design is 85% complete, the detailed design is 25% complete, and tender documentation is 8% complete. The procurement of environmental engineering, geotechnical engineering and surveying services required to advance the design work is being hindered by the lack of funding for the project	

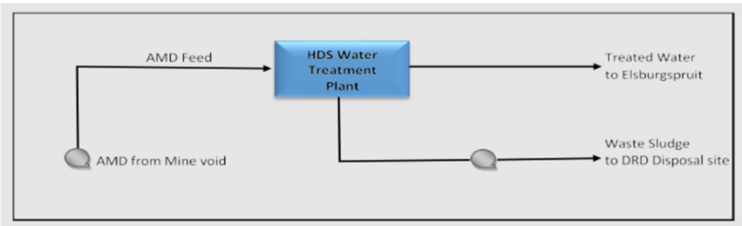
8.8.7.2 Trans-Caledon Tunnel Authority

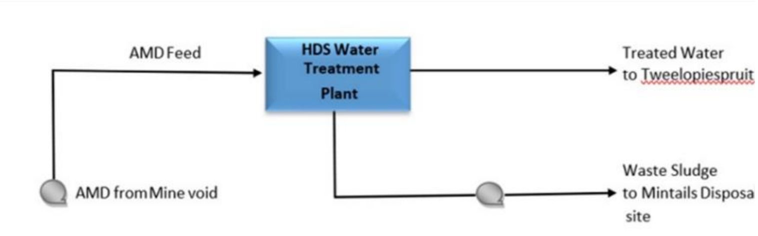
The project summary in the table below presents an overview of various TCTA projects at various stages and the status of the projects. Climate change, increasing population growth, and urbanisation continue to exert pressure on the timely delivery of traditional water infrastructure projects to meet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

No.	Project name	Start date	End date	Project description	Status
PROJECTS AT PREPARATION PHASE					
1.1	uMkhomazi Water Projects – Phase 1	February 2019	2031	Water requirement projection indicates that the Umgeni System is experiencing a deficit since 2016 and therefore there is a need for new water resources, hence uMWP-1. uMWP-1 consists of Bulk raw water implementation by	Design Complete: N/A

No.	Project name	Start date	End date	Project description	Status
				TCTA and Bulk Potable Water Implementation by Umgeni Water. The Bulk Raw Water portion consists of: • 81m high dam and appurtenant works at Smithfield on the uMkhomazi River near Bulwer. • Conveyance infrastructure (32km 3.5m diameter tunnel and 5km 2.6m diameter raw water pipeline) to the proposed Umgeni Water's Water.Treatment Works (WTW) in the uMlazi River valley. Cost at Completion: R 23.243 billion Percentage Actual Spend to Date: 0%	
1.2	Berg River Voelvlei Augmentation Scheme (BRVAS)	May 2017	February 2028	The Water Reconciliation Strategy for the Western Cape Water Supply System (WCWSS) indicates that the system is projected to be in deficit soon and should have been augmented by at least 2019/20 to avert a serious shortfall. The urgent need for augmenting the WCWSS has become evident by the system's inability to cope with the current drought situation. BRVAS is conceptualised to abstract winter flows from the Berg River and pump it to the existing Voëlvlei Dam, increasing the yield by 23 million m^3 per annum and consists of: • abstraction works in the Berg River - diversion weir, sediment traps, 5MW pump station; • canoe chute-fish way; and • a 6.3 km long pipeline to deliver the water to the Voëlvlei Dam Revised Cost at Completion: R 1 746 242 452 Percentage Actual Spend to Date: 3%	Design Complete: 100% (conceptual design)
1.3	Mokolo and Crocodile River Water Augmentation Project-Phase 2A (MCWAP-2A)	April 2019	April 2030	Additional water from MCWAP-2A is required to provide Eskom with a second water source to run their two Waterberg power stations, Medupi and Matimba. This water is to further provide Medupi Power Station with enough water to operate the additional three Flue Gas Desulphurisation (FGD) units and Matimba Power station to operate their 6 FGD units could not be supplied from the MCWAP-1 pipeline. It will also provide the Lephalale Local Municipality with water and provide Exxaro with the required additional water to increase its mining capacity. The Industrial Development of the Waterberg area is one of the objects of the PICC SIP-01 programme, and the project will also aim to provide water to aid that industrialisation. MCWAP-2A consists of an abstraction weir, a River Management System and implementation of	Design Complete: 99%

No.	Project name	Start date	End date	Project description	Status
				a 160 km water transfer infrastructure with a capacity of 75 million m3/annum with associated ancillary infrastructure. Design Complete: 99% Cost at Completion: R12.36 million	
ADVISORY SERVICES					
2.1	Mzimvubu Water Project (MWP): Stage 1	2019	2025	Two multi-purpose dams and associated infrastructure, Ntabelanga and Lalini dams, on the Tsitsa river, which is a tributary of the Mzimvubu river, will be developed to provide for potable water supply, irrigation, hydropower, and tourism. Government has classified the project as a Strategic Integrated Project under SIP-3. The project aims to develop the water resources in the Mzimvubu river catchment to provide a stimulus for the regional economy, in terms of domestic water supply, irrigation, hydropower generation and job creation. The project was envisaged to be implemented in 4 stages (2018/19). Stage 1 is Advanced Infrastructure, mainly access road. Stage 2 is the Implementation of Ntabelanga Dam and Water Treatment Works. Stage 3 involves the bulk distribution system. Stage 4 is the Irrigation and Hydropower components – roads, staff housing. TCTA is only providing Project Management advisory services for implementation of Stage 1. Cost at Completion: R 15 billion construction cost Percentage Actual Spend to Date: 29% of construction cost.	Design Complete: 0%
PROJECTS AT CLOSE OUT PHASE					
3.1	Olifants River Water Resources Development project –Phase 2C	March 2012	2020	The ORWRDP-2 bulk distribution system (BDS) transfers water from the De Hoop and Flag Boshielo dams for municipal and mining needs in the middle Olifants river catchment area, unlocking significant social and economic development. Phase 2C will improve water supply to Jane Furse/Nebo Plateau and for mining activities in the Steelpoort-Burgersfort area. Phase 2C has been implemented by TCTA as per revised Ministerial Directive Construction Complete: 100% Cost at Completion: R2 544 million	Construction Status: 100% Complete

Project		Directive	Strategic Impact	Status
PROJECTS ON HOLD				
4.1	Olifants River Water Resources Development Project – Phase 2B (ORWRDP-2B)	To source funding and implement commercial portion of Phase 2B. Augment water supply to Mogalakwena Local Municipality by 50 million m^3 per year. DWS signed MOI with Mines for the implementation of the outstanding phases on a JV basis with shared responsibility.	Augment water supply to Mogalakwena Local Municipality by 50 million m^3 per year	DWS signed MOI with Mines for the implementation of the outstanding phases on a JV basis with shared responsibility. TCTA awaits DWS guidance on what role TCTA will play within the new institutional framework. TCTA also placed this on agenda with the Minister.
4.2	Acid Mine Drainage – Long Term Solution (AMD-LTS)	To fund and implement the AMD Long-term solution.	Desalination of partially treated acid mine drainage water from the Short-term Intervention to a potable or industrial standard.	TCTA Board raised the way forward on the implementation of the Long-Term solution during the meeting with the Minister, feedback from DWS is awaited.
POTENTIAL PROJECTS				
5.1	Olifants River Water Resources Development Project (ORWRDP - 2D, 2E and 2F) – Phase 2B	Possible directive for TCTA to implement social phases related to Phases 2D, 2E and 2F withdrawn.	Development of additional water resource infrastructure.	See ORWRDP-2B above
5.2	Nwamitwa Dam	Possible directive to TCTA to implement the project.	Increase in water supply for commercial and social use in the Tzaneen area.	Proposal made to DWS and awaiting response.
OPERATIONS AND MAINTENANCE				
6.1	Acid Mine Drainage Treatment Plants in the Western, Central and Eastern Basins	**Objectives:** • To draw down the AMD Central Basin water level to be at or below the level recorded on 31 March 2021. • To operate and maintain the Central Basin – High Density Sludge (HDS) Water Treatment Plant in a cost effective and environmentally sustainable manner.  Winze 18 Shaft. During the year 1 April 2021 - 31 March 2022, the water level not to exceed 1m below shaft collar to operate and maintain the Western Basin - High Density		

Project		Directive	Strategic Impact	Status
		Sludge (HDS) Water Treatment Plant in a cost effective and environmentally sustainable manner.  		
6.2	Delivery Tunnel North (DTN) of the Lesotho Highlands Water Project (LHWP)	**Objectives:** • To transfer water as per LHWP Treaty, protocol VI. • To operate and maintain the Delivery Tunnel North transfer scheme in a cost effective and environmentally sustainable manner. Operator: As from 1 January 2021, Nafasi Water (Pty) Ltd was appointed to operate the plant for duration of 60 months.		

8.8.8 Water monitoring programmes

This section outlines the water monitoring programmes extracted from the National State of Water Report, 2021.

8.8.8.1 Surface water monitoring

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

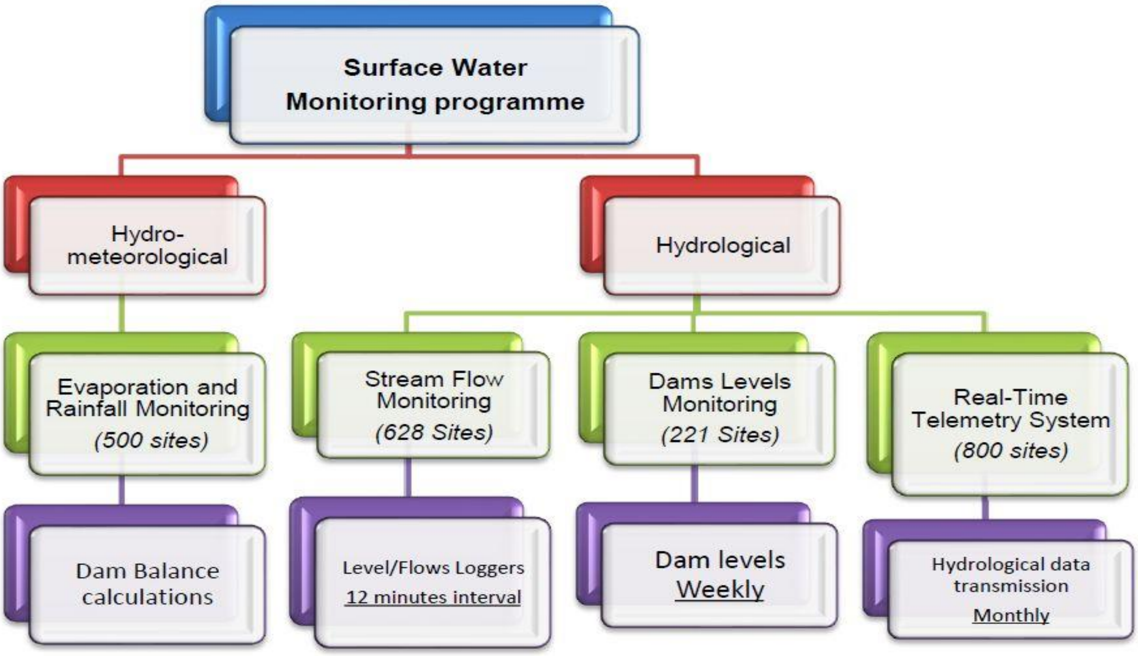


Figure: Summary structure of the surface water monitoring programmes

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

Dam Levels Monitoring

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

Evaporation and Rainfall Monitoring

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

Streamflow Monitoring

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

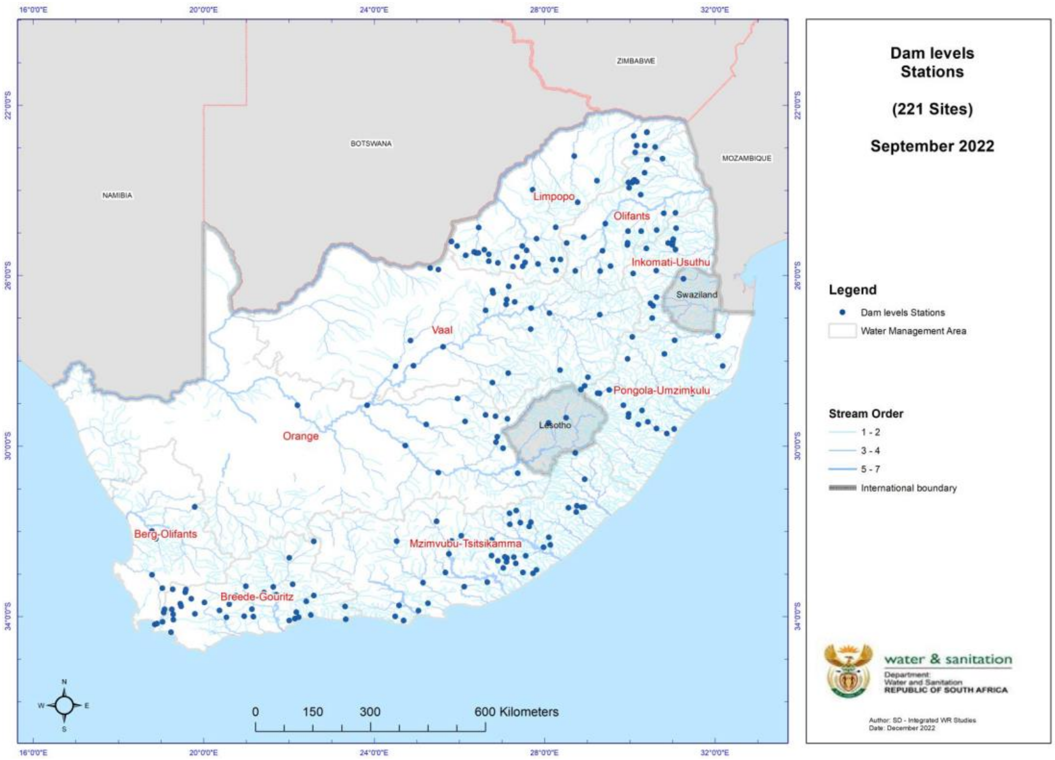


Figure: Dam levels monitoring stations network

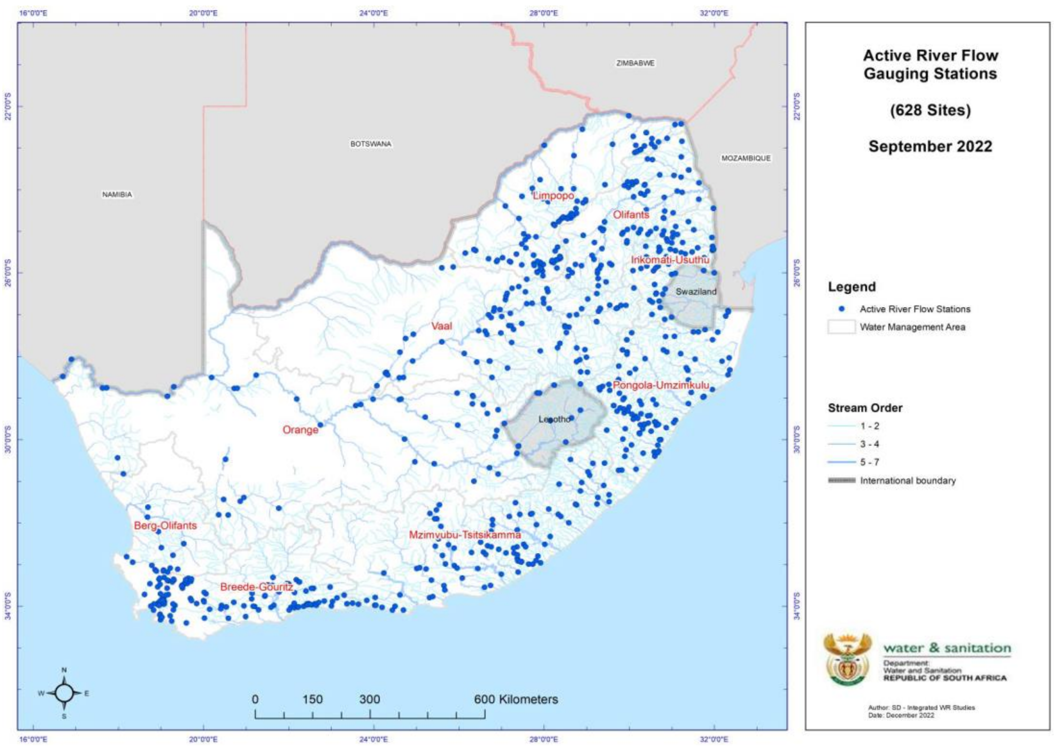
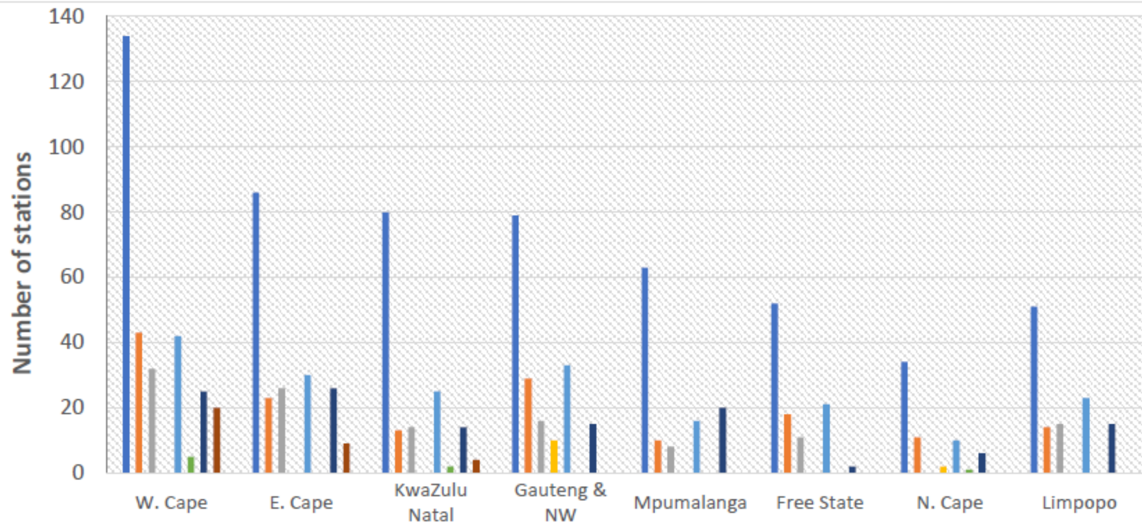


Figure: Streamflow monitoring network

8.8.8.2 Surface water monitoring network data availability

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

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



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

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

8.8.8.3 Ground water monitoring

The groundwater monitoring within the Department of Water and Sanitation consists of two programmes which are groundwater quality monitoring and groundwater level monitoring, as presented in the figure below.

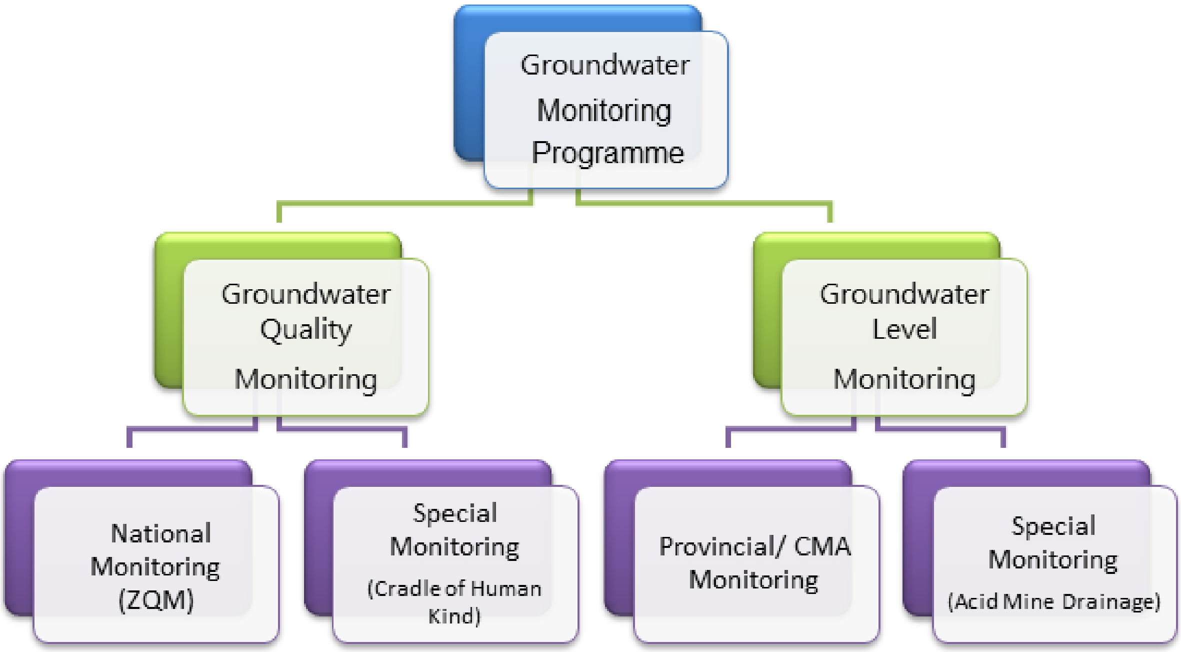


Figure: Groundwater Monitoring Programmes

8.8.8.4 Ground water level monitoring

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

Figure: Active groundwater level monitoring sites 2022

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

8.8.8.5 *Available groundwater level monitoring*

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

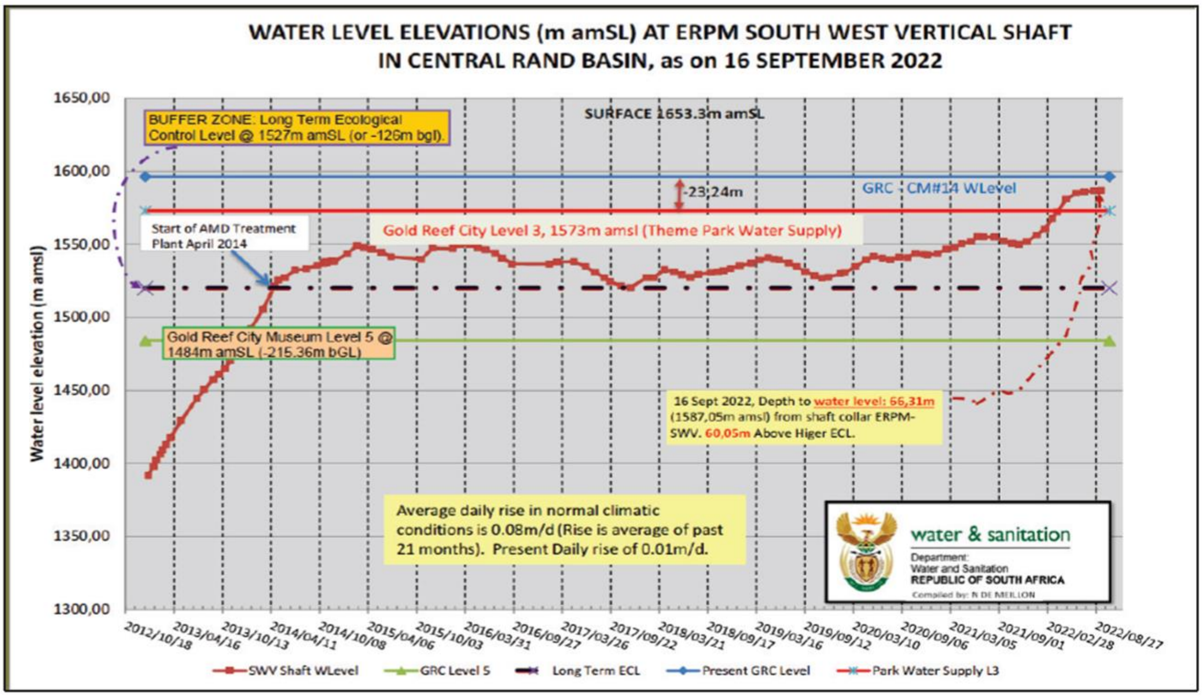


Figure: Water level special monitoring for AMD data analysis

Most groundwater level monitoring equipment is still predominately manually utilizing a dip meter. KwaZulu-Natal, Gauteng, Free state, and the North West regions are 100 percent monitored by electronic data loggers. Electronic data loggers improve the timeliness of data which can be helpful to the water sector in helping with sustainable management of groundwater resources in the wake of climate change. The promise of the data revolution has not been oversold, and researchers have highlighted the need for investment to build robust, validated models and infrastructure.

8.8.8.6 *Available groundwater quality monitoring*

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

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

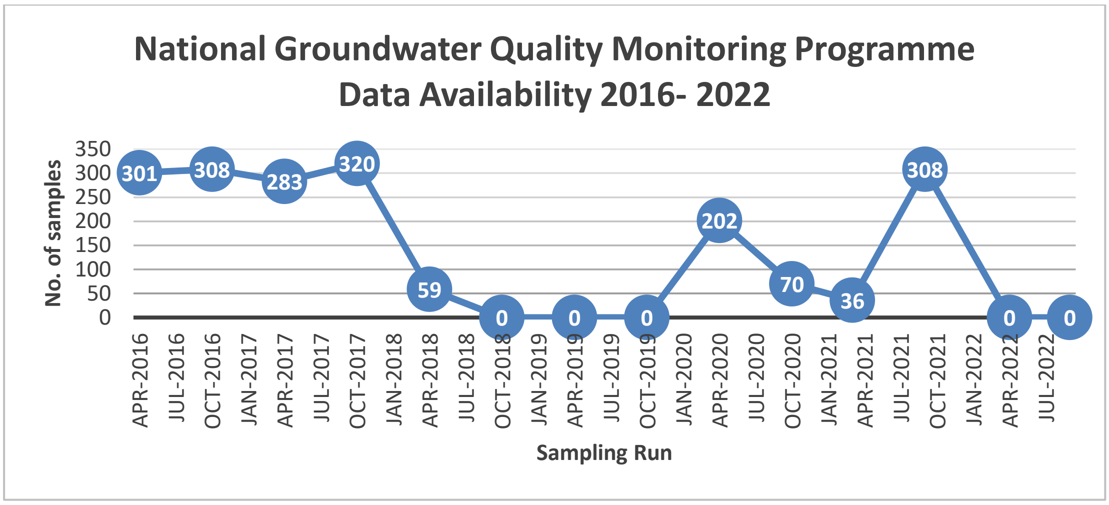


Figure Groundwater quality samples analysed - end September 2022

8.8.8.7 *Surface water quality monitoring*

This section outlines the surface water quality monitoring programmes and the information was extracted from the National State of Water Report, 2022.

National chemical monitoring

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

The main objectives of this national scale programme include:

- Determining the inorganic status and trends in South African rivers.
- Supporting the National River Ecostatus Monitoring Programme (REMP); the United Nations Environmental Programme – Global Environmental Monitoring System (UNEP GEMS), and Sustainable Development Goals (especially SDG 6.3) initiatives.
- Contributing to the integrated overarching historical database; and
- The dissemination of data and information.

The parameters monitored include the salinity, which is measured as Total Dissolved Solids (TDS) or Electrical Conductivity (EC), the concentrations of Iron (Fe), Sodium (Na), Chloride (Cl), Magnesium (Mg), Potassium(K), Sulphates (SO_4), Ammonium (NH_4) and Nitrates-nitrites (NO_3 + NO_2). The NCMP also measures the ammonium and nitrate-nitrite levels, indicating nutrient loading from discharges and return flows into water resources.

The priority NCMP sites had a sampling compliance of 1.1% for the 2020/21 hydrological year, while the sampling compliance for 2021/22 increased to 7.0%. Site visits also increased from 15.9% for the 2020/21 period to 42.2% for the 2021/22 hydrological year. It is anticipated to increase to at least 70% in 2022/23.The Department is currently reviewing all sampling sites in line with the optimised network to consider possible additional sampling sites and to refine the current sample site list of the priority NCMP. Additionally, the formalisation of the working relationship with DWS Regional Offices through Service Level Agreements (SLAs) is at an initial stage to ensure better understanding and cooperation between sampling and coordination.

National eutrophication monitoring

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

- Establishing trophic status in dams/lakes
- Early warning system – water treatment
- Early warning system – blooms
- Early warning system – invasive macrophytes
- Early warning system – long-term impacts
- Nutrient balance

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

A total of 119 sites were sampled during the 2021/22 hydrological year, and this was a significant improvement from 52 sites reported during the 2020/21 period. The improvement can be attributed to the improvement of RQIS laboratory capacity after method development, recruitment of additional sampling personnel, and committed monitoring in the RQIS, IUCMA, Limpopo Regional Office, Eastern Cape Regional Office, and various Water User Associations. Plans are underway to reactivate monitoring in Northern Cape, Western Cape, and KwaZulu-Natal Provinces.

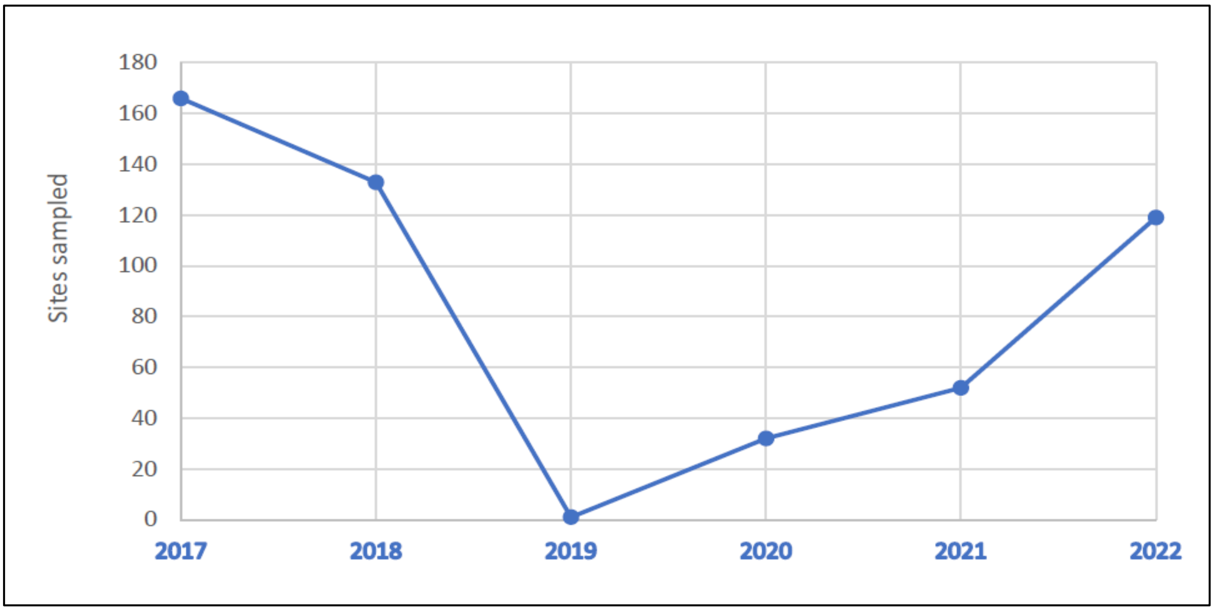


Figure: NEMP data availability from the year 2017 to 2022

8.8.8.8 *NEMP optimisation*

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

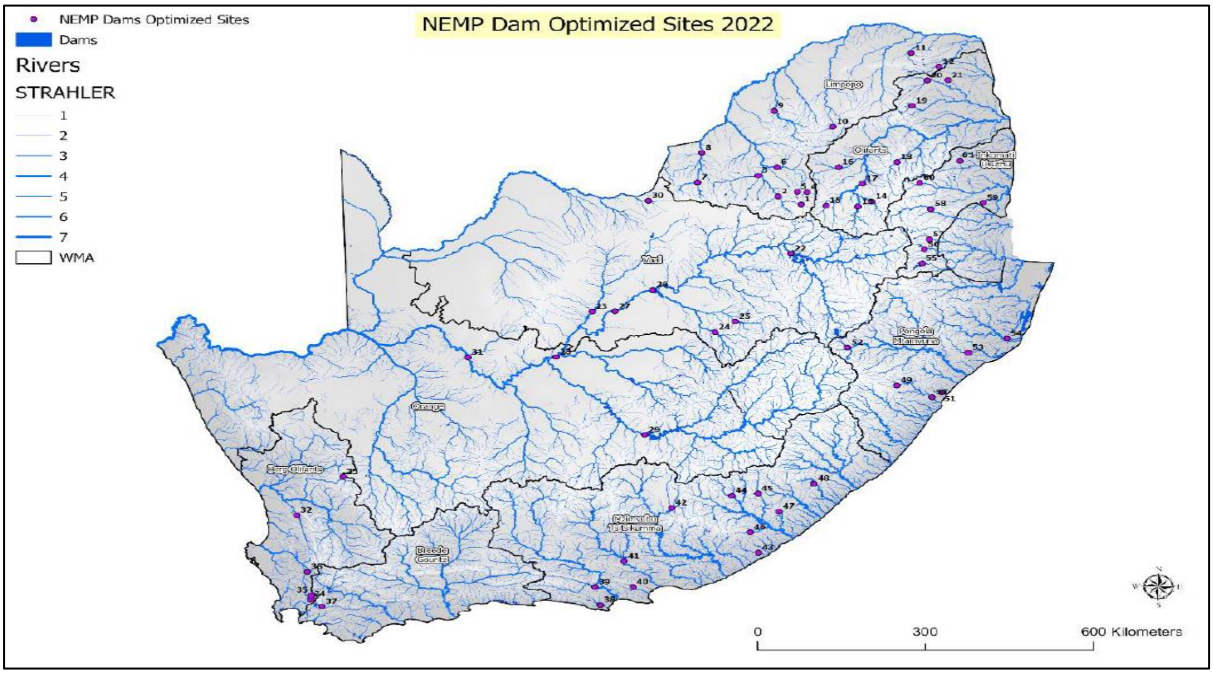


Figure: Distribution of Optimised NEMP dam sites across the country

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

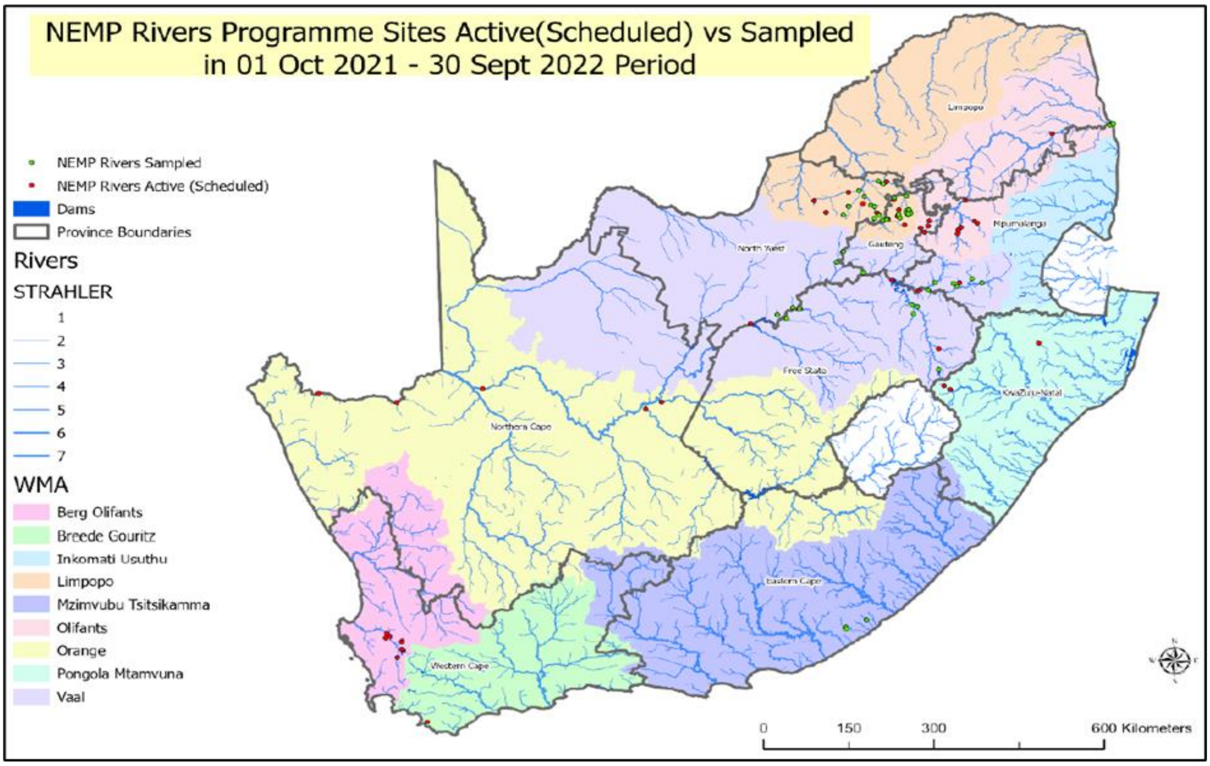


Figure: Map showing scheduled NEMP rivers versus sampled site

National microbial monitoring

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

8.8.8.9 *National integrated water information system*

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

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

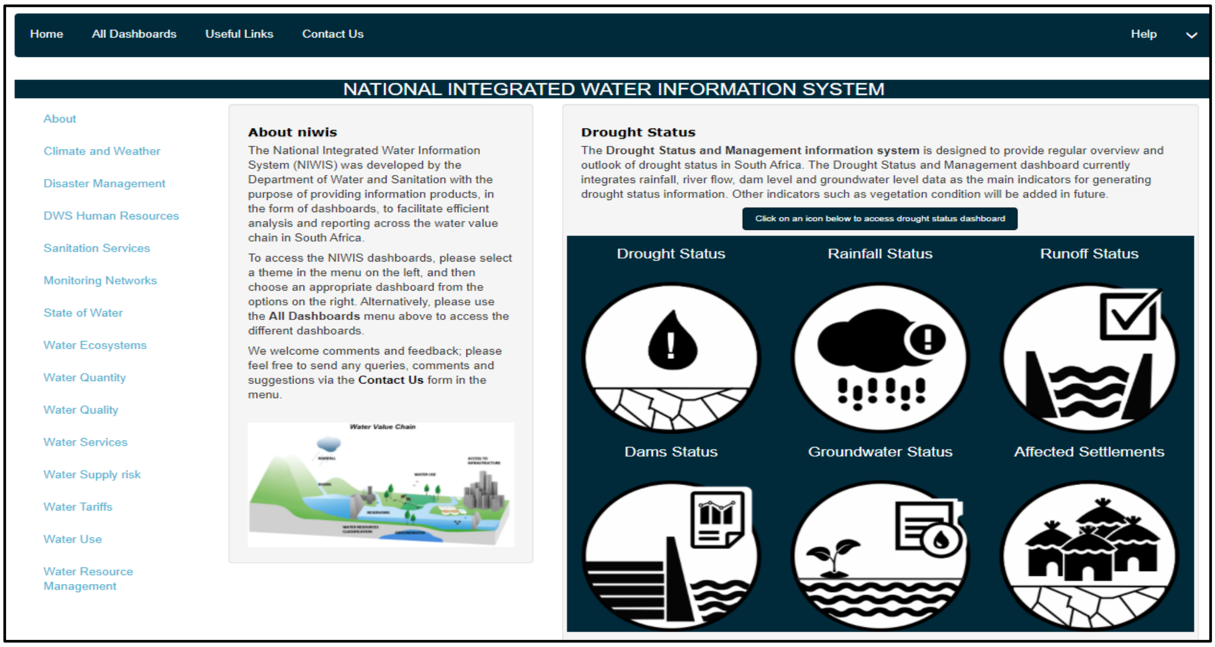


Figure: NIWIS landing page (https://www.dws.gov.za/niwis2/)

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

8.9 Youth participation

This section summarises initiatives meant to encourage youth and youth-led organisations participation in environmental management which is line with Chapter 2 of the National Environmental Management Act (No. 107 of 1998) and Sustainable Development Goals (SDGs) and the National Development Plan 2030 which also stipulates the need for (i) active citizenry; (ii) creation of work opportunities for youth; (iii) development of environment sector skills; (iv) creation of work experience opportunities to ensure youth employability; and (vi) enhancing the environment capacity in municipalities to enable effective and efficient execution of environment functions addressing existing environment capacity gaps.

8.9.1 Driving force for change pilot youth support initiative

During 2019/20 financial year the Department of Forestry, Fisheries and Environment (DFFE) developed a dedicated pilot support initiative equivalent to ZAR 1 million for the youth and youth-led organisations. Through this pilot initiative, youth and youth-led organisations will have the opportunity to apply for funding and each successful applicant is eligible for financial support of up to ZAR 100 000 per project in the areas of climate change, waste and biodiversity, with the view to contributing to achieving our Nationally Determined Contributions (NDC) and the Sustainable Development Goals (SDGs). The support is for the following activities:

- Stakeholder engagement and consultation;
- Prefeasibility studies;

- Feasibility studies;
- Project structuring; and
- Identification of full project financing.

Through this pilot initiative the DFFE is hoping that the supported youth and youth-led organisations will become that "Driving Force for Change" and develop and lead environmental initiatives that will put the country on the path of a low carbon and climate resilient development pathway.

8.9.2 Youth community outreach programme

The Youth Community Outreach Programme (YCOP) is a ward-based environmental education programme aimed at nurturing youth to be environment ambassadors who will participate actively in environment management whilst creating jobs and work experience. The key objectives of the programme include –

- Enhancing active participation of youth in environmental management in line with Chapter 2 of the National Environmental Management Act No. 107 of 1998 (NEMA) which stipulates the need for active participation of communities, women, youth and people with disabilities in environmental management; the Sustainable Development Goals (SDGs) and the National Development Plan (NDP) which also stipulates the need for active citizenry.
- Creation of youth work opportunities and work experience in line with the Presidential Youth Employment Programme to ensure youth employability.
- Development of environment sector skills.
- Enhancing the environment capacity in Municipalities to enable effective and efficient execution of environment functions addressing existing environment capacity gaps.

The DFFE intends to appoint 5075 youth who will be divided into three categories namely, municipality youth environment coordinators, environment awareness campaigners and general workers and be placed in the 213 municipalities of South Africa. These young people are the champions of the Thuma Mina Good Green Deeds Programme which is aimed at ensuring a clean and safe South Africa by conducting environmental education and awareness, daily clearing of illegal dumps and mobilise community based clean up campaigns of illegal dumps at ward level. To date 5064 youth have been appointed of which 4862 are employed as Extended Public Works Programme (EPWP) participants. The role of these EPWP participants is to do daily clearing of illegal dumping sites and others do environmental awareness in the areas where the illegal dumping sites are situated.

The 202 youth are DFFE employees contracted for 3 years effective from 2019 and placed in the 191 municipalities. hey are environment graduates whom are incubated to attain experience for employability. They are part of the local government support programme team of the department which is aimed at enhancing the capacity of municipalities to ensure effective and efficient delivery of environment functions. They are responsible for the following functions –

- Providing support in the implementation of the Good Green Deeds Programme which is composed of ward-based environmental education and awareness, and clean up campaigns of the illegal dumps/hot spots identified, prioritized, approved by the Municipality and the Department Forestry, Fisheries and the Environment.
- Development of ward profiles reflecting environmental challenges.
- Environment stakeholder liaison within the municipality. Champion the coordination of school based environmental education in consultation with the Provincial Department of Environmental Affairs, Local Government Support (LGS) team and other environment sector stakeholders.

- Providing support in the coordination of environment governance structures.
- Participation in the ward-based local government development structures convened by the Ward Councillors to capture all environmental related challenges raised.
- Supporting municipalities in executing the environmental functions as stipulated in their Service Delivery and Budget Implementation Plans (SDBIP) such as waste management, air quality and climate change, compliance and enforcement. This is the key performance area which will strengthen environment capacity in municipalities whilst the youth gain work experience and environmental knowledge.
- Developing and maintaining a database of employed youth in the environment sector programmes and projects as well as unemployed youth with environment qualifications.
- Disseminating environmental information to the community libraries.
- Providing support in the planning and implementation of Environmental Calendar Days activities as planned by the Department of Forestry, Fisheries and the Environment, and environment sector stakeholders.

To date these young people have achieved the following –

- Exposed to capacity building programmes such as climate change, air quality, biodiversity and conservation, waste management;
- Conducted 1547 community-based environment awareness campaigns;
- Convened 3315 community clean up campaigns;
- Conducted schools-based environment awareness campaigns;
- Profiling of municipalities for the Presidential District Development Model; and
- Provided support to the municipalities in the waste management functions such as auditing of landfill sites, development of waste management bi-laws, development of integrated waste management plans, air quality monitoring stations, development of climate change response plans, coordination of Ministerial and Mayoral events relating to environment and forestry, environment compliance and enforcement, convening municipality environment government structures- amongst others.

Youth Community Outreach Programme Workshop, 02 -03 September 201, DEFF National Office - Pretoria

Environmental awareness- handing out information on recycling and illegal dumping to communities

Conducting Community Environmental Education that took place on the 10th of January 2020 at Theunissen local clinic.

8.9.3 Work integrated learning programme

The work integrated learning (WIL) programme was piloted by the Department of Forestry, Fisheries and the Environment (DFFE) in the 2018/19 financial year with hundred (100) university students recruited over six months period and was followed by the same number of students in 2019/20 financial year. The programme is ongoing with a target of 400 WIL placements for 2022/23, to cover the slow COVID-19 lockdown period, and an overall 5-year MTSF 2019-2024 target of 1000. The programme is in response to the demand for work-ready graduates who are familiar with organizational practices in the workplace. The programme provides a career-related experience that extends the learning process beyond the limitations of the lecture room. It offers a learning opportunity for final third year universities students through dialogue, reflection, tutorials and assessable work to prepare students to be ready for work. The students are guided by workplace supervisors and mentors to understand how the environmental, scientific and technical principles work to improve sustainable systems to solve environmental issues

The final third year students are provided with an opportunity to undertake a work practicum as part of the degree in order for them to acquire the scientific, technical skills, research, communication and management to meet workplace expectations.

The targeted one hundred (100) WIL students recruited annually by DFFE secure placement with relevant DFFE line functions, public entities, provincial departments or municipalities. The students receive an opportunity to understand more about the expectations and requirements of their professional field, expectations of the employer and the level at which they will be required to function, once qualified. They learn from real-life situations which are effectively and authentically assessed by university-based educators. The work experience gained during WIL is of value when the students apply for permanent employment backed by useful employment contacts and marketable experience. Thus, WIL benefits students in many ways including, for example, sharpening their interpersonal relations, practical knowledge of policy formulation and analysis, writing skills, awareness of workplace culture, mastery of job knowledge and skills, project management, coping in a rapidly changing world of work, enhanced employment prospects, developing interactive attributes, and building a network of contacts.

For some of the employers the benefit is using WIL as a recruitment pathway; an opportunity to closely examine the skills and suitability of students before they graduate. For others, it may provide an enthusiastic, short term ‘employee’ who can undertake projects or tasks which might not otherwise get done while providing existing employees opportunities to learn valuable mentoring and management skills. Some employers are enthused by raw talent, research skills, and fresh ideas and approaches that students bring to the workplace. For the DFFE, the experience goes beyond altruistic outcomes as the students are positioned to contribute to the environment sector and address the shortages of environmental management, scientific and technical skills much needed in the country. Worth noting is that the DFFE has an opportunity to consider contributing in respect of curriculum design and research or better still strengthen relationships with participating tertiary institutions. This is also an opportunity for academics to not only integrate theory and practice, but also be able to assess their experiential learning component as part of qualification.

8.9.4 Keep it cool climate change education project

Keep it Cool Climate Change Education (KIC-CCE) project is implemented by VVOB Education for Development and GreenMatter in partnership with Fundisa for Change. Fundisa for Change is a national programme that was developed by the environmental sector partners to provide a coordinated approach to transformative environmental and Education for Sustainable Development (ESD) learning for systemic impact.The project’s objective is to utilise the education sector as a strategic resource in South Africa’s transition towards a more climate resilient society. Through the KIC-CCE project, VVOB and GreenMatter in partnership with Fundisa for Change bring together multiple actors from the side of the government, relevant entities; academia – specifically the university members of Fundisa for Change; and civil society. The key expected outcome is an enabling environment for secondary schools in KwaZulu Natal (KZN), Eastern Cape and Limpopo to make climate change education part of school and classroom practice. The project is meant to support 100 secondary schools in the implementation of innovative, curriculum aligned climate change adaptation projects that actively involve students and surrounding communities.

The project comprises of four result areas which are formulated as follows –

- Result Area 1: At national level, multiple key actors (DFFE, DBE, Higher Education Institutions (HEI's), parastatals and NGO partners) address CCE in education policy, guidelines and materials.
- Result Area 2: At local level (province / district), multiple key actors (DFFE, DBE, HEI's and other stakeholders) collaborate to overcome the fragmentation of knowledge, policy and practice.
- Result Area 3: At secondary school level, teachers – with the support of school leaders – implement innovative, curriculum-aligned CCE projects, involving students and communities.
- Result Area 4: Selected HEIs conduct process tracing on teacher professional development and implemented CCE projects and disseminate findings at national and local levels.

The project also includes a communication strategy that promotes the exchange of knowledge and promising practices among the stakeholders involved and raises awareness and creates support for CCE and for the project beyond its immediate scope.

The project is currently engaging with various stakeholders at National and Provincial levels, developing the research design that would accompany the project, gathering information and identifying Climate Change Projects working with schools in the various provinces.

8.9.5 Groen sebenza programme

Groen Sebenza is a South African National Biodiversity Institute's (SANBI) and the biodiversity sector's pioneering and flagship human capital development programme aimed at operationalizing the biodiversity sector's 20-year National Human Capital Development Strategy (NBHCDS). SANBI is mandated through the National Biodiversity Framework (NBF) and National Biodiversity Strategy and Action Plan (NBSAP) to lead the development and implementation of the human capital development strategy with and for the biodiversity sector.

The programme was officially launched in June 2013 by the late Honourable Minister of Department of Forestry, Fisheries and the Environment (DFFE), Ms Edna Molewa, following the recruitment of the first cohort of 955 unemployed young people from across the country. SANBI led the implementation of the programme with 44 host institutions within the biodiversity sector and the programme was funded by The Presidential Jobs Fund Programme (managed by National Treasury) to the tune of R300m.

The Groen Sebenza Programme has the following three main objectives –

- Through the 'incubator model' young people are given workplace experience through an extended internship programme of at least two years involving structured mentoring, skills development and training opportunities.
- Enhance collaboration amongst biodiversity stakeholders to address shortage of priority skills and job creation in the biodiversity sector
- Unlock additional job opportunities and encourage economic activity in the medium term, through performing skilled roles, entrepreneurial initiatives, running projects that support extension, regulatory and compliance functions critical to the development of new markets for Biodiversity and Environmental services.

At the end of Groen Sebenza I over 630 young people were placed in permanent jobs in the biodiversity sector. This significant number injection in the biodiversity/environmental sector is likely to have a profound impact on the transformational intent of the NBHCDS from a gender, age, and race and skills perspective now and into the foreseeable future. SANBI is now in the second iteration of the programme through R15m secured from the Department of Forestry, Fisheries and the Environment (DFFE) Environmental Programmes branch. Like its predecessor Groen Sebenza II aims to develop priority skills in the biodiversity sector through incubation by bringing experienced biodiversity professionals and young people together to learn, grow and eventually gain the competence and confidence to embark on rewarding and meaningful biodiversity careers. In Groen Sebenza II, due to limited funding, only 59 young people were recruited and placed only across various divisions in SANBI. The 59 comprised of graduates of various diplomas, bachelor, honours and masters degrees across various fields in the sector. The 59 were trained and mentored in different fields including horticulture, estate management, environmental and science education, forensic genetics, biodiversity planning, veterinary science, conservation, horticulture, eco-tourism, biological invasion, threatened plant species, plant physiology, wildlife and biodiversity economy, marine science research, freshwater ecology, GIS/Remote Sensing/Statistical Ecology and Climate Change. Groen Sebenza II comes to an end in March 2021 and it is hoped that further funding will be secured to continue fulfilling the NBHCDS goals of bridging the gap between qualifications and the workplace. As the NBHCDS marks its tenth year of implementation, an implementation review has been commissioned by SANBI with funding from the Lewis Foundation. The final report is expected in March 2021; it is expected that the review report will provide useful insights as to how best programmes can better support the implementation of the NBHCDS in the last remaining ten years ensuring that the ultimate goal of developing suitably qualified and skilled biodiversity professionals for the country is attained.

Groen Sebenza II interns at the national induction held at Kopanong Conference Centre, Johannesburg, September 2019

8.9.6 Youth environmental service

The Department Forestry, Fisheries and the Environment (then Department of Environmental Affairs and Tourism) introduced three (3) National Youth Service Pilot programmes which were implemented from 2008 – 2011. These pilot programmes were aligned with the Youth Service Programme that was introduced in 2003 as a Presidential programme aiming at responding to the multiple needs of young people to enable them to access new opportunities for employment, income generation, skills development and personal development while contributing to the reconstruction of South Africa. An evaluation study was conducted on the 3 National Youth Service Pilot programmes introduced by the Department and, from the lessons learnt, the department established a new programme called the Youth Environmental Service (YES).

The YES entails the involvement of unemployed young people in activities which provide environmental services that benefit the community whilst they are also provided with opportunities for personal development. The programme brings solutions to environmental problems including, but not limited to, erosion, waste, deforestation, biodiversity management, education and awareness.

The environmental services provided through this programme should meet a community need, fit within departmental objectives, and add value to the beneficiaries' development whilst providing employment, further training or self-employment by opening up business ventures as participants exit from the programme. The Youth Environmental Service is not a special employment programme or a training programme but includes service and skills development. During the time of involvement in the YES programme the youth will receive an allowance. The programme is currently on the 2017 – 2019 cycle which is planned to be concluded or closed before the end of December 2020. Each province has an implementer who is appointed by the department to implement the project. For the 2017 -2019 cycle, a total number of 2340 youth participated in the project. This was achieved through taking 260 youths per province in a period of 2 years (i.e. 2018 and 2019).

The participants are hosted by different organisations in their respective provinces which provide environment related services (these organisations are referred to as host institutions). The host institutions are responsible for providing environment related skills to the participants, this is achieved by involving the youths in the daily activities of the organisation. During the course of the programme, participants are also provided with the opportunities to attend multiple training courses such as Waste and Recycling Management, Nature Conservation Resource Guardianship, understanding aquatic ecosystems and implementing integrated catchment planning.

The last vital objective of the project is to ensure opportunities to the participants post the project or providing exit opportunities. The implementer is responsible for ensuring that participants get opportunities such as furthering their studies, employment or starting their own business after they participated in the project. So far, out of the total number of 1172 participants trained during 2018, 193 managed to secure opportunities (i.e. employment or starting business and furthering studies) after participating in the project, this number will keep on rising as more participants exits the programme. The next cycle of this project will be 2020 – 2021.

8.10 Gauteng province

The following section is an edited extract of the Annual Gauteng Environment Sustainability Report, 2022, and readers are encouraged to read the report for more, in-depth, fully referenced, information on Gauteng's state of the environment.

The section covers the following topics: (i) Air quality; (ii) Biodiversity management; (iii) Climate change; (iv) Compliance monitoring and enforcement; (v) Environmental empowerment services; (vi) Environmental information management; and (vii) Acid mine drainage.

8.10.1 Air quality management

It is a legal requirement to monitor ambient air quality to assess compliance with ambient air quality standards. Compliance with ambient air quality standards upholds the constitutional right to an environment that is not harmful to health and well-being.

The following air quality management indicators were monitored during the 2022 reporting year:

8.10.1.1 Number of continuous ambient air quality monitoring stations

The Gauteng Province has a well-established network of 32 municipal-owned ambient air quality monitoring stations, located in various parts of the province. The stations are well placed to cover emissions from residential areas and high traffic hotspots. At the stations, pollutants such as Particulate Matter (PM_{10}), $PM_{2.5}$, Sulphur dioxide (SO_2), Ozone (O_3) are measured because there are more pollution sources in the province to pose a threat to the environment and human health, hence this report focuses on these four criteria pollutants. To provide credible data to the South African Air Quality Information System (SAAQIS), the monitoring stations should always be properly maintained, operational and calibrated. It is a legal requirement to monitor ambient air quality by assessing compliance with ambient air quality standards.

8.10.1.2 Percentage of facilities reporting to National Atmospheric Emission Inventory System (NAEIS)

The NAEIS monitoring programme is a web-based atmospheric emissions monitoring and reporting system that is aimed at providing accurate, current and complete information on all significant sources of identified atmospheric emissions from South Africa. A trend analysis done on the number of facilities registered on the NAEIS in the past four years indicates an increase from 378 registered facilities in 2019 to 412 facilities in 2020. In 2021 the number of facilities increased to 428 registered facilities. In 2022, there was a decrease in the number of registered facilities to 412. The breakdown is as follows:

- The City of Ekurhuleni tops the list with 191 registered facilities, with 93.19% of facilities reporting to the NAEIS.
- City of Johannesburg has 41 registered facilities, with a 100% reporting to the NAEIS.
- City of Tshwane has 77 registered facilities, with 96.1% facilities reporting to the NAEIS.
- GDARDE licensed 9 facilities, with 100 % facilities reporting to the NAEIS.
- Sedibeng region has 48 facilities licensed and registered, with a 97.92% facilities reporting to the NAEIS.
- West Rand has 46 registered facilities, with 100% facilities reporting to the NAEIS.

The registered facilities get audited on an annual basis to ensure compliance with the AELs and associated legislative instruments. The auditing results are as follows: out of the total 412 registered facilities, 386 facilities reporting were audited, and only 36 facilities failed the audit, based on information reported.

- In the City of Ekurhuleni, 165 facilities were audited and 147 met the audit requirements, while 18 facilities failed the audit requirements.
- In the City of Johannesburg, 41 facilities were audited, and all facilities met the audit requirements.
- In the City of Tshwane, 75 facilities were audited and 73 met the audit requirements, and 2 facilities failed the audit.
- For the GDARDE, 9 facilities were audited, and all facilities met the audit requirements.
- Sedibeng District Municipality, 48 facilities were audited, and all facilities met the audit requirements.
- West Rand District Municipality, 46 facilities were audited, and 45 facilities met the audit requirements while 1 facility failed the audit requirements.

The audit results for registered facilities reporting on the NAEIS are affected by factors such as the lack of understanding of the reporting requirements. The Air Quality Management Directorate undertakes regular training of registered facilities to ensure proper reporting; moreover, the directorate also calls on registered facilities to submit their reports for auditing timeously. The department will also issue non-compliance notices to those facilities that fail to submit their reports.

8.10.1.3 Air quality management interventions undertaken

Procurement of Spare Analysers/Equipment: GDARDE procured various spare analysers/equipment to assist municipalities with spare equipment/analysers while theirs are taken out for repairs. The procured analysers include the following: Sulphur Dioxide (SO_2), Hydrogen Sulphide (H_2S), Ozone (O_3), Nitrogen Oxide (NO_X), Carbon Monoxide (CO) and Dual Particulate Matter ($PM_{10/2.5}$) Monitor. This initiative will help to mitigate data loss at the affects monitoring stations.

Procurement of 3xCalibration Gases, 3xRegulators, 1xCalibrator and 1xZero Air Generator: the calibration gases will provide physical assistance to municipalities/network owners during the zero and span calibrations. The initiative is aimed at assisting municipal officials particularly where there are no appointed service providers to manage and maintain the monitoring stations.

Ambient Data Validation Trainings: GDARDE provided physical capacity building to all network owners/municipalities on ambient data validation as it was noted that some network owners were struggling to validate their ambient data using the new South African Air Quality Information System (SAAQIS). As a result, network owners are validating their ambient data for the monitoring station under their care at their relevant jurisdiction.

Indoor Low-Cost Monitoring Sensors: two (2) indoor low-cost monitoring sensors were commissioned to measure indoor pollution at some floors at No, 56 Eloff Street, Umnotho House. The initiative is to investigate and to note the concentration of parameters within the building and compare that with the World Health Organization (WHO) standards for indoor air pollution.

Outdoor Low-cost Monitoring Sensors: two (2) outdoor low-cost monitoring sensors were commissioned, one located in Heidelberg to provide support to Sedibeng District Municipality (SDM) to gather data for the purpose of responding to frequent air pollution queries received in the area which is far from any of the existing continuous ambient air quality monitoring stations. The other sensor was installed at the top of Umnotho House to get ambient data around the building. Both the indoor and outdoor sensors will also be used to monitor before and after when the Mitigation Strategy Team is rolling out a pollution mitigation project.

The GDARDE, in partnership with City of Ekurhuleni and Gauteng Department of Community Safety conducted vehicle emission testing and awareness program at Kempton Park (P40 Road), Boksburg (Near Unilever) and Elsburg Road (Near Carnival City Casino) in October 2022. The ultimate purpose of the emission testing was to raise awareness to the motorists on the dangers posed by vehicle emissions to human health and environment with a view to change motorist's behavioural patterns. The vehicle emission test was conducted using the Hartridge smoke meter machine. The machine measured the amount of smoke emitted from the vehicle exhaust system. The maximum permissible amount of smoke the vehicle could emit was 60 Hartridge Smoke Units (HSU). The lowest emissions recorded were 0.5 HSU on a Hino truck.

8.10.2 Biodiversity management

The following biodiversity management indicators were monitored during the 2022 reporting year.

8.10.2.1 Expansion of conservation estate

Participation in the biodiversity stewardship program is voluntary and ultimately aims to incorporate more land into the provincial protected area network and conservation estate in focus areas of high biodiversity value. The department works to expand the provincial protected area network and conservation estate through primarily the biodiversity stewardship mechanism. The Gauteng Government's 418 ha land was incorporated into the Crocodile River Reserve (CRR) through the NEM: PAA declaration. The CRR, situated in the City of Tshwane was established through a partnership between the GDARDE and the landowners for biodiversity conservation purposes. Expansion of the protected area network and the conservation estate include sites that have already been declared through the biodiversity stewardship mechanism and must receive adequate support for protected area management to remain NEM: PAA compliant. Support in this regard included, amongst others:

- The compilation of a photographic tree and shrub guide for one protected area;
- The mapping of alien and invasive plants on four protected areas;
- The compilation of a management plan for bankrupt bush (*Stoebe plumosa*) for one protected area;
- Conducted veld condition assessments on one protected area to inform rangeland management; and
- Facilitated the installation of five externally sponsored signboards on three protected areas.

General conservation extension services are rendered to conservancies and any interested landowner in order to promote biodiversity conservation outside of formally protected areas. Assistance was rendered primarily for alien vegetation management and biocontrol agents were harvested and supplied for certain species.

8.10.3 Climate change

The following climate change indicators were monitored during the 2022 reporting year:

8.10.3.1 Number of climate change projects planned and implemented in Gauteng

As at the end of 2022, the climate change register had 405 projects registered, 205 of those were mitigation, 144 were for adaptation while 56 were crosscutting projects. There are 17 new projects that were registered in 2022 which includes 10 projects from mitigation, 2 from adaptation and 5 from crosscutting, with 23 education and awareness activities undertaken, see figure below.

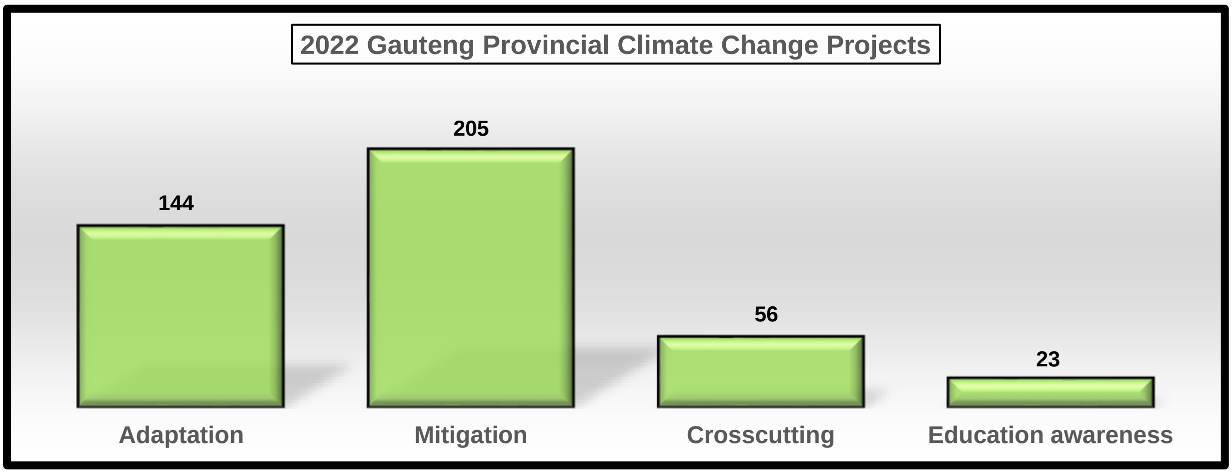


Figure: Climate change projects registered in 2022

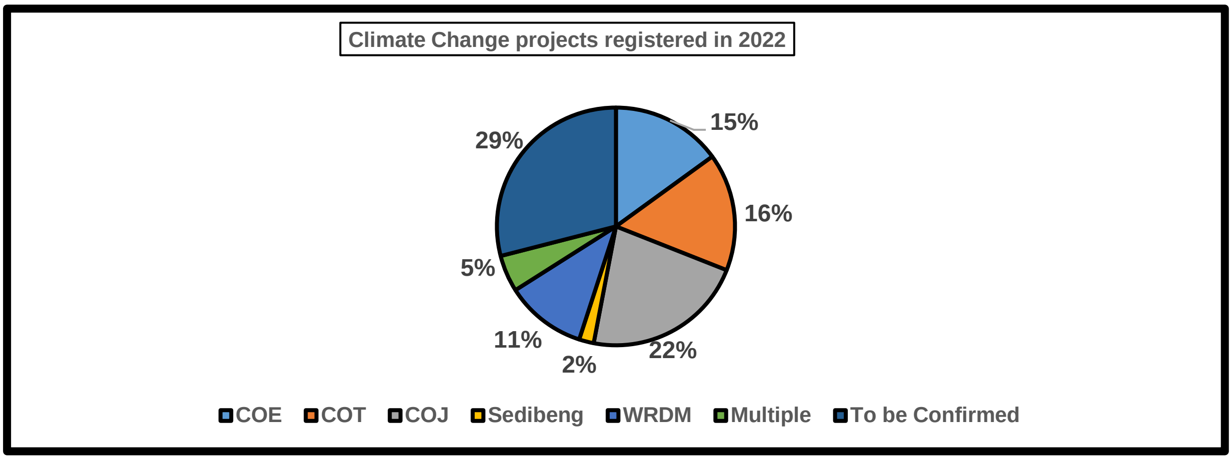


Figure: Location of Climate change projects registered in 2022

The 29% of "projects to be determined" are as a result of insufficient information such as name and location of the projects registered, further investigation will be undertaken.

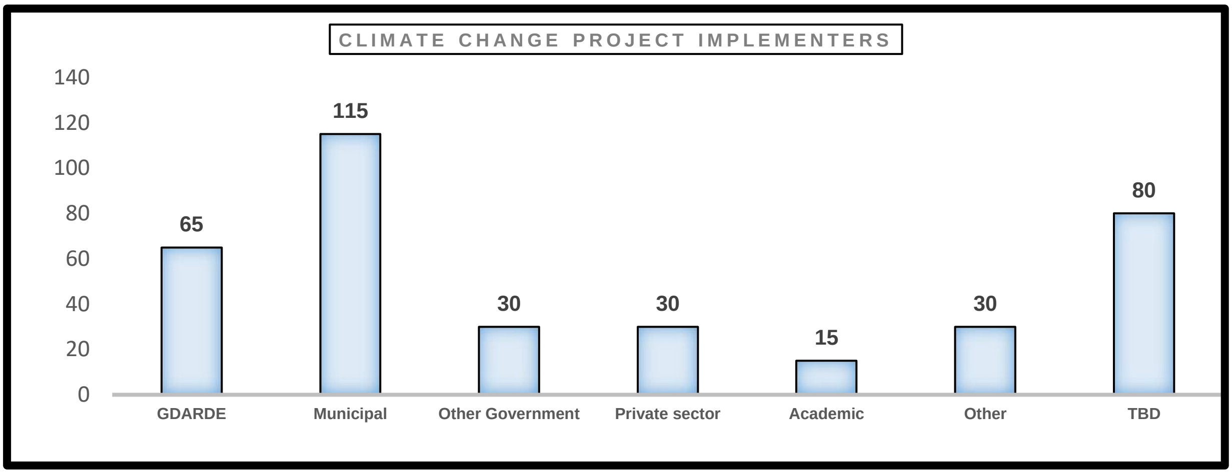


Figure: Climate change projects implementers in 2022

During the reporting period, the number of projects on the climate change register surpassed 400 mark and just over 100 projects were verified as a response to the MEC's directive. The verification helped with the estimation of emissions reduction figures (CO_2eq.) and impacts.

8.10.3.2 Climate change awareness programmes undertaken

The following Climate Change Awareness programmes were undertaken in 2022:

- Quarterly Climate Change Forums were held on 23rd of June 2022; 22nd of Sept 2022; 8th of December 2022 and the 23rd of March 2023.
- Establishment of the Premiers Expert Advisory Committee on Climate Change (PEACCC), which was officially Launched on 1st of June 2022. It seeks to mainstream climate change into the Sector specific plans that are aligned to the Gauteng Growing Together 2030 (GGT), which reflects a collective vision for the Gauteng City Region of 2030. The committee will also provide expert advice on elements of a just transition

pathway for the Gauteng City Region. It will also guide the process to ensure that the just transition is incorporated within a low-emission and climate resilient economy.

- GDARDE: EPPC engaged the Gauteng Department of Housing to raise awareness and training regarding Climate change. The engagement took place on 15th November 2022.
- GDARDE: EPPC engaged EAPs during the Gauteng EAPs forum on awareness regarding Climate change principles in development. The forum took place on 18th November 2022.

This annual programme seeks to effectively build capacity and enhance climate change response efforts within the Gauteng City Region.

8.10.3.3 Climate change school awareness campaign

This annual programme seeks to effectively build capacity and enhance climate change response efforts within the Gauteng City Region. The objectives of this programme include:

- Providing background knowledge and understanding on the concept of climate change.
- Raise awareness on the devastating effects of climate change and the consequences thereof across all sectors.
- Raise awareness on mitigation opportunities to reduce climate change impacts; and challenge the learners understanding of climate change.

The programme focuses on Grade 10 and 11 learners. No Climate Change School Awareness programmes undertaken.

8.10.4 Compliance monitoring & enforcement

The following compliance and enforcement indicators were monitored during 2022 reporting year:

8.10.4.1 Number of criminal enforcement actions undertaken for non-compliance with environmental management legislation.

The objective of the programme is to protect and manage Gauteng's natural resources and environment. Data is collated quarterly on actual criminal investigations finalised and handed over to the National Prosecuting Authority (NPA). In the past four years (2019-2022), the department finalised 132 criminal investigations and handed them over to the NPA. As depicted in a figure below, the breakdown is as follows: In 2022, 48 criminal investigations were finalised and handed over against the annual target of 30, in 2021, 29 criminal investigations were finalised, in 2020, 21 criminal investigations were finalised, while in 2019, the department finalised 33 criminal investigations.

The number of criminal investigations finalised, and cases handed over to the NPA in 2022 was more than anticipated because more matters were finalised under biodiversity enforcement. The following species were seized and forfeited to the State: 2 X Pangolin; 3 X Blue Cranes and 1 X Leopard tortoise. Eight suspects were arrested and a total of R35000 was paid as fines. The breakdown per municipality is as follows:

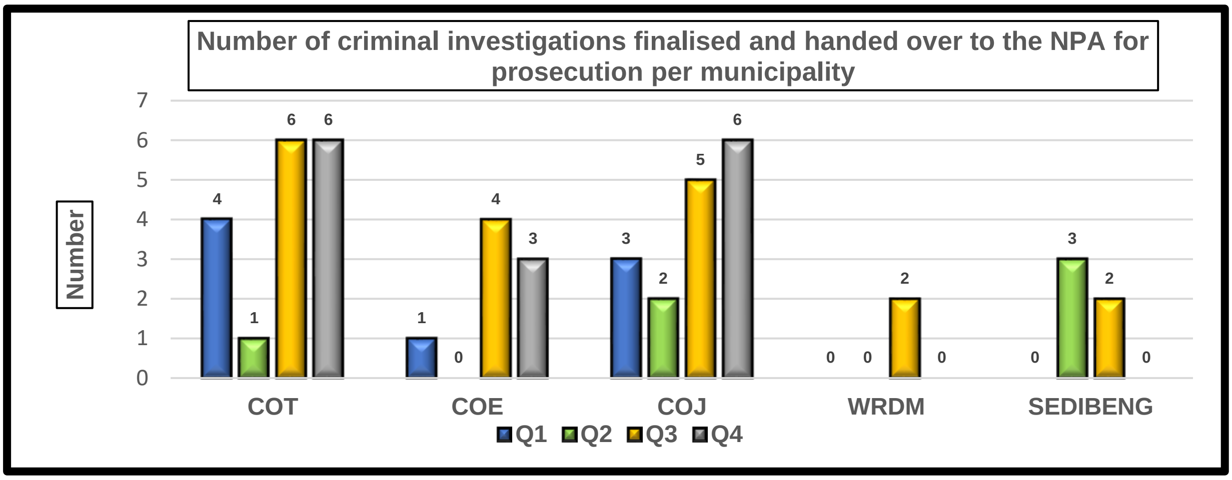


Figure: Criminal investigations finalised and handed over to the NPA for prosecution per municipality in 2022

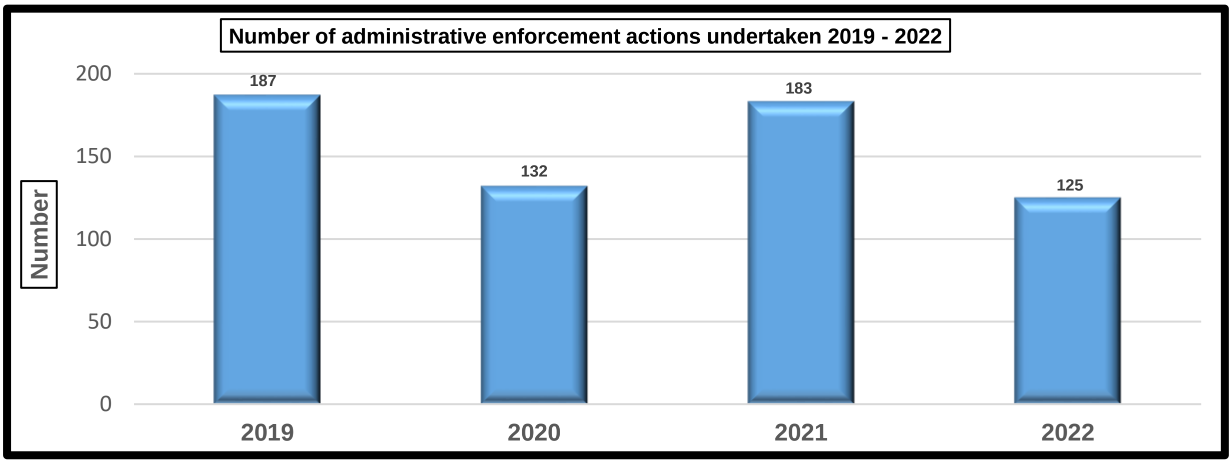


Figure: Number of criminal investigations finalised and handed over to the NPA for prosecution from 2019 to 2022

The breakdown per municipality is as follows:

The types of criminal investigations handed over to NPA are as follows:

- CoJ jurisdiction:
  - 4 cases for contravention of Section 57(1) of NEMBA.
  - 2 cases of Section 24 (f) of NEMA.
  - 7 cases of the Nature Conservation Ordinance 12 of 1983.
  - 2 cases of Section 31 L (4) of NEMA.
  - 1 case of Section 16 (1)(d) of NEMWA.
- CoT jurisdiction:
  - 4 cases for contravention of Section 49A 1 (c) of NEMWA.
  - 9 cases of Ordinance 12 of 1983 Section 43.
  - 3 cases of NEMBA 10 of 2004 section 57(1).

  - 1 case of Section 31 L (4) of NEMA.
- CoE jurisdiction:
  - 1 case for contravention of the National Environmental Management Act (NEMA) Section 24(F).
  - 4 cases of the Nature Conservation Ordinance 12 of 1983.
  - 2 cases of NEMBA 10 of 2004 section 57(1).
  - 1 case of Section 67 (1) (h) of NEMA.
- Sedibeng jurisdiction:
  - 3 cases of Nature Conservation Ordinance 12 of 1983.
  - 1 case of NEMBA 10 of 2004 section 57(1).
  - 1 case of Section 31 L (4) of NEMA.
- WRDM jurisdiction:
  - 2 case of Nature Conservation Ordinance 12 of 1983.

8.10.4.2 Number of administrative enforcement action taken for non-compliance with environmental legislation

In 2022, the department finalised 125 administrative enforcement actions against the set target of 100. In 2021, the department finalised 183 administrative enforcement actions against the set target of 100 while in 2020, 132 administrative enforcement actions were finalised in 2019, 187 administrative enforcement actions undertaken. The set targets has been achieved through all the reporting period 2019-2022 calendar years.

Below is a breakdown of administrative enforcement actions undertaken per municipal jurisdiction. In 2022, the City of Tshwane received 38 administrative enforcement actions which indicates a decrease in administrative enforcement actions issued when compared to the past four years. In 2021, the City of Tshwane received 57 administrative enforcement actions compared to 2020 where 46 enforcement actions were taken, while in 2019, 53 administrative enforcement actions were taken. In 2022, the jurisdiction of the City of Ekurhuleni received 44 administrative enforcement actions, while in 2021, 80 were taken and in 2020, 40 were taken and in 2019, 58 administrative enforcement actions were taken. In 2022, the City of Johannesburg received 19 administrative enforcement actions, in 2021, the City received 19 administrative enforcement actions, while in 2020, 14 administrative enforcement actions were taken against the 36 issued in 2019.

In 2022, the West Rand District Municipality received 12 administrative enforcement actions, in 2021, 11 administrative enforcement actions were issued, while in 2020, 11 were issued and 27 administration enforcement actions were issued in 2019. In 2022, 12 administrative enforcement action were received in the Sedibeng District Municipality, while in 2021, 16 administrative enforcement actions were issued, while 21 were issued in 2020 compared to 13 issued in 2019. Majority of the administrative enforcement notices issued were for non-compliance with conditions of environmental authorisations.

Below is a depiction of administrative enforcement actions undertaken in 2022 per municipal area. The breakdown is as follows:

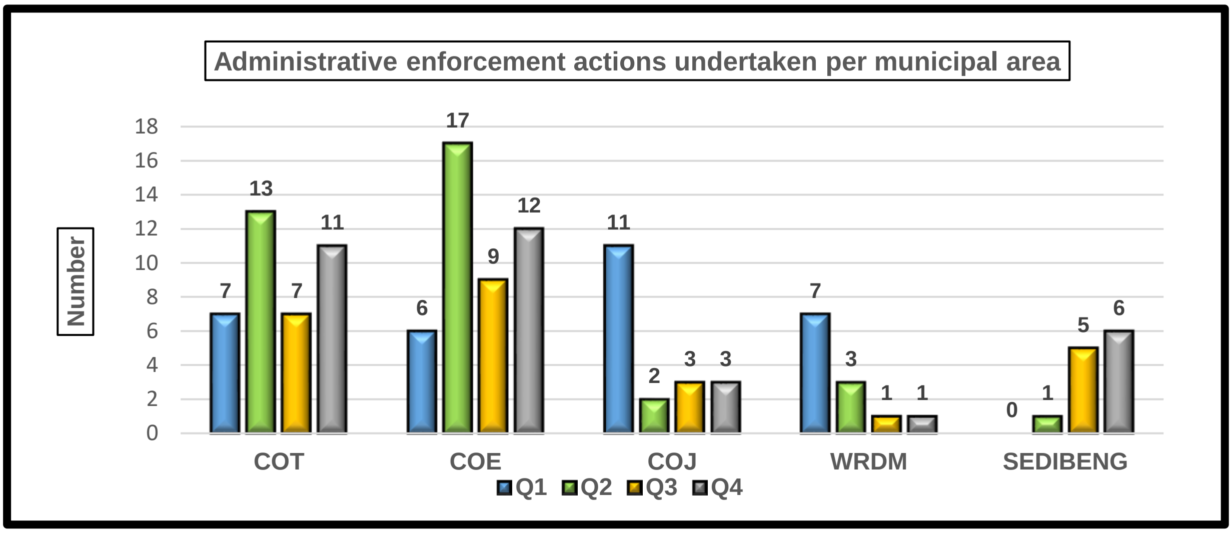


Figure: Administrative enforcement actions undertaken per municipal area in 2022

More work is being done on an ongoing basis to raise awareness on the relevant environmental legislations that needs to be complied with to ensure that the regulated community is kept informed of their obligations in terms of environmental legislations.

8.10.5 Environmental empowerment services

The following environmental empowerment services indicators were monitored during the 2022 reporting year:

8.10.5.1 Number of EPWP work opportunities created through environmental programmes.

During reporting period, a total of 7087 job opportunities were created, the breakdown is as follows: The City of Tshwane created 309, City of Ekurhuleni created 1262, City of Joburg created 1521, West Rand District Municipality created 1453 and lastly Sedibeng District Municipality managed to create 2542 EPWP job opportunities which is an indication that Sedibeng has performed well on this indicator during the reporting period.

8.10.5.2 Environmental awareness activities undertaken

These environmental awareness activities not only aim to protect and conserve the environment, but also to raise public awareness and possibly lead to behavioural changes from society. The department undertook 310 environmental awareness activities province wide. The municipal breakdown where these activities were undertaken is as follows: The City of Tshwane undertook 80 environmental awareness activities followed by City of Ekurhuleni with 58, City of Johannesburg with 107, West Rand District Municipality with 15 and Sedibeng District Municipality undertook 50 environmental awareness activities.

8.10.5.3 Capacity building created through the awareness activities

In the 2022 reporting period, 49 capacity building activities were undertaken by the department in varying municipalities, the breakdown is as follows: the City of Tshwane undertook 14 capacity building activities. The City of Johannesburg undertook 11 activities and Sedibeng District Municipality undertook 7 capacity building activities. The City of Ekurhuleni undertook 11 and lastly West Rand District Municipality undertook 6 capacity building activities.

8.10.5.4 Hectares (Ha) protected through the creation of firebreaks

In the 2022 reporting period, a total of 544 ha of firebreaks was created, the breakdown is as follows: the City of Tshwane created 41 hectares of firebreaks, the West Rand District Municipality created 291ha of firebreaks and the Sedibeng District Municipality created 212ha of firebreaks. The City of Joburg and City of Ekurhuleni didn't report work done in terms Ha protected through the creation of firebreaks. The Cradle of Humankind has created 81ha firebreaks and cleared 77ha of Invasive alien species contributing to the protection of the environment. The Dinokeng Nature Reserve burned 1223ha through the creation of firebreaks.

8.10.5.5 Number of wetlands rehabilitated and maintained

Wetland rehabilitation is a key programme that contributes to water security and diversity of fauna and flora in the province. The rehabilitation actions implemented have mitigated deterioration of areas downstream specifically water quality and quantity. Only the City of Tshwane rehabilitated 4 wetlands as well as the City of Ekurhuleni which rehabilitated 2 wetlands as part of their municipal key programmes. Wetland rehabilitation is a key programme that contributes to water security and diversity of fauna and flora in the province. The rehabilitation actions implemented have mitigated deterioration of areas downstream specifically water quality and quantity.

8.10.5.6 Tonnes of waste removed from river clean-ups

The river clean-up programme is implemented to remove solid waste from the rivers and wetlands to improve water flow and quality. In 2022 reporting period, a total of 567 tonnes of waste were removed from rivers during the river clean-up campaigns, the City of Tshwane removed 537 tonnes of waste and the City of Ekurhuleni removed 30 tonnes of waste.

8.10.5.7 Number of trees planted

In 2022 reporting period, GDARDE facilitated the planting of 103 901 trees in the province. The number of trees and areas where they were planted is as follows:

- In City of Tshwane 16 952 were planted.
- In City of Ekurhuleni 30 497 were planted.
- In City of Joburg 15 471 were planted.
- In West Rand District Municipality 29 600 were planted.
- In Sedibeng District Municipality 11 381 trees were planted.

8.10.6 Environmental information management

8.10.6.1 Conservation plan impacts

In 2022, the impact of development approvals on the Conservation Plan (C-plan) area represents half of the area authorised. This implies that if these areas are not well catered for in the Environmental Impacts Assessments process or that mitigation and management do not adequately address the impacts, a significant area of the environment would be lost. There was roughly a 2% impact on Ecological Support Area through the Gauteng Province Environment Management Framework (GPEMF) registration process. Table below shows that in 2022, 32% of the 177 decisions have greater than 50% of the site being Critical Biodiversity Area and 25% of the 177 decisions had more than 50% of the site being Ecological Support Area.

Table: Cumulative impact (hectares) on Conservation Plan features of developments in Gauteng

Hectares	Decision				
Conservation Plan Category	Authorisation		Registration		Grand total
	Granted	Refused	Granted	Rejected	
Critical Biodiversity Area	1232.21	7.53		1.75	**1241.49**

Ecological Support Area	968.16	0.67	3.85	1.65	**974.33**
Not C-plan	2311.38	30.80	141.13	104.58	**2587.88**
Grand total	**4511.75**	**38.99**	**144.98**	**107.98**	**4803.70**

* - "Not C-plan" area, are areas developed that fall outside this sensitivity feature

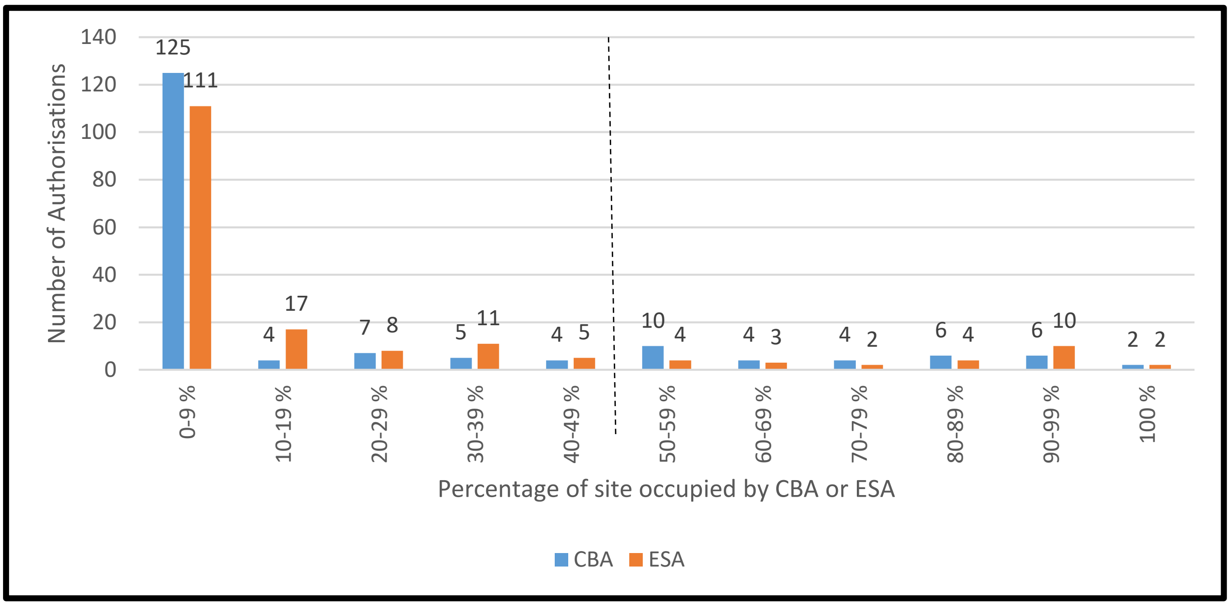


Figure : Frequency distribution of the aerial impact of developments on the conservation plan CBA and ESA areas

This finer detailed information shows that most applications have minimal impact on conservation plan areas. The fact that over 14% of the sites have over 50% of the site covered by either or both CBA and ESA Areas is of concern.

8.10.6.2 Rivers impacted upon by environmental decisions

In addition to the national wetlands' layers, the impact on existing river systems data was also assessed. This river data is based on buffered centreline river data where rivers in the urban fabric are buffered by 32m and outside the urban fabric are buffered by 100m from the mapped centreline. This data is skewed as the feature is based on manmade buffer rather than a hydrological area on the ground.

Table: Impacts on rivers in the province

	Decision				
River types	**Authorisation Granted**	**Authorisation Refused**	**Registration Granted**	**Registration Rejected**	**Grand total**
Perennial	120.44	1.80		1.47	123.71
Non-perennial	281.35	1.61		0.69	283.64
Not river	4109.96	35.59	144.98	105.82	4396.35
Grand total	**4511.75**	**38.99**	**144.98**	**107.98**	**4803.70**

In 2022, 9% of the area developed impacts rivers, and of the rivers impacted, non-perennial rivers are more impacted.

Main stem rivers

These rivers were taken from main stem exiting the province, so they are not a reflection of quaternary catchments. However, the analysis does show which rivers (in catchments) may be more impacted than others.

Table: Breakdown of impacts into main stem river catchments in Gauteng

Primary catchment	Main stem river catchments	Decision				Grand total
		Authorisation		Registration		
		Granted	Refused	Granted	Rejected	
Crocodile	Crocodile	1229.63	8.45	94.29	107.98	1440.35
	Pienaars	831.84		11.35		843.19
Vaal	Blesbokspruit - Suikerbosrant	553.03		23.14		576.17
	Grootspruit					
	Klip	1141.84	30.54	13.82		1186.20
	Loopspruit	5.97				5.97
	Mooi	449.98		0.28		450.26
	Reitspruit	160.65		2.10		162.75
Olifants	Elands	8.59				8.59
	Moses - Olifants					
	Wilge	130.22				130.22
	Grand total	**4511.75**	**38.99**	**144.98**	**107.98**	**4803.70**

The Vaal River catchment had the highest development, with most of the development in the Klip and Blesbokspruit river main stem catchments. The Crocodile catchment showed the most development in the Crocodile main stem catchments.

8.10.6.3 Area of wetlands impacted upon by environmental decisions

Seep, Unchanneled and Channelled valley bottom and Floodplain wetlands are the most affected by environmental decisions of the Gauteng Department of Agriculture, Rural Development and Environment in 2022. This totalled 398.45 hectares out of the 408.12 hectares of wetlands affected by EIA authorisation. In 2022, 9% of the area impacted by the EIA process consists of wetlands. In the cumulative impact of registrations granted, no wetlands are affected.

Table: Cumulative impact (hectares) on wetlands by developments in Gauteng

Decision					
Wetland type	Authorisation Granted	Authorisation Refused	Registration Granted	Registration Rejected	Grand total
Channelled Valley Bottom	77.45	1.66		1.41	80.52
Depression	4.98			2.93	7.92
Floodplain	46.19				46.19
River	1.75				1.75
Seep	137.17			0.01	137.18
Unchanneled Valley Bottom	132.12	0.01		2.42	134.55
Waterfall					

Wetland Flat					
Not Wetland	4112.08	37.31	144.98	101.21	4395.58
Grand total	**4511.75**	**38.99**	**144.98**	**107.98**	**4803.70**

* - not wetland area are areas developed that fall outside this sensitivity feature

8.10.6.4 Wetlands impacted by development

The extent to which the impact of the development affects the overall wetland area is shown in the below figure. The impact is mostly on seep and unchanneled valley bottom wetlands. The impact on Channelled Valley bottom wetlands, seep and depression wetlands all show at least some wetlands have 100% of their area affected by the development. This would affect the functioning of the wetland both hydrologically and biologically. When comparing both these datasets, the smaller wetlands tend to be the ones with the greater impact as they, for the most part, fall mostly within one site.

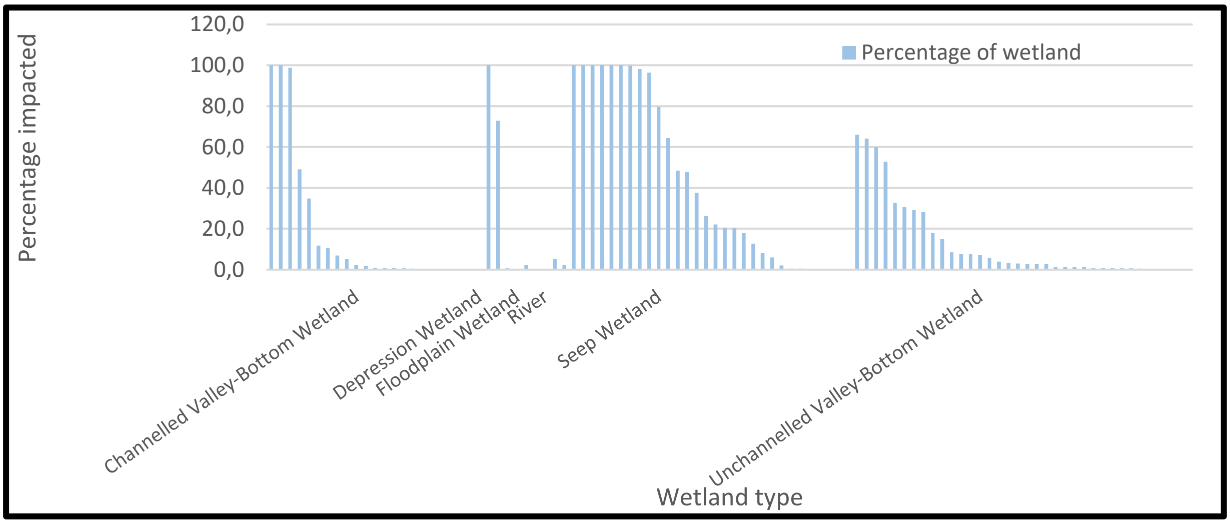


Figure: Percentage of the overall wetland size (polygon) impacted by the development of the site for each of the NWM5 wetland categories

8.10.7 Acid mine drainage

The following indicators were monitored during the 2022 reporting year:

8.10.7.1 Water quality of neutralised Acid Mine Drainage in the Eastern, Central and Western basins.

The Acid Mine Drainage (AMD) monitoring programme is the program of the Department of Human Settlements, Water and Sanitation operated from the three AMD treatment plants located in the province. The treatment plants are Western Basin located in Krugersdorp, Central Basin in Germiston and the Eastern Basin in Springs. The plants treat and monitor pH, Electrical conductivity, Sulphate, Iron and Manganese levels before release into the river system. The legal thresholds are site specific and based on the water quality of the AMD pre-neutralisation, thus the difference in limits for each of the basins.

All variables being monitored at the Western and Central Basin met the legal requirements for the reporting period. The Eastern Basin was offline from 2nd of February 2022 until the 16th of December 2022 due to motor failure on the AMD pumps. The repair to the motor was finalised in the last week of August and the pumping commenced on the first week of September 2022.

Below is a short narrative to support the graphical representations of the neutralised AMD discharge:

- pH must be maintained between 6.8 to 9.6 pH units. This is a suitable pH for the ecological functioning of the receiving water resources.
- Electrical conductivity serves as measure of dissolved salts. Generally, higher conductivity points to higher pollution loading. By maintaining the Electrical conductivity below 450 mS/m, ecological integrity is protected as well as ensuring that the downstream water users are not compromised.
- Metals such as iron and manganese are typical pollutants in AMD. These metals are toxic if their concentrations exceed legal threshold. For this reason, AMD is treated to recover the metals and reduce their concentration to the permissible level of <1mg/L for iron and <10mg/L for manganese.

During the reporting period, the Western basin plant was operational, and all treated variables were within the legal threshold.

The results on the parameters monitored are reflected below:

- The pH for treated water is within legal specifications.
- The Electrical Conductivity is within legal specifications.
- The Sulphates content in treated water was also within the legal limit of 3000 mg/L.
- The Iron content for treated AMD is within the required specifications.
- The Manganese content in treated water was also within the legal limit of <10 mg/L.

8.11 KwaZulu-Natal province

8.11.1 KwaZulu-Natal Estuary Observer Programme

KwaZulu-Natal estuaries are exposed to a range of pressures that compromise estuarine condition, often exacerbated by poor compliance monitoring and enforcement. Common and widespread offences include illegal breaching, sand mining, poaching, pollution spills, sewage spills, habitat destruction and riparian vegetation removal. The 2018 National Biodiversity Assessment highlights the trajectory of degradation of the KZN estuary resource. The KZN Estuary Observer Programme (EOP) was initiated by the Oceanographic Research Institute (ORI) through the KZN Department of Economic Development, Tourism and Environmental Affairs (EDTEA) to provide this much needed background knowledge.

The programme is intended to support conservation planning, protect biodiversity and estuarine ecosystem function and the sustainable use of the critical resources that are unique to estuarine habitats, as envisioned in the Draft National Estuarine Management Protocol (of the Integrated Coastal Management Act, No 24 of 2008).The programme focuses on anthropogenic activities that impact these ecosystems and their ability to continue to provide critical ecosystem services. Data is presented in a user-friendly 'toolkit' format to provide support to policy makers, planners, decision-makers, and estuary managers. It is only a stopgap to important estuarine monitoring that is needed going forward. Monitoring is a critical inclusion for future provincial plans if KZN estuaries are to be managed sustainably and continue to deliver ecosystem goods and services to reach national and local estuary conservation targets and mitigate against the projected socio-ecological consequences of climate change.

8.12 Limpopo province

8.12.1 Limpopo climate change response strategy 2022

According to the Limpopo climate change response, 2022, climate change is one of the greatest challenges that we face today. Rising temperatures and extreme weather events are already severely disrupting and affecting communities, ecosystems and economies globally. Limpopo is already experiencing climate change impacts which exacerbate social and economic challenges, undermine efforts to improve people's wellbeing, and threaten provincial developmental ambitions, prosperity and community's livelihoods. Unless the province tackle this challenge by reducing its carbon foot print and preparing society for the impacts of projected changes, the problems created by climate change will only get worse and our natural, social and economic systems will be impacted to a point where decent living conditions will become impossible to maintain.

The climate change response strategy and implementation plan sets out the Limpopo's commitment to action over the next five years. The key expected impacts/outcomes of the 2022 Provincial Climate Change Response Strategy implementation include:

- Greater public awareness of climate change issues and impacts;
- Increased institutional capacity and mainstreaming of climate change responses into provincial and
- municipal planning;
- Greater contribution to provincial vulnerability and GHG emissions reduction efforts; and
- Increased community resilience through of a just, inclusive and equitable transition to green and low
- carbon economy

For more in depth information readers are encouraged to read Limpopo climate change response strategy 2022 and climate change response actions.

8.12.2 The Limpopo Environmental Implementation Plan 2020 – 2025

The implementation of the Limpopo Environmental Implementation Plan 2020 – 2025 is a platform for the province to contribute towards the realization of the seven (7) government priorities as pronounced by the President of the Republic of South Africa for the 6th Administration as well as attaining the objectives of the National Development Plan (NDP): Vision 2030. The seven (7) government priorities are:

- Priority 1: Building a capable, ethical and developmental state;
- Priority 2: Economic transformation and job creation;
- Priority 3: Education, skills and health;
- Priority 4: Consolidating the social wage through reliable and quality basic services;
- Priority 5: Spatial integration, human settlements and local government;
- Priority 6: Social cohesion and safe communities; and
- Priority 7: A better Africa and world.

The Limpopo Environmental Implementation Plan (EIP) will be implemented in the next five (5) years in adherence with the provisions of the NEMA. Section 16(1)(b) of NEMA provides that every organ of state must report annually within four months of the end of the financial year on the implementation of its adopted EIP to the Director-General of the national Department of Forestry, Fisheries and the Environment (DFFE). Therefore, the province will report through this Department to the Director-General of the Environmental Ministry from the financial year 2020/2021 based on the commitments included in this plan. Effective environmental governance is critical for implementation of this plan across all spheres of the society, from governments to Non-Governmental Organisations (NGOs), the private sector and civil society, co-operation is critical to achieving effective governance that can help us move towards a more sustainable future. Some of the key recommendations include but not limited to the Limpopo Provincial Government:

- Drafting environmental policies based on up-to-date, accurate information on emerging issues and the state of the environment;

- Ensuring that environmental sustainability was an integral part of all the provincial development planning, helping to reduce poverty and increase long-term security for vulnerable populations;
- co-operating effectively on the national and global stage, engaging in national and international agreements that moved us closer to a sustainable future; and
- Entering into lasting and effective strategic alliances with major groups and stakeholder to achieve common goals and objectives.

8.13 Mpumalanga province

8.13.1 Mpumalanga Biodiversity Sector Plan

Mpumalanga is a province well known for its globally important biodiversity, its wealth of natural resources and spectacular natural vistas. Its terrestrial ecosystems are characterised by high levels of both plant and animal diversity and a significant number of unique species that are not known to occur anywhere else outside the province. Three different biomes occur within Mpumalanga and, although they all contain important and often unique biodiversity, it is in the grasslands that many of the province unique, rare and threatened species and ecosystems are found. Mpumalanga's freshwater ecosystems are also home to important biodiversity and represent high value ecological infrastructure for delivering water for human use.

Endowed as it is with over 150 000 wetlands, and with the waters of at least five of South Africa's important river systems rising in its highlands, the Mpumalanga accounts for a high proportion of the country's Strategic Water Source Areas (27.5%) and plays a critically important role in terms of regional and national water security. Most of the wetlands occur in grasslands of the wetter highveld and escarpment regions, with the greatest concentration of pans in the Chrissiesmeer area near Ermelo. These wetlands represent high value ecological infrastructure for securing water for human use.

Although approximately 50% of Mpumalanga's landscapes outside of protected areas are still in a 'natural' state, these are not in a good ecological state – a variety of land-use pressures and consumptive practices over the years have resulted in the degradation and loss of important habitat, with the result that many of the natural ecosystems are currently classed as either Vulnerable or Endangered. As Mpumalanga is underlain by diverse and mineral rich geological formations, mining is a major land-use for gold, chromium, iron, and platinum-group metals, as well as for coal, and in some areas, granite. Half of Mpumalanga's natural habitat has already been irreversibly modified, mostly through large-scale agriculture, plantation forestry and mining, and there is currently rapid growth in the number of applications for prospecting and mining rights, particularly for coal (more than 70% of all mining-related applications are for coal). Agriculture, plantation forestry and mining (with its associated energy-generation industry) are the cornerstones of the provincial economy. Another non-consumptive and important sector is tourism - adventure and nature-based tourism is a growing economic sector that relies on going into the future. In addition to causing direct habitat loss, these activities have significant impacts on Mpumalanga's water security as, wetlands are often drained for mining and agriculture, plantation forestry lowers the water table and poorly located or poorly managed open-cast mining affects the quantity and quality of water entering and leaving wetlands and rivers.

Mpumalanga's biodiversity and ecological infrastructure is a valuable, though vulnerable, asset that could be a rich source of natural solutions to the challenges posed by poverty, unemployment, and climate change. But, for this potential to be realised, end-users need accurate and up-to-date scientific information. There is also a need for well-informed policies and legislation that safeguards important biodiversity and ecological infrastructure, together with well-capacitated institutions that are responsible for effective management and governance of biodiversity assets. The Mpumalanga Biodiversity Sector Plan (MBSP) is such a spatial tool which serves to provide such information to end-users and guide decision making to ensure that the biodiversity objectives are achieved. The MBSP covers the whole province, which is divided into three District Municipalities: (i) Ehlanzeni; (ii)Gert Sibande; and (iii) Nkangala, and forms part of a broader set of national biodiversity planning tools and initiatives that are provided for in national legislation and policy. The MBSP is based on an objective planning approach which considers national and provincial biodiversity targets while trying to avoid conflict with competing land uses.

Planning for climate change is a common thread throughout the MBSP where it has been explicitly considered and incorporated into the spatial priorities. The spatial priorities have been developed at a relatively fine spatial scale (1:10 000 – 1:25 000) that can be used for planning at local and district municipal and provincial levels. It supports the principles of integrated development planning and integration with Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs). The comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines that make the most recent and best quality biodiversity information available for use in land-use and development planning, environmental assessments and regulation, and natural resource management.

Both terrestrial and freshwater biodiversity priority areas are identified in the MBSP, either as Critical Biodiversity Areas (CBAs) or Ecological Support Areas (ESAs). These CBA and ESA areas must be considered and taken into account in processes that will result in a change in land use and will also form part of the geographic areas in which certain activities will require environmental authorisation in terms of the Environmental Impact Assessment Regulations Listing Notice 3 (Government Notice R985 of 04 December 2014, as amended by Government Notice R324 of 07 April 2017), in terms of the National Environmental Management Act, 1998 (Act 107 of 1998).

The MBSP Handbook presents the map products and explains how they were developed, and how and when they should be used. It describes the ecosystems and important biodiversity features of Mpumalanga and presents a set of land-use guidelines and other tools that can be used to effectively conserve Mpumalanga's biodiversity as part of living landscapes that combine multiple land-uses.

8.14 North West province

8.14.1 The North West Provincial Environmental Implementation Plan

The North West Province gazetted the North West Provincial Environment Implementation Plan 2020 – 2025 with the aim to coordinate and harmonise environmental policies, plans, programmes and decisions of various departments that exercise functions that may affect the environment in order to minimise the duplication of procedures; and functions and to promote consistency in the exercise of functions that the environment.

These include departments that are entrusted with powers and duties aimed at the achievement, promotion, and protection of a sustainable environment, and of provincial and local spheres government. The province has championed and been in the forefront at national landscape with regard to promoting integrated planning and co-operative governance. The implementation of this plan will also assist government to realise the government priorities pronounced by the president of the Republic of South Africa, these priorities are as follows:

- Priority 1: Building a capable, ethical and developmental state;
- Priority 2: Economic transformation and job creation;
- Priority 3: Education, skills and health;
- Priority 4: Considering the social wage through reliable and quality basic services;
- Priority 5: Spatial integration, human settlements and local government;
- Priority 6: Social cohesion and safe environment; and

- Priority 7: A better Africa and world.

For exciting and new provincial and local government policies, plans and programmes that when implemented may significantly affect the environment both negatively and positively, readers are encouraged to read North West Provincial Environment Implementation Plan 2020 – 2025 for more and in-depth information.

8.14.2 Annual Environmental Implementation Plan Compliance Report

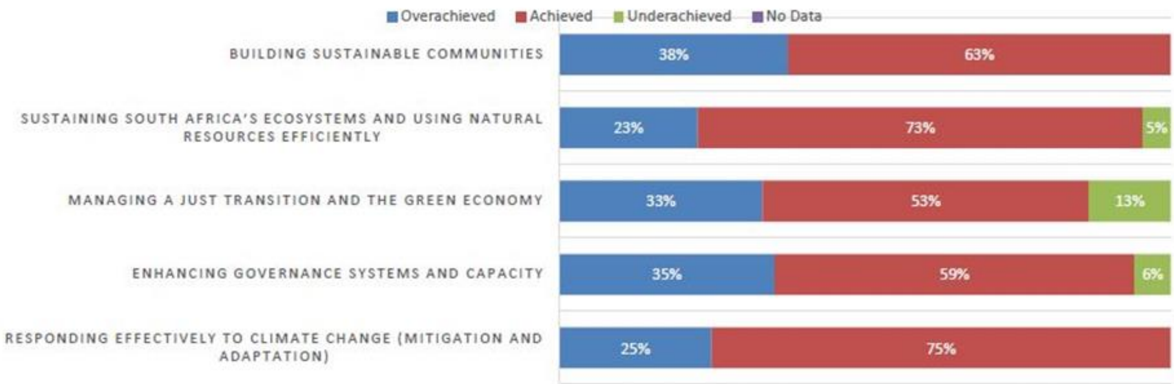
The North West province have compiled the 2022/23 Annual Environmental Implementation Plan Compliance Report and which covers among the others, progress made in achieving the targets committed for implementation in 2022/23 financial year. Readers are encouraged to read the report for more, in-depth, fully referenced information.

8.15 Western Cape province

8.15.1 Environment performance

With respect to Provincial Government's implementation of the programmes, plans and policies that have a significant effect on the environment of the Western Cape, 87 percent of the priority indicators included in the 3rd Edition Environmental Implementation Plan were achieved including over-achieved for the 2018/19 financial year. This leaves 7 percent of the indicators having been under-achieved, excluding the 6 percent of the indicators for which updated information was available by the time of publishing this compliance report. The following is extracted from the Environmental Implementation Plan Annual Compliance Report (July 2019) outlining the overall achievement of EIP Strategic Priorities for the period 2018 - 2019:

Overall achievement of EIP Strategic Priorities for the period 2018 – 2019



The EIP is currently under review towards the 4th Edition Environmental Implementation Plan (2021 – 2025)

8.15.1.1 Energy

The Western Cape recognises the acute importance of energy security to support its economic growth and the economic growth rates that the province aspires to. It furthermore recognises that extraordinary effort is needed to change the energy landscape of the Western Cape to support its economic and population growth. Therefore, one of its "Game Changer Goals" is to ensure energy security that supports economic growth in the Western Cape, incorporating diverse and low carbon sources of energy by 2020. Alternative energy sources and energy efficiency are two levers of change, amongst others identified (full details captured in WCG Game Changers Annual

Reporting. The following graph reflects the installed PV capacity in the province from 2015/16 financial year to 2019/20.

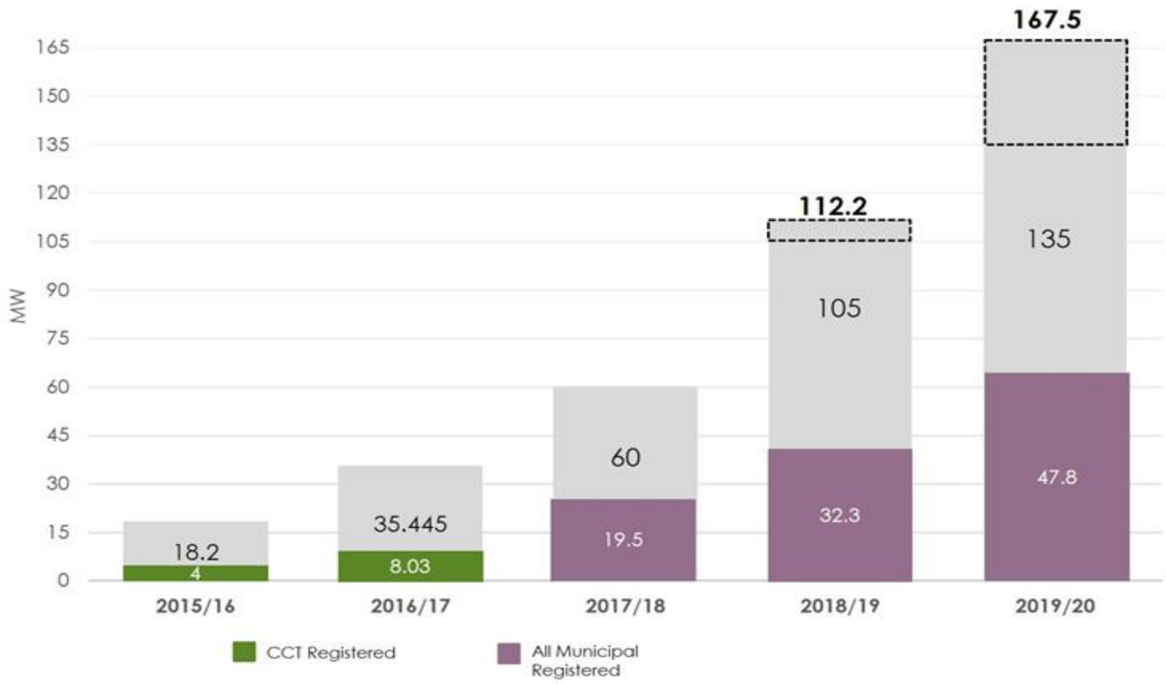


Figure: Installed PV capacity in the Western Cape

Increased Solar Photovoltaic (PV) uptake

This lever aims to increase the uptake of rooftop PV to 135 MW by 2020. The focus is on encouraging businesses to consider the benefits of taking up rooftop PV while remaining on the grid. To date, the work of this game changer has resulted in an estimated 167 MW of installed PV capacity in the Western Cape (from 18 MW in 2015).

Small-scale Embedded Generation in municipalities

The Western Cape Energy Game Changer strategy formulation included in its focus the introduction of Small-Scale Embedded Generation (SSEG) on a wide scale, with the key focus on the rooftop solar PV installed in the first place by business and then by households. Critical to this strategy is to ensure that customers stay on the grid and feed their unused solar energy back into the grid, for which they receive a credit against their electricity bill. This ensures there is a benefit to the municipality – the consumer continues to support grid maintenance and investment through their own usage of municipal power and through supplying additional energy into the grid. There is also a benefit to the consumer, as the effective payment from the municipality for their power contributes to their investment in solar PV, making it much more cost effective.

Cape Town was the first municipality in South Africa to receive approval from the energy regulator (NERSA) for a feed-in tariff for rooftop PV, and through this game changer, the WCG and its partner, GreenCape (which supports businesses to invest in the green economy) have worked with other municipalities to get tariff approval from NERSA. To date, 24 municipalities allow SSEG and 19 have feed-in tariffs in place.

Energy efficiency: focus on Western Cape Government buildings

In the wake of the extreme drought being experienced in the Western Cape, there was a drive to expand the energy efficiency programme to include much-needed water saving interventions – in other words, putting the emphasis more broadly on resource efficiency. By undertaking efficiency audits and responding to recommendations for potential savings across its government buildings, the WCG is leading by example through a demonstrable reduction in resource consumption. As an example, the WCG has set a target of 30 percent reduction in energy usage in government buildings by 2030. As at March 2019, the WCG is on track to meet this target, with a 14 percent reduction in energy consumption (145.3 kW/m²/yr).

8.15.1.2 Climate change

The Western Cape Climate Change Response Strategy: Vision 2050 (WCCCRS) describes a climate future that the Western Cape province will strive towards. It is centred on a vision and four guiding objectives defining the direction of climate change response action for the region. A set of responses under each of the guiding objectives will be used to develop an Implementation Plan, which will define actions and activities as well as timelines, quantified targets and specific responsibilities for implementation. The Implementation is currently under development and will be completed by March 2023 after going through an extensive stakeholder consultation process.

The starting point for the Strategy is the 2050 Vision – "to be a net zero emissions and climate resilient province by 2050, built on an equitable and inclusive economy and society that thrives despite the shocks and stresses posed by climate change"

The Western Cape province needs to accelerate the implementation of response actions that will mitigation climate change and increase our general resilience to the rapidly changing conditions. This response must align with provincial priorities of providing safe and cohesive communities, promote job and economic growth, mobility and spatial transformation as well as value culture and inspire innovation amongst its citizens.

Four guiding objectives, aligned to the aspiration expressed in the vision, give structure to the Strategy:

- Objective 1: Responding to the climate emergency
- Objective 2: Transitioning in an equitable and inclusive manner to net zero emissions by 2050
- Objective 3: Reducing climate risks and increasing resilience
- Objective 4: Enabling a Just Transition through public sector, private sector and civil society collaboration

The Western Cape needs a bold and ambitious, yet realistic Climate Change Strategy, that takes us towards net zero carbon emissions by 2050, with transformative risk reduction and adaptation actions; otherwise, all other development decisions and pathways currently planned and implemented will be undermined.

We need science-driven policy-led political and private sector leadership to take bold, societal changing, decisive action to ensure nobody is left behind. In this way the Western Cape will realise its vision as the most resilient and low-carbon province in Africa.

Climate change monitoring and evaluation (M&E)

This is the third iteration of a multi-sectoral climate change response stocktake for the Western Cape. It gives recommendations and highlights opportunities for rapidly strengthening Western Cape stakeholder's climate change response thereby creating a low carbon and resilient province. The M&E report assists in providing further clarity and a way forward on more informed targets for the province in future.

The report provides a narrative as well as tracking the transition to a low carbon, climate resilient and more prosperous Western Cape through the implementation of the Western Cape Climate Change Response Strategy (WCCCRS). The objectives of the report include:

- Providing a clear picture of the various response measures included in climate change mitigation and adaptation programmes;
- Providing an assessment of the effectiveness of the response measures included in the Strategy;
- Increasing co-ordination of climate change response measures and monitoring and evaluation; and
- Increasing awareness of observed and projected climate impacts.

The WCCCRS was developed in a manner that would focus in on specific programmes of work and thus, whilst covering most of the key sectors of the economy and governmental functions at province and local level, the degrees of focus of each is not extensive, but rather specific and focused on priority programmes. The focus areas have been selected based on the urgency of action required.

There are ten (10) focus areas included in the M&E report, with 44 indicators across the focus areas. The focus areas are:

- Climate Risk Management with 4 indicators;
- Water with 6 indicators;
- Food Security and Agriculture with 6 indicators;
- Energy with 5 indicators;
- Waste Minimisation and Management with 3 indicators;
- Sustainable Transport with 4 indicators;
- Human Settlements with 2 indicators;
- Biodiversity and Ecosystem Goods and Services with 7 indicators;
- Coastal and Estuary Management with 4 indicators; and
- Healthy Communities with 3 indicators.

8.15.2 Oceans and coasts

The Western Cape Provincial Coastal Management Programme (PCMP) fits within the framework of coastal management programmes (CMPs) that, according to the Integrated Coastal Management Act, must be developed both nationally and for all municipalities and provinces with coastal borders. The Provincial Coastal Management Programme must be in line with the National CMP and the National Estuarine Management protocol, whilst the municipal CMPs must in turn be consistent with the PCMP and NCMP. Adopted in March 2016, the Western Cape Provincial Coastal Management Programme sets out priorities for coastal management in the Western Cape and provides a five-year prioritised implementation programme for 2015/16 to 2020/21 financial years. Thereafter the Provincial Coastal Management Programme must be reviewed and amended if necessary. During the 2021/22 financial year the 2016 PCMP underwent this review process, by engaging with its coastal stakeholders and assessing its achievements over the five-year cycle. This was facilitated by the annual implementation reports which were produced by the sub-component and signed off by the Head of Department. These reports allowed an overall assessment of the achievements and challenges experienced in the implementation of the inaugural Western Cape PCMP.

The 2016 Western Cape Provincial Coastal Management Programme reached the fifth year (5) of implementation in the 2020/21 financial year and despite many challenges made significant progress and achieved milestones in all nine priority areas. Some challenges were unable to be overcome, while others required some amendments to timeframes, which are set out in detail in the report above. With the review of the Provincial Coastal Management Programme, priority actions or processes which could not be concluded or implemented, will be rescheduled and/or alternative approaches will be explored to find improved ways of solving these challenges.

8.15.2.1 Gender and Human Rights Assessment

The Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) has committed to mainstreaming and improving gender and human rights within all its internally produced planning and policy documents and decisions. The Departmental Gender Equity Strategic Framework (GESF) was developed to guide the gender mainstreaming in DEA&DP between 2020 and 2025. The GESF set a goal to include gender or aspects thereof in all newly developed and reviewed policy documents, programmes, and research projects. During 2020, the Western Cape Government revived its commitment to a Human Rights Approach and DEA&DP therefore undertook to incorporate all human rights “priority” groups into its gender mainstreaming approach. The 2016 PCMP was selected to undergo a gender and human rights gap assessment, since it was in the process of being reviewed and amended as per the requirements of NEM: ICMA Section 46. Issues of gender and human rights were then explored during the coastal workshops and specific gender engagements with identified stakeholders and specialists and these issues were then highlighted to be mainstreamed and specifically included in projects within the amendment process for the development of the Western Cape Provincial Coastal Management Programme 2022-2027.

8.15.2.2 Challenges to implementation

During the last two years, the COVID-19 pandemic severely disrupted the global economy, restrictions on the movement of people, closure of business and other “lockdown” measures implemented by government significantly reduced economic activity causing a national and global recession. The Western Cape Government have implemented the Provincial Recovery Plan and the fight against the pandemic is showing signs of success, with the economy reopening and recovering. The programme managed to achieve a number of output indicators as reported on in the 2020/21 Annual Implementation Report despite the challenges of the pandemic and a reduction in resources; although there were some output indicators that were not achieved during the programme life cycle. The DEA&DP continued to implement the 2016 Western Cape Provincial Coastal Management Programme (PCMP) and attempted to conclude on some of the outstanding 2016 PCMP deliverables; like the establishment of the Coastal Management Line (CML) for the City of Cape Town and the development of a draft coastal policy to inform the CML implementation mechanism, as well as moving forward with the gazetting process for the approval of the developed Estuary Management Plans. During this current year (2021/22) the sub-component concentrated on delivering on some of those output indicators, while conducting the required review and amendment of the 2016 PCMP. Another significant event that took place during the 2021/22 financial year was the amendment of the National Estuarine Management Protocol (NEMP).

The NEM: ICMA was developed to promote ecologically, socially and economically sustainable coastal development and resource use, as well as to control inappropriate development along our coast. In South Africa, all three spheres of Government are mandated to develop CMPs, which are essentially policy or strategy documents that contain a system of principles to guide decisions and achieve outcomes relating to the coastal environment. This responsibility along with the concurrent environmental management responsibility in term of the Constitution requires an enabling cooperative governance framework. To that end the NEMP was amended to ensure that it complied with Schedules 4 and 5 of the Constitution of the Republic of South Africa. The NEMP assigns the Provincial Lead Agencies as Responsible Management Authorities where an estuary falls within the boundary of a municipality and where an estuary is within a protected area or is identified as part of a protected area expansion strategy, the management authority responsible for that protected area must develop an Estuary Management Plan in consultation with the relevant government departments. This mandate change requires consultation within the Department considering current resource and capacity constraints. The amended PCMP will be required to align its outputs with that of the estuary programme after consultation with CapeNature as the Departments conservation entity.

8.15.2.3 Local government mandates

The Western Cape Department of Environmental Affairs and Development Planning continues to support the Municipal Coastal Committees and the development and implementation of the Municipal Coastal Management Programmes. Uptake and implementation of local government's integrated coastal management mandates continue to be affected by the lack of finalisation related to key legal and implementation protocols driven by national Department of Forestry, Fisheries, and the Environment (DFFE), including the DFFE/SALGA legal protocol and the business reengineering process that was embarked upon by the South African Local Government Association (SALGA). This remains a key strategic risk for the province, specifically in respect of related local government mandates. Provincial Coastal Management Programme: Annual Implementation Report 2021/22 121 Key to enabling ongoing improvements in performance of municipal mandates is the Department's Local Government Support Strategy within which compliance and performance in terms of the Coastal Management aspects are addressed annually.

8.15.2.4 Enabling coastal spatial resilience

Proactively enabling coastal spatial resilience must be a transversal priority for the Western Cape. With the restrictions on budgets the emphasis on developing partnerships to achieve on the targets related to spatial resilience is essential. Mainstreaming and proper integration of risk information into planning and decision-making remains of paramount importance; the implementation of CMLS remaining the key focus. The integrated departmental work on environmental risk and vulnerability will provide for further mainstreaming of coastal risk and vulnerability. A Green Climate Fund project concept is being development for Coastal Adaptation Strategies in response to impacts from Climate Change in South Africa. The Western Cape Department of Environmental Affairs and Development Planning is engaged in the Task Team for the development of the concept note and proposals and will aim to position critical work to draw resources towards addressing adaptation priorities.

8.15.2.5 Coastal management lines (CMLs)

The establishment of the City of Cape Town CML in terms of S25(1) of NEM: ICMA is the first for South Africa. To enable better transversal traction of the CMLs as a regulatory mechanism, a departmental Coastal Task Team, comprising of senior officials from the planning, environmental and coastal components, will act as a steering committee to facilitate the establishment and implementation of the CMLs for the West Coast, Overberg and Garden Route Districts. This task team has recommended a range of instruments enabling implementation, including a provincial policy, regulations, but will also drive the outcome that the established CMLs are delineated in the municipal zoning schemes as prescribed in S25(3) of NEM: ICMA. The establishment of the CMLs for the province is also included in the Workplan for Working Group 7 (previously WG8) and will contribute national targets for the implementation of NEM: ICMA. To initiate the enabling tools for the implementation of CMLs the Department drafted and circulated the Circular for the consideration of coastal risk in land-use decision making as well as the way forward for CMLs. This circular explains how land-use decisions makers must apply their minds to the various zones as defined in the NEM: ICMA as well as the coastal risk considerations as developed in the CML delineation projects for West Coast Overberg and Garden Route Districts. This Circular also sets the foundation for the Draft Provincial Policy for the implementation of CMLs that will be finalised in the new financial year.

8.15.2.6 Coastal access

The implementation of priority area 3, coastal access has continued momentum this year. Public access to the coast remains contentious for the province. Municipalities have requested support and guidance from the Western Cape Department of Environmental Affairs and Development Planning with implementing the recommendations from the coastal access audits. While not all cases will entail the designation of coastal access land as provided for in NEM: ICMA, a level of intervention is required as described in the Western Cape Provincial Coastal Access Strategy and Plan. The coastal access audits will be updated in collaboration with the municipalities, to record progress and assist municipalities to prioritise their efforts. The Department will continue to support municipalities and provide strategic and technical guidance in alignment with our provincial priorities and local government support strategy.

The pilot implementation project within the Overberg District Municipality, to facilitate public access to the Bot River Lagoon, will continue into 2022/23 and will enable the legal mechanisms for coastal access provided for in NEM: ICMA to be tested. This process will run in parallel with the DFFE: O&C Coastal Access Infrastructure Project for which the pilot implementation project was also selected. The Department has developed four Coastal Access Bylaws for the administrative process, designation, withdrawal and adjustment of boundaries of coastal access land. These draft bylaws are ready for presentation to the MEC so that they may be circulated to the municipalities in the 2022/23 financial year. 3.9. Estuarine management The Estuary Management Programme's Implementation Plan will form a critical component of the programme of work for the amended WC PCMP 2022-2027. The estuary management programme will be expanded upon in PA7 within the amened coastal programme – and will incorporate the approval and implementation of number of EMPs which have recently gone through the final stage of public participation. A comprehensive Governance Tool, designed to initiate, track and report on management actions stemming from the Estuarine Management Plans is in the process of development by CapeNature with the management component complete and the estuary health dashboard under development. This tool will be implemented during the next few years in CapeNature's priority estuaries. Significantly increased budgets for cost of employment and operations will be required in order to provide effective estuarine management in the Western Cape.

8.15.2.7 Way forward

The review process of the 2016 Provincial Coastal Management Programme was presented to the Provincial Coastal Committee and endorsed. The amendment process took place in compliance with the restrictions on gathering and travel during the COVID-19 pandemic, this the workshops and engagements took place online via MS Teams. The coastal team also utilised the online platform Jamboard to engage the larger groups in developing ideas and identifying issues to be considered in the amended Western Cape Provincial Coastal Management Programme 2022-2027. The workshops / consultations were conducted with all spheres of government and identified stakeholders. From these consultations and the inputs provided from various Directorates and other WCG Departments and identified stakeholders, the Draft Zero WC: PCMP and associated five-year implementation tables were developed. The draft zero Western Cape Provincial Coastal Management Programme was shared with these identified stakeholders for an initial round of comments during December 2021 and January 2022. Once these initial comments have been considered a DRAFT WC: PCMP 2022-2027 will be made available to the public for comment. It is envisaged that the final draft will be ready for Ministerial Adoption in 2022/23 financial year.

8.15.3 The Ecological Infrastructure Investment Framework

The Ecological Infrastructure Investment Framework provides the rationale for coordinating investment into the clearing of alien invasive plants within the province, including the guiding principles, and the investment objectives as arrived at by landscape stakeholders. The document also explores funding options that could be used to promote investment, and touches on the principles of monitoring and evaluation associated with the initiative.

The Ecological Infrastructure Investment Framework:

- Defines the vision of the initiative and the threats.
- Describes the four investment objectives of the framework, namely to:
  - Improve water quality and quantity in support of people's health and livelihoods by controlling the threat of alien invasive plants and improving the ecological status of water resources.
  - Reduce the vulnerability/risk of people and the environment to wildfires.
  - Support local livelihoods by improved land use practices on rangelands.
  - Reduce the risk of flooding on communities, their environments and infrastructure.
- Explores financial mechanisms.
- Outlines broad implementation, monitoring and evaluation measures needed to realise the Ecological Infrastructure Investment Framework (EIIF).

8.15.3.1 EIIF: Catchment Prioritisation Report

The Catchment Prioritisation Report summarises the process undertaken in identifying catchments to prioritise for detailed study and development of Management Unit Control Plans (MUCPs) within the context of developing the Ecological Infrastructure Investment Framework in the Western Cape.

8.15.3.2 EIIF: Management Unit Control Plans Report

The Management Unit Control Plan set out to achieve effective control of invasive alien plants within the province by elucidating the Management Unit Control Plans process, and the associated weighting of input data. The document largely sets out a methodology of creating MUCPs, and then goes on to create MUCPs for the Holsloot, Keurbooms and Karatara catchments.

The document also outlines assumptions and limitations both for the catchments in question and data in question, but also for the MUCP tool.

This document:

- Outlines the data needed to accurately estimate the extent of alien invasions for the province.
- Provides case studies for how to weight information to arrive at effective priorities when clearing and following up.
- Quantifies the financial demand associated with clearing.
- Quantifies the investment period to get on top of invasions given the level of investment.
- Quantifies the amount of water released as a result of investment per year per funding trajectory.
- Also provides an overview of the catchment area, extent of invasion, Mean Annual Runoff as well as MAR reduction as a result of invasive plants.

8.15.3.3 EIIF: Implementation and Monitoring Plan

The Implementation and Monitoring Plan (IMP) builds on the EIIF and seeks to unpack how the implementation of the investment strategy, as detailed in the EIIF, will take place. The IMP is intended to actualise the aspirations of the strategic plan (the EIIF) by identifying critical actions to be undertaken to achieve the stated vision. Furthermore, it seeks to identify indicators that can be used to monitor the outcomes of implementation. Its ultimate aim is to enable decision-makers and investors to track how investment is contributing to the resilience of EI in the Western Cape.

This document:

- Sets out high level indicators based on the objectives of the EIIF.
- Each high-level indicator is broken down into activities, and each activity has a responsible team, a unit of measure, a desired target, and a description of the assumptions for each activity.
- The IMP gives a good idea of the actions that need to be undertaken to achieve the EIIF, as well as the people involved. This could be used to model costs associated with implementation of the EIIF.

8.15.4 Green economy

The Western Cape Green economy promotion activities are spearheaded by the Department of Environmental Affairs and Development Planning (DEA&DP), the Department of Economic Development and Tourism, Department of Agriculture and GreenCape. The primary areas of focus are on resource efficiency, including energy, water, and waste, but include other elements including Sustainable Public Procurement (SPP), land-use management, biodiversity, and communications.

The work takes the form of support to Provincial and Local Government bodies, support to business, financial support, public awareness, educational programmes, training, and direct funding on selected issues. The Western Cape Green Economy Report 2022 provides information on projects that have delivered significant results in the past year. It provides stakeholders with a basis for assessing the Western Cape Government's work in the Green Economy; and contextualises the Western Cape Government policy and strategy response to the Green Economy. The report identifies the Green Economy issues that are most material to the Western Cape, focusing on the role for provincial government specifically; and prioritises report topics in line with the Green is Smart Strategy Framework and the Western Cape Green Economy Indicators.

Current feedback on the green economy investments is that approximately R11.6 billion were committed to the Western Cape during 2020/21 - through the support of GreenCape and Wesgro. These investments will lead to the creation of approximately 970 jobs in the Western Cape and were in a commercial rooftop PV solar system, a crypto-driven global peer-to peer solar panel leasing platform and cloud computing data centres. During 2020/21, a total of 1670 support engagements were undertaken with businesses and municipalities, with an additional 30 businesses being provided with technical advisory support towards encouraging the take up of rooftop PV systems. Due to load shedding, the renewable energy and energy services sector desk recorded higher instances of support to green economy businesses.

The Western Cape Green Economy Report provides more detailed information on specific project initiatives and outcomes, including: the Provincial Biodiversity Economy Strategy, Bioprospecting and Natural Products Honeybush Community of Practice (HCoP), Bitou Agroforestry Projects (BAP), Sustainable Flower Harvesting Certification/assurance system, the Ecological Infrastructure Investment Framework (EIIF), Alien Invasive Species Strategy and Restore Eden Programme. Readers are encouraged to access the unabridged report for further information.

8.15.5 Western Cape Environmental Implementation Plan

With respect to Provincial Government's implementation of the programmes, plans and policies that have a significant effect on the environment of the Western Cape, the 4th Edition Western Cape Environmental Implementation Plan (EIP) was developed. The compilation of the Western Cape 4th Edition EIP was therefore guided by Section 13(1) of NEMA and the plan contains the following information –

- Guiding international, national, provincial and local-level documentation;
- Provincial and departmental Policies, Strategic Plans, Annual Performance Plans;

- Inter-departmental consultations;
- NEMA, SDGs, Agenda 2030, NDP 2030;
- MTSF 2019 – 2024, IPSS/WCMES;
- Inputs and comments solicited from DFFE and EIP/EMP Sub- committee members; and
- SDGs Country Report 2019 – South Africa.

For exciting and new provincial and local government policies, plans and programmes that when implemented may significantly affect the environment both negatively and positively, readers are encouraged to read the 4th Edition Western Cape Environmental Implementation Plan for more and in-depth information.

9 KEY INDICATORS

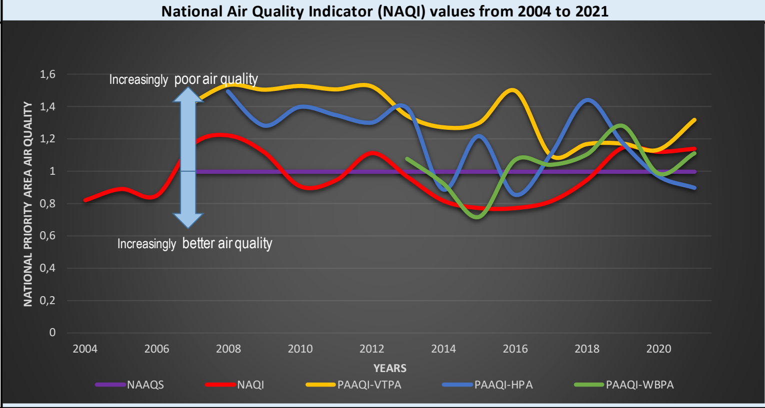
An environmental indicator is a piece of numerical data which allows us to measure the changes in the environment over time. Indicators enable better environment decision making by representing large amount of complex data in simple manner.

Indicators for the South Africa Environment Outlook have been carefully selected to provide a representative picture of the state of various environmental themes, as well as the changes over time to the drivers, pressures, impacts and responses related to those themes. This was achieved by tracking the indicators over time, therefore the Outlook assess the effectiveness of responses to environmental challenges.

9.1 Air quality

9.1.1 National air quality indicator

The National Air Quality Indicator (NAQI) provides a measure of ambient air quality in relation to current air quality standards across the country and in recognised national air pollution hot spots, (PAAQI). Scientifically, the NAQI/PAAQI is defined as the maximum value of the normalized ratios of the annual averages of PM_{10} and SO_2 measured by the air quality monitoring station network in priority areas for each year. Indicator values of 1 and above means, that air quality does not meet ambient air quality standards. NAQI/PAAQI values below 1 means that overall, air quality complies with current ambient air quality standards.

State of Environment Indicator Description: National Air Quality Indicator (NAQI)		
National Air Quality Indicator (NAQI)		
STATE	National Air Quality Indicator (NAQI) values from 2004 to 2021	OUTLOOK
		
2021 **Concern -** The current air quality indicator shows that, on average, national ambient air quality is not compliant with national ambient air quality standards and the trend is stable or negative	The graph indicates that South Africa's national and priority air quality indicators are exceeding the recommended threshold. The air quality indicators confirm that the most problematic air pollutant in the Vaal Triangle Airshed Priority Area (VTAPA) and the Highveld Priority Area (HPA) is particulate matter (PM_{10}) and has been decreasing over the years. Although it is still too early to tell whether these positive trends, especially noticeable in 2014, are due to the implementation of air quality management plans in the areas or whether it is simply a reflection of general pollutant emission reductions over the region due to, for example, improved electrification, fuel switching, weather conditions (e.g. 2014 was a relatively wet year which reduces particulate matter for example) or reduced economic activity, it is clear that air quality is improving slightly in the priority areas. At a national level, the National Air Quality Index (NAQI) shows that since 2009, there has been a decrease in the levels of PM_{10} across the country, however it increased from 0.81 in 2017 to 1.14 in 2021. The NAQI should be treated with caution as major metropolitan areas such as Johannesburg, Tshwane, eThekwini and Ekurhuleni have not reported ambient air quality consistently to the South African Air Quality Information System (SAAQIS) since 2010. As such, the Department of Forestry, Fisheries and the Environment has put in place a NAQI station management program to assist struggling networks and to ensure consistent data reporting. The increase in the indictors since 2015 is also because the National Ambient Air Quality Standards (NAAQS) has been tightened from 50 to 40ug/m^3.	**Concern** - An annual air quality indicator value of less than 1.0 is unlikely to be met within the next 5 years

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.2 Climate change

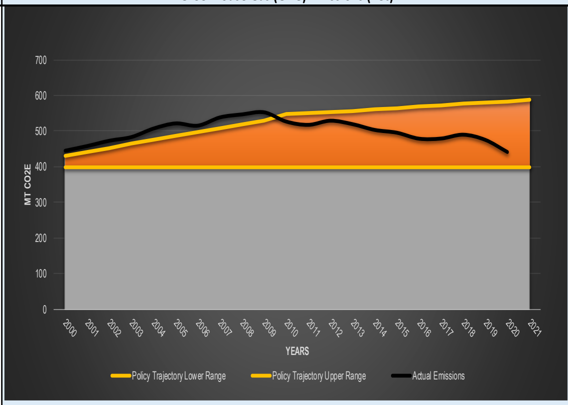
9.2.1 Climate change awareness and education indicators

Eleven climate change awareness and education Indicators spanning vulnerable sectors were developed against which the South African Climate Change Education and Awareness Survey findings were measured to determine progress made in each Indicator. As reflected in the table below, progress determination for each of the indicators is expressed as a percentage – for example, the % of the respondents who exercised or practiced an activity associated with relevant indicators.

Number of an Indicator	Indicators	Sector	Progress
Indicator 1	Re-use and recycling of water and waste materials	Waste	62% of the public respondents reported to have practiced re-use and recycling of water and waste materials
Indicator 2	Tree planting	Forestry	90% of the public respondents reported to have valued the need to plant trees to benefit the environment
Indicator 3	Turning off lights when not in use	Energy	88% of the public respondents reported to have switched off lights when not in use
Indicator 4	Perceived increasing or decreasing yield	Agriculture	90% of the public respondents reported that climate change affects their production
Indicator 5	Stop/Reduce time taking car/bus and walk or cycle	Transport	10% of the public respondents reported to have cycled in order to combat climate change
Indicator 6	Climate change health related epidemics, e.g. malaria, diarrhoea, dehydration, heatwaves	Health	66% of the public respondents reported to have experienced dehydration due to heatwaves
Indicator 7	Percentage of the population believing that climate change exists	General	88% of the public respondents reported to have heard about climate change
Indicator 8	Which sources have people heard about climate change	Communication	88% of the public respondents reported to have heard about climate change from different dissemination channels including TV and Radio
Indicator 9	Curricula introducing climate change education into national education systems	Education	54% of the public respondents reported not to have been aware whether government has introduced climate change education into school curriculum
Indicator 10	Number of climate change relevant plans/policies developed over a period of five years across all relevant sectors/departments	Policies	Climate change experts reported that there were many climate change related policies

9.2.2 Greenhouse gas emission

The National Greenhouse Gas (GHG) Emissions Indicator measures South Africa's actual greenhouse gas emissions against the National GHG Emissions Trajectory Range that is used as the benchmark against which the efficacy of GHG mitigation action is currently measured in terms of the National Climate Change Response Policy (2011).

State of Environment Indicator Description		
South African Greenhouse Gas (GHG) Emissions (net)		
STATE	Greenhouse Gas (GHG) Emissions (net)	OUTLOOK
		
2000-2020 **Favourable -** The current status meets policy objectives, targets or standards and the trend is stable or positive	The results from the graph shows that South Africa's GHG emissions was 442 Mt CO2e during 2020 and this was a decrease of 38 Mt CO2e (7.9%) when compared to the year 2017 value of 480 Mt CO2e. However, looking at the entire table, there has been a 0.9% overall decrease of GHG emissions in South Africa from the year 2000 (446 Mt CO2e) to 2020 (442 Mt CO2e). It can be noted from the graph that South Africa's GHG emissions from 2010 onwards are within the National GHG emissions trajectory range. The implemented mitigation measures in all sectors contributed to the reduction of GHG emissions. With the efforts of reducing its GHG emissions, South Africa is implementing measures which includes renewable energy, energy efficiency and green transport strategy. The MTSF 2019-2024 identifies the following outcomes: Greenhouse gas emissions (GHG) reduction, municipal preparedness to deal with climate change, a just transition to a low carbon economy and improved ecological infrastructure.	**Good -** Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation

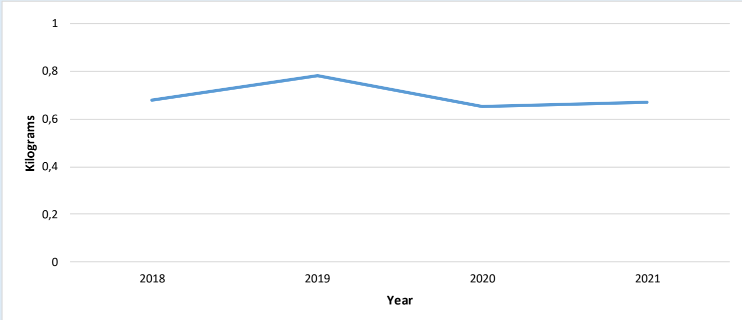
Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.3 Waste management

9.3.1 Hazardous waste generated per capita

The indicator measures the volume of hazardous waste generated per capita in South Africa. This aspect of the indicator is particularly important as hazardous waste that is unaccounted for is typically also untreated and has a high potential to impact the environment.

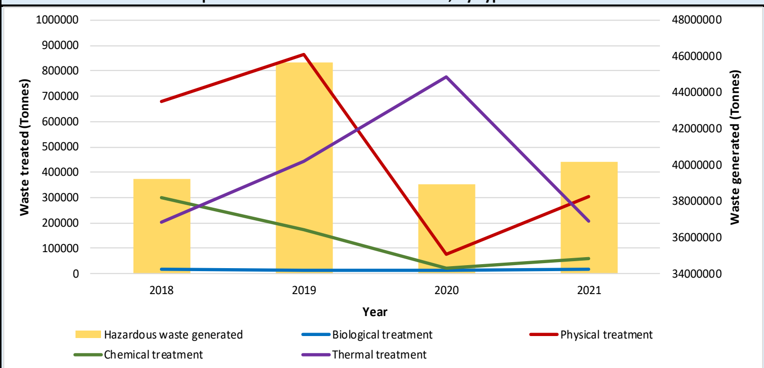
State of Environment Indicator Description		
Hazardous waste generated per capita		
STATE	**Hazardous waste generated per capita**	**OUTLOOK**
		
2021 **Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	Overall, hazardous waste generated per capita in South Africa remained relatively constant over the assessment period, with minor variations recorded in 2019 and 2020. In 2021, hazardous waste generated per capita stood at 0.67 kilograms per capita. The decline from 2019 to 2020 may be attributed to the COVID-19 pandemic, which resulted in diminished household consumption and reduced industrial activity.	**Uncertain -** Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.3.2 Proportion of hazardous waste treated, by type of treatment

The indicator includes hazardous generated, hazardous waste generated by type (including e-waste as a sub-indicator) and the proportion of hazardous waste treated. This aspect of the indicator is particularly important as hazardous waste that is unaccounted for is typically also untreated and has a high potential to impact the environment.

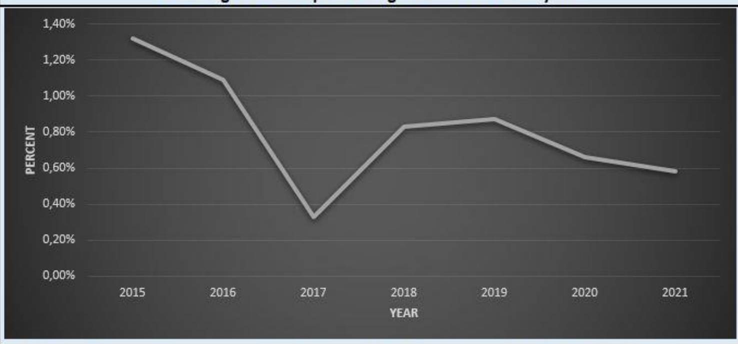
State of Environment Indicator Description		
Proportion of hazardous waste treated, by type of treatment		
STATE	Proportion of hazardous waste treated, by type of treatment	OUTLOOK
		
2021 **Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	In 2018, physical treatment of hazardous waste was the dominant treatment method with nearly 700 00.00 tonnes of hazardous waste being physically treated. This was followed by chemical treatment (300 748.64 tonnes) and thermal treatment (202 955.67 tonnes). The overall treatment of hazardous waste increased substantially in 2019 and was largely driven by increases in thermal treatment, which recorded a sevenfold increase. Thereafter, in 2020, the treatment of hazardous waste declined across all treatment types. This may, as previous mentioned, be ascribed to reduced industrial activity induced by the onset of the COVID-19 pandemic. In 2021, volumes of hazardous waste treated recovered across all treatment types apart from thermal treatment. Although substantial volumes of hazardous waste are treated in South Africa, it should be considered relative to the volumes generated annually. In 2018, 39.2 Mt of hazardous waste was generated in South Africa throughout the year and increased to 45.7 Mt in 2019. Thereafter, the volume of hazardous waste was generated nationally declined to 38.9 Mt in 2020 before increasing to 40.2 Mt in 2021. As such, hazardous waste treatment in South Africa is thus considerably lower relative to the volumes generated annually.	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.3.3 Percentage of municipal waste generated that is recycled

Percentage of total amount of generated municipal waste, reported on South African Waste Information System (SAWIS) in tonnes per annum, that is recycled. Municipal solid waste' generally refers to waste collected from residences, businesses and institution. Municipal waste stream excludes commercial and industrial waste, organic waste, construction and demolition waste, paper, plastic, glass, metals and tyres.

State of Environment Indicator Description		
Percentage of municipal waste generated that is recycled		
STATE	**Percentage of municipal waste generated that is recycled**	**OUTLOOK**
		
2021 **Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	Indicator looks at the percentage of municipal waste that has been recycled. The figure above shows an over all decline in the percentage of municipal waste recycled during the entire measured period (i.e. 2015 to 2021). There was however a noted decline to the lowest point (i.e. 2017) between 2015 and 2017 from 1.3% to 0,33% respectively. Even though it is evident that slow progress was made between 2015 and 2016, South Africa needs to put more efforts on reducing waste generation through prevention, reduction, recycling, and reuse. Note: Municipal waste stream excludes commercial and industrial waste, organic waste, construction and demolition waste, paper, plastic, glass, metals and tyres. The reported data is based on the input reported by the registered waste activities to the South African Waste Information System (SAWIS). Non-reported recyled municipal waste data is excluded.	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

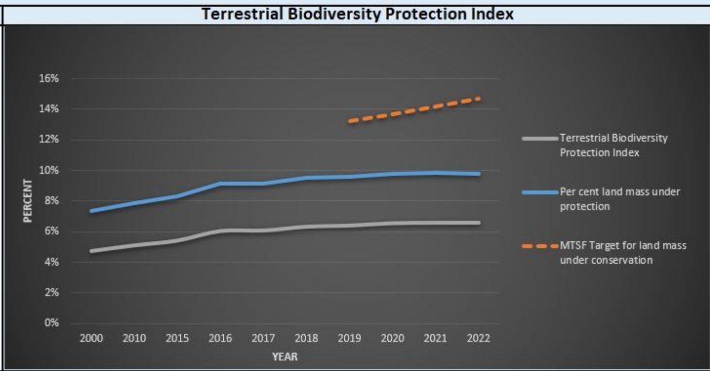
Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.4 Biodiversity

9.4.1 Terrestrial Biodiversity Protection Index

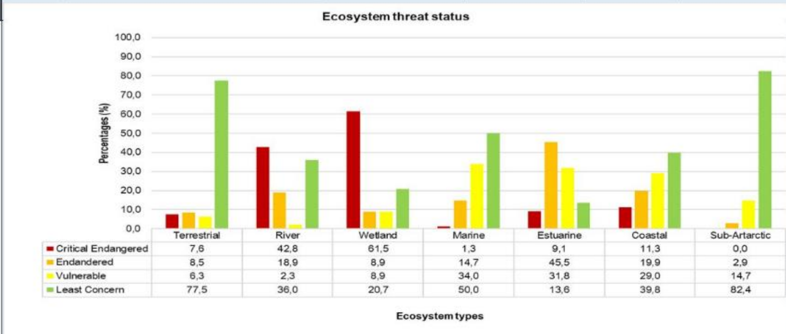
The Terrestrial Biodiversity Protection Index is a biodiversity related indicator that measures how extensive South Africa's protected areas are, and how well they represent our ecosystem types.

State of Environment Indicator Description		
TERRESTRIAL BIODIVERSITY PROTECTION INDEX		
STATE	Terrestrial Biodiversity Protection Index	OUTLOOK
		
2022 **Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	There was a steady increase in the protected area network extent and the Terrestrial Biodiversity Index since 2000. The per cent land mass under protection increased from 7.25% in 2000 to 9.78% in 2022. The TBPI increased from 4.65% in 2000 to 6.60% in 2022. South Africa's terrestrial protected area network continuously expanding, in terms of per cent land mass under protection and the range of biodiversity represented in these protected areas. It should be noted that the MTSF target is set to expand the conservation target from 13.2% in 2019 to 15.7% by 2024. The TBPI index as it currently stands only considers South Africa's protected area network, and does not include conservation areas such as biosphere reserves, botanical gardens, bird sanctuaries or World Heritage Site buffers in its calculations. This indicator is not well suited to track the MTSF target and as a result it will not reach the target until it considers the contribution of Other Effective-Area based Conservation Measures (OECMs) such as botanical gardens, biosphere reserves, etc.	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

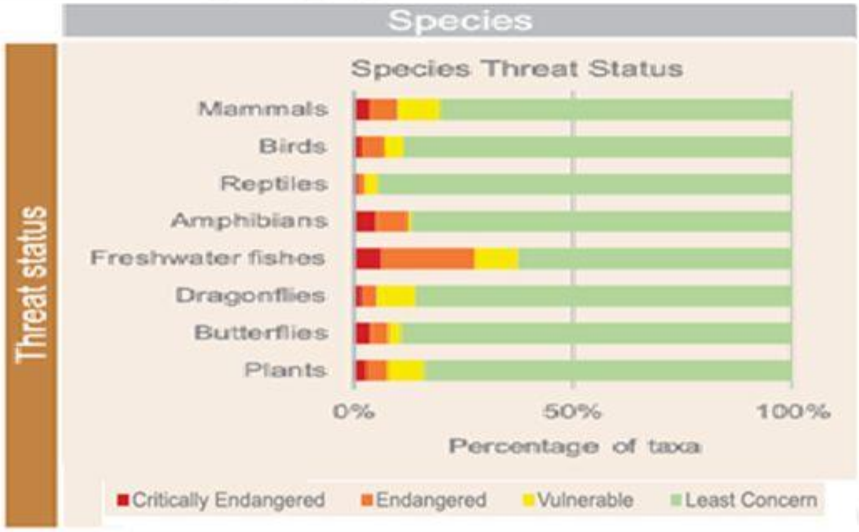
9.4.2 Ecosystem threat status

STATE		OUTLOOK
		
2018 Improving - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	Inland wetland, river and estuarine ecosystems have very high levels of threat. Rivers and inland wetlands have the highest proportion of types in the Critically Endangered category; 43% and 62% respectively. Estuaries have the highest overall proportion of threatened ecosystem types (86%), followed by inland wetlands (79%) and rivers (64%).	Uncertain - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years.

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.4.3 Species threat status

<table>
<tr><th colspan="2">Species Threat Status</th></tr>
<tr><td>From a species perspective, all 20 401 plants have been assessed and 14% were listed as threatened. All mammals, birds, reptiles, amphibians, freshwater fishes, butterflies and dragonflies were assessed, together with selected marine and estuarine fishes and invertebrates. Of the 2192 animals assessed, at total of 16% were listed as threatened.</td>
<td>
</td></tr>
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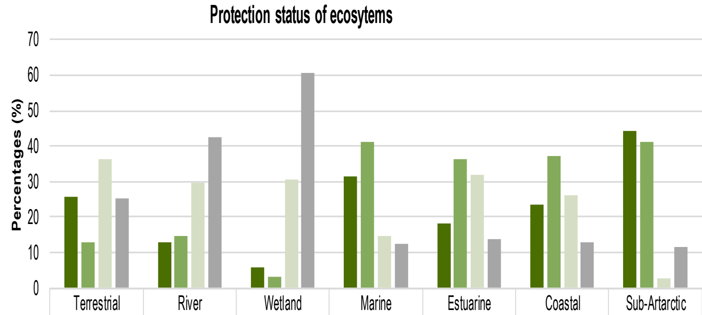
9.4.4 Ecosystem protection level

ECOSYSTEM PROTECTION LEVEL

STATE



	Terrestrial	River	Wetland	Marine	Estuarine	Coastal	Sub-Artarctic
Well protected	25,76419214	13,06306306	5,925925926	31,33333333	18,18181818	23,65591398	44,11764706
Moderately protected	12,88209607	14,86486486	2,962962963	41,33333333	36,36363636	37,09677419	41,17647059
Poorly protected	36,24454148	29,72972973	30,37037037	14,66666667	31,81818182	26,34408602	2,941176471
Not protected	25,10917031	42,34234234	60,74074074	12,66666667	13,63636364	12,90322581	11,76470588

Ecosystem types

OUTLOOK

2018		
meets policy objectives, targets or standards and the trend is stable or positive	The graph above shows that Sub-Artarctic ecosystem is the most well protected ecosystem in South Africa with about 44% of its area categorised as well protected. It is followed by Marine and Terrestrial ecosystems with about 31% and 26% of their area considered as well protected respectively. Wetlands are the least protected ecosytem with 61%. Improvement in Marine protection can be attributed to the declaration of 20 new MPAs during the year 2018.	Good - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years.

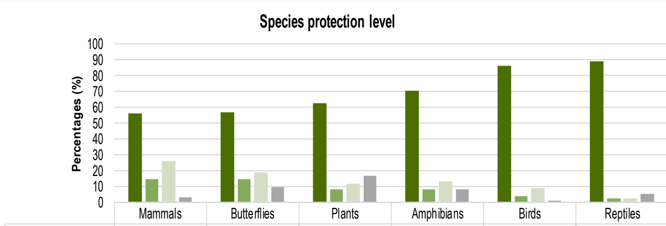
Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.4.5 Species protection level

State of Environment Indicator Description

SPECIES PROTECTION LEVEL

STATE		OUTLOOK
		
2018 Favourable - The current status meets policy objectives, targets or standards and the trend is stable or	The graph above shows that above 85% of birds and reptiles taxa are Well Protected. Mammals have the lowest levels of protection, with 56% of species categorised as Well Protected. The graph further show that birds are the most unprotected taxa with 0.8% falling under Not Protected category. The insufficient mitigation of threats to these species within the protected areas, result in population declines.	Good - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious

	Mammals	Butterflies	Plants	Amphibians	Birds	Reptiles
Well protected	56,11510791	56,72436751	62,9877369	70,4	86,55737705	89,20308483
Moderately protected	14,38848921	14,64713715	8,584169454	8	3,93442623	2,827763496
Poorly protected	26,25899281	19,30758988	11,5942029	13,6	8,68852459	2,827763496
Not protected	3,237410072	9,320905459	16,83389075	8	0,819672131	5,141388175

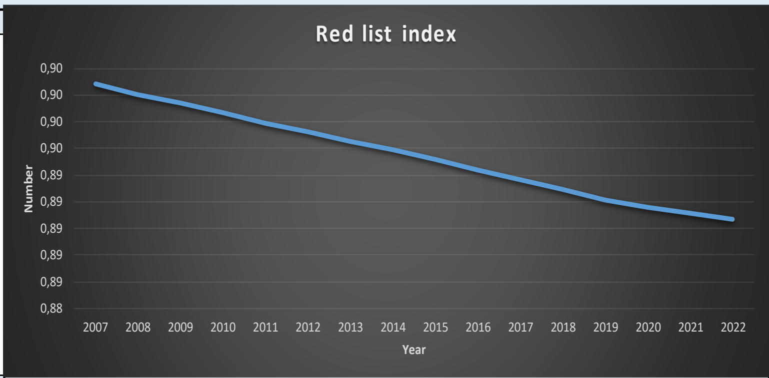
Species Types

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.4.6 Red list index

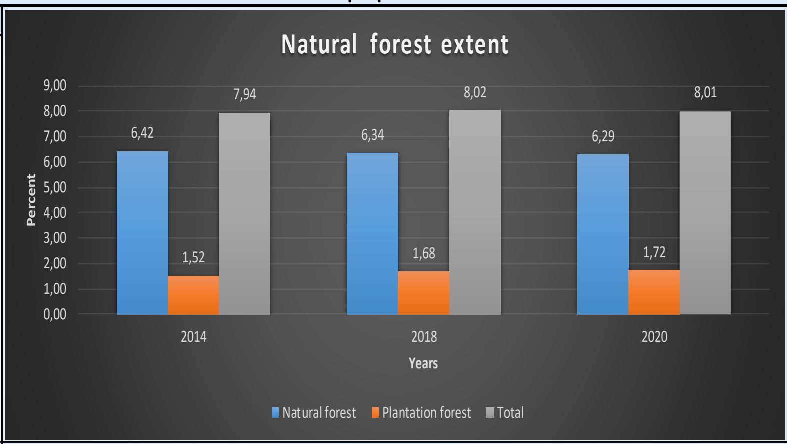
The index measures the performance of the country in terms of the species threat status using the IUCN red list categories. The purpose of this indicator is to demonstrate how South Africa is doing in terms of managing species that are on different IUCN red list categories.

Red List Index		
STATE		OUTLOOK
		
2022	The above graph shows an overall negative trend over the assessment period (1990 -2022), and this means that species became more threatened overtime in South Africa. There are some species in groups such as mammals, odonata (dragonflies and damselflies) and bird species that showed improvements. However, this has not changed the general negative trend for these species' groups since the overall trend on the graph still remains negative. This is however not a hopeless situation, there are interventions such as continuous conservation action, expansion of protected areas, and improvements to the state of existing populations which can change in the trajectory.	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years
Concern - The current status does not meet policy objectives, targets or standards and/or the trend is positive		

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.4.7 Forest area as a proportion of total land area

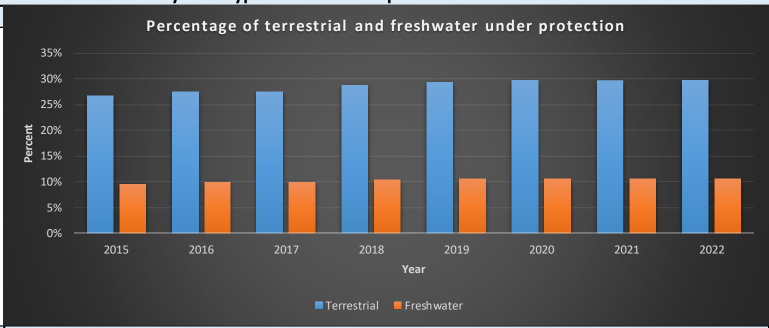
Forest area as a proportion of total land area		
STATE		**OUTLOOK**
		
2020	The graph show a slow rate of decline in forest extent. This is due to various forest protections initiatives afforded by the National Environmental Management Act and the National Forest Act as well as cultural practices that protect forests in communal lands. Another reason for the overall low rate of decline is that in some landscapes forests are expanding due to increased growth rates of forest species that have been shown to result from increased CO_2 levels in the atmosphere (known as CO_2 fertilization). The graph further shows that there had been continuous growth in terms of the area covered by plantation forest since 2014 up until 2020.	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years
Concern - The current status does not meet policy objectives, targets or standards and/or the trend is positive		

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.4.8 Terrestrial and freshwater biodiversity protection

The indicator measures the growth in terrestrial and freshwater protected areas to show how the protected area network is growing in South Africa.

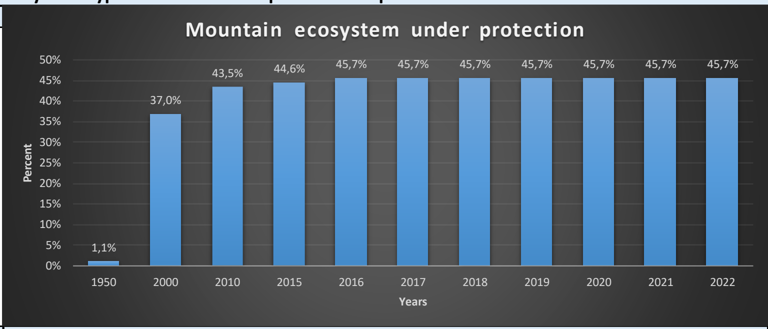
Percentage of terrestrial and freshwater ecosystem types that are well protected		
STATE		**OUTLOOK**
		
2022 **Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	The important trends to note are the steady increases in the number of Well Protected ecosystem types, and that Freshwater ecosystem types are relatively poorly protected (10% compared to 29% for Terrestrial types). Recent improvements in Terrestrial Protection Levels have been driven by private conservation initiatives linked to Biodiversity Stewardship Programmes, and the declaration of a large PA in the Northern Cape (Meerkat National Park). Efforts are underway to explore further opportunities and mechanisms to expand the PA and OECM (Other Effective Area based Conservation Measures) network in order to meet the highly ambitious targets of the Kunming-Montreal Global Biodiversity Framework.	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.4.9 Percentage of mountain ecosystem types that are well represented in a protected areas

The indicator measures the representativity of mountains in the protected area network. The purpose of this indicator is to track the representativity of mountains in the protected area network of the country.

Percentage of mountain ecosystem types that are well-represented in protected areas		
STATE		OUTLOOK
		
2023	The important issue to note on the above graph is the complete lack of increase in the protection of mountain ecosystems since 2016. This may be attributed to the South African protected areas expansion policy (NPAES 2018) that considers mountains as better protected than adjacent lowland habitats. Due to this, the lowlands have seen great efforts at Protected Area (PA) expansion in recent years. This therefore means that even though there is no increase in the representativity of mountain ecosystems in the country's protected area network, the mountains are however still considered well protected. The following are reasons why mountains are generally well protected. a) Mountains were identified as important water catchments in the early 1900 and remained in state hands, eventually being transferred to nature conservation agencies for control, and b) Mountains generally provide fewer opportunities for agriculture and settles than lowland areas. Efforts are underway to explore further opportunities and mechanisms to expand the PA and OECM (Other Effective Area based Conservation Measures) network in order to meet the highly ambitious targets of the Kunming-Montreal Global Biodiversity Framework, and mountainous regions are likely to benefit.	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years
Improving - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive		

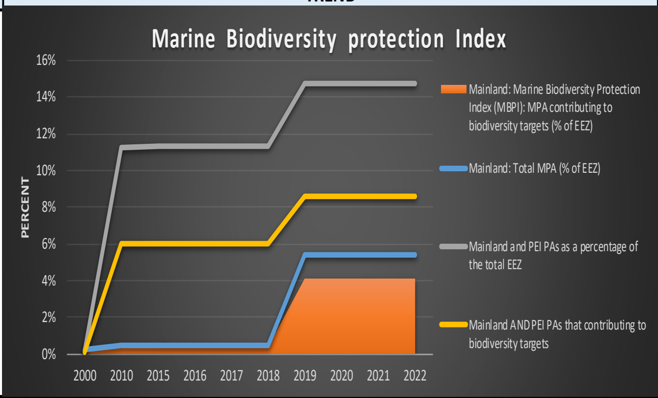
Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.5 Oceans and coasts

9.5.1 Marine Biodiversity Protection Index

The Marine Biodiversity Protection Index measures how extensive South Africa's protected areas are and how well they represent the marine ecosystem types.

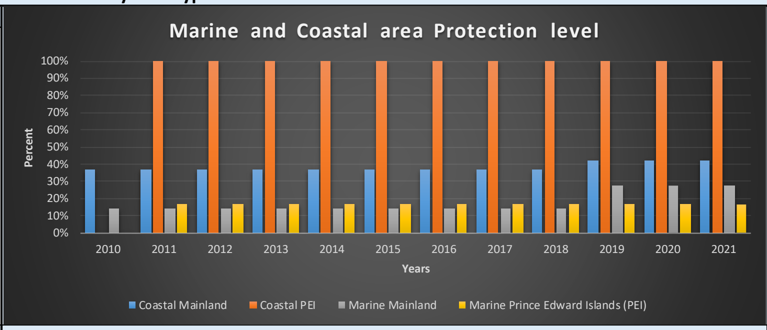
MARINE BIODIVERSITY PROTECTION INDEX		
STATE	**TREND**	**OUTLOOK**
		
State as at 2022	Thanks to the Operation Phakisa Ocean Economy initiative South Africa has made major strides towards achieving its national and international targets. 20 new Marine Protected Areas (MPAs) were declared on 23 May 2019, increasing the MPAs coverage (expressed as a percentage of the Mainland Exclusive Economic Zone) from 0.46% in 2018 to 5.38% in 2022. The increase in protection has also led to an increase in the number of ecosystem types represented in the marine protected areas network, driving the MBPI up from 0.35% in 2018 to 4.08% in 2022 in the Mainland EEZ. There have been no new declarations of MPAs since 2019	Uncertain - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive.		

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.5.2 Marine and coastal ecosystem protection

The indicator measures the growth in the protection of Marine and Coastal ecosystem. The purpose of this indicator is to track the progress in marine and coastal ecosystem protection.

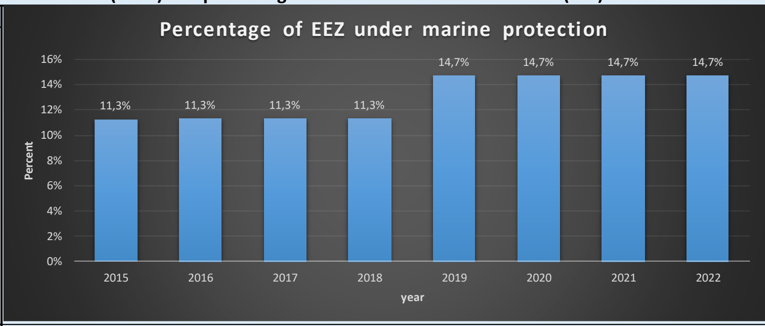
Percentage of Marine and Coastal ecosystem types that are Well Protected		
STATE		OUTLOOK
		
2023 **Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	The important trends to note are the stability of the protection levels in the Prince Edward Islands (PEI) Exclusive Economic Zone (EEZ) in the Southern Ocean, where all the coastal ecosystems are Well Protected (100%) and 16.7% of marine ecosystems are Well Protected. No Marine Protected Area (MPA) expansion is planned in the PEI region at this stage. In contrast, in the mainland EEZ the percentage of ecosystem types that are Well Protected doubled between 2018 and 2019 (from 14% to 27%) following the declaration of 20 new MPAs, many of which were off-shore. Mainland coastal ecosystem types saw a more modest increase in protection, from 36% to 42% Well Protected. Further MPAs and other conservation tools are being considered in the mainland EEZ.	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years

Key

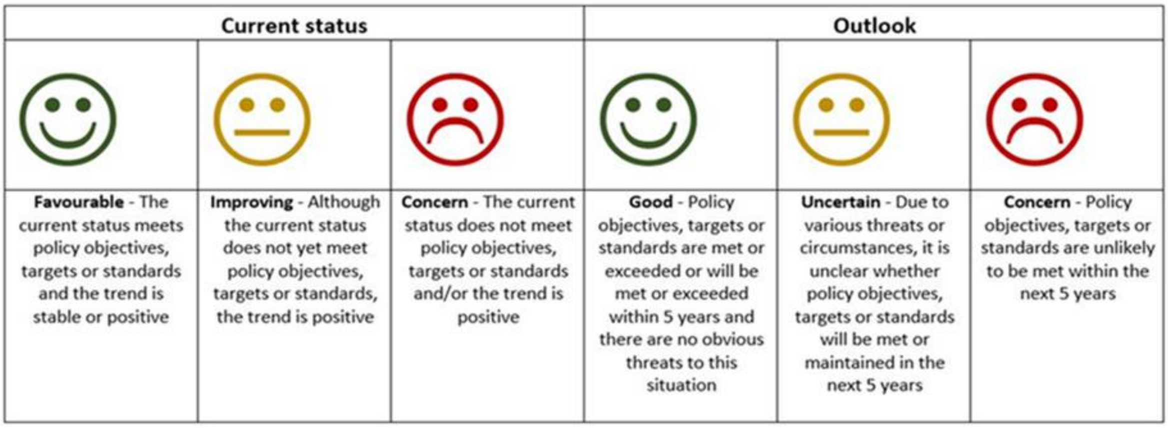
Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.5.3 South African marine protected areas as a percentage of exclusive economic zone

The indicator measures the proportion of the EEZ that is falling under protection. The purpose of this indicator is to track the progress in the protection of the EEZ.

South African Marine Protected Areas (MPA) as a percentage of the Exclusive Economic Zone (EEZ)		
STATE		OUTLOOK
		
2022		
Concern - The current status does not meet policy objectives, targets or standards and/or the trend is positive	South Africa can report that 14.7% of its marine extent is protected, a number that has remained steady since substantial increases in early 2019 when twenty new Marine Protected Areas were declared, the result of dedicated work by multiple institutions under the banner of Operation Phakisa. The Marine Protected Areas (MPAs) declared were carefully designed and situated to be representative of the various ecosystem types in the Exclusive Economic Zone (EEZ). The result was that the mainland EEZ portion of South Africa's marine extent saw an increase in protection from just 0.4% in 2018 to just over 5.4% in 2019. Since then it has remained stable. The Subantarctic EEZ portion around Prince Edward Island saw the addition of a very large Marine Protected Area in 2011 resulting in over 34% coverage, since then it has remained stable.	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

Key



Current status			Outlook		
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

9.6 Fisheries

9.6.1 The number and percentage of stock of concern or not

The number and percentage of stock of concern or not		
STATE	TREND	OUTLOOK
		
State as at 2020 Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	The number of stocks that are considered to be of concern has decreased from 10 in 2014 and 2016 to nine in 2020. The number of stocks considered to be over-exploited has remained at 15. This is the net result of the inclusion of new resources in this assessment since 2016 (dageraad, oceanic whitetip shark and great hammerhead shark), the exclusion of two resources included in the 2016 report (elf and white steenbras), the decline in status of one resource (shortfin mako sharks) and the improvement of status for Atlantic yellowfin tuna and silver kob.	Good - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation

	2012	2014	2016	2020
Stocks not of concern	20 (46%)	22 (49%)	27 (52%)	37 (61%)
Stocks of concern	23 (54%)	23 (51%)	25 (48%)	24 (39%)
Number of stocks assessed per year	43	45	52	61

Key

Current status			Outlook		
					
Favourable - The current status meets policy objectives, targets or standards and the trend is stable or positive	**Improving** - Although the current status does not yet meet policy objectives, targets or standards, the trend is positive	**Concern** - The current status does not meet policy objectives, targets or standards and/or the trend is positive	**Good** - Policy objectives, targets or standards are met or exceeded or will be met or exceeded within 5 years and there are no obvious threats to this situation	**Uncertain** - Due to various threats or circumstances, it is unclear whether policy objectives, targets or standards will be met or maintained in the next 5 years	**Concern** - Policy objectives, targets or standards are unlikely to be met within the next 5 years

10 INFORMATION SHEETS

10.1 Air quality information sheet

- South African air quality index

10.2 Forestry factsheets

The following new factsheets are now available on the South African State of Environment website (http://soer.environment.gov.za/soer/) –

- Land utilisation comparison
- Land use comparisons (2009, 2014, 2019)
- Plantation area by species/ownership
- Plantation area by species/province
- Plantation area by ownership, 2019
- Plantation area by species, 2019
- New afforestation by province
- New afforestation by species over last 7 years
- Roundwood sales from plantations
- Gross value of output comparisons (2009, 2014, 2019)
- Roundwood production by province and Genera, 2019
- Total roundwood production Ex plantations by product, 2019
- Composition of roundwood production by product, 2019
- Number of processing plants by type of plant and intake
- Roundwood intake by primary processing sector
- Sales Ex primary processing plants by volume
- Sales Ex primary processing plants by value
- Roundwood intake into processing plants 2019
- Roundwood intake into processing plants by province and product, 2019
- Imports Vs exports of forest products, 2019
- Export comparisons (2009, 2014, 2019)

11 GLOSSARY

A glossary of all the terms used in the SAE 2023 and previous editions is available on the State of the Environment website (http://soer.environment.gov.za/soer/).

12 ACRONYMS

A list of all the acronyms used in the SAE 2023 and previous editions is available on the State of the Environment website (http://soer.environment.gov.za/soer/).

13 ACKNOWLEDGMENTS

The SAE is updated annually by the State of Environment Report Drafting Team made up of representatives of: (i) all the DFFE's line function branches (Regulatory compliance and sector monitoring; climate change and air quality management, chemicals and waste management, biodiversity and conservation, fisheries, oceans and coasts, forestry management, etc.); (ii) the Department of Water and Sanitation; (iii) the Entities – the South African National Biodiversity Institute (SANBI); the South African Weather Service (SAWS); Ezemvelo KZN Wildlife; South African Environment Observatory Network (SAEON); CapeNature and (iv) all provincial environmental management departments.

Every year the Drafting Team meets to review the previous year's edition of the SAE, removes any information that is more than four years old and identifies and collects all newly published information for inclusion in the update. This information is, where possible, organised and structured using the international Driver-Pressure-State-Impact-Response (DPSIR) Framework for state of environment reporting.

For the SAE 2023, the DFFE would like to acknowledge and thank all the members of the SAE 2023 Drafting Team listed below –

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