Western Cape Government

BETTER TOGETHER.

State of Environment Outlook Report for the Western Cape Province

EXECUTIVE SUMMARY

2013

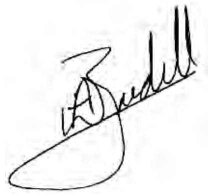
FOREWORD

Foreword by the Minister of Local Government, Environmental Affairs and Development Planning.

It has often been said about the Western Cape that our gold is above the ground and not below the ground such as in other provinces. Our gold in the Western Cape is our biodiversity, natural beauty and way of life. Our lifestyles and the choices we make affect the environment in which we live. Thus without having a realistic picture of the condition of the environment we will not be able to make the right management choices. For this reason the Western Cape Government embarked on a project to research and compile a Western Cape State of Environment Outlook Report. The environment is a cross-cutting issue and the purpose of this State of Environment Outlook Report is to provide information on environmental trends so that politicians, officials, researchers and managers can take decisions that affect the environment based on credible information. It is also able to create awareness among the general public on the condition of the environment.

This report indicates that although we are ahead of many other Provinces in our service delivery, this has been achieved at the cost of our natural resources. This is an indication that in the future we will not be able to afford the resource intensive municipal services and infrastructure we have today – we must therefore build smarter settlements.

We recognise the need to portray an accurate picture, but as is evident from the report findings, we will have to take more wise decisions and change our lifestyles to safeguard our environment if we want to ensure clean and healthy ecosystems for our children and future generations.



Provincial Minister,
Anton Bredell

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1 STATE OF ENVIRONMENT REPORTING IN THE WESTERN CAPE

The Western Cape is blessed with natural beauty that includes the unique fynbos vegetation, mountain ranges and beautiful shorelines, and also possesses a cultural diversity with a long and rich history. The province's natural capital is impacted by a range of factors, including the need for economic development and social welfare, as well as global climatic change. To enable decision-making that will balance the needs of the human and natural systems and achieve a sustainable future, regular environmental assessment in the form of 'state of the environment' reporting is required.

State of Environment Reporting

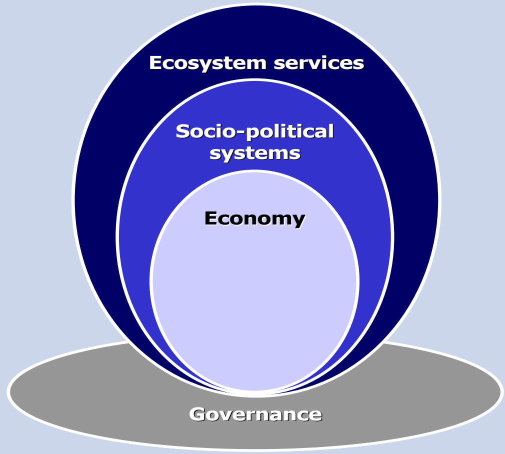
A State of Environment Report is used to highlight changes in the environment, as well as the causes of these changes, and to identify appropriate responses.

SoE reporting is not an end in itself. It is part of a broader process aimed at achieving sustainable resource management, through providing accurate and relevant information to the correct target audience, and influencing decisions through effective communication.

Source: DEAT, 2006

What is Sustainable Development?

The 2013 Western Cape State of Environment Outlook Report adopts a systems approach to sustainability where the economic system, socio-political system and ecosystem are seen as embedded within each other, and then integrated through a governance system that holds all the other systems together within a legitimate regulatory framework. Sustainability implies the continuous and mutually compatible integration of these systems over time; sustainable development means making sure that these systems remain mutually compatible as the key development challenges are met through specific actions and interventions to eradicate poverty and severe inequalities.



Source: National Framework on Sustainable Development (NFSD) 2008

South Africa has produced a range of State of Environment products, including three national reports (1999, 2006, 2012). This 2013 report is the second comprehensive report on environmental trends in the Western Cape, following on from the "*Western Cape State of Environment Report – Year One*" baseline report (DEADP 2005). The aim of the 2013 report is to detail the current state of environmental resources and identify environmental trends and priority concerns. It must therefore be seen as a critical supportive process for the provincial visioning exercise which is being undertaken under the name 'OneCape 2040'. OneCape 2040's vision is to enhance the sustainability of the regional economy by rising to the challenge of creating: "*...a resilient, inclusive and competitive Western Cape with high rates of employment, growing incomes, greater equality and an improved quality of life for all our citizens and residents that addresses the crisis of joblessness, overcomes our legacy of skills and asset deficits and responds to environmental risk.*" The vision acknowledges the need for a sustainable balance between economic access, cultural diversity, human activities and, importantly, sustained integrity of the delicate ecological system that the Western Cape is custodian of.

2 THE FRAMEWORK FOR THE STATE OF ENVIRONMENT OUTLOOK REPORT

2.1 The Drivers-Pressures-State-Impact-Response framework

As in the 2005 report, the 2013 Western Cape State of Environment Outlook Report reports on the state of the environment specifically for the Western Cape based on the internationally accepted 'Drivers-Pressures-State-Impact-Response' (DPSIR) framework (Figure 1). The framework acts as an effective way to provide a 'big picture' snapshot of the state of the environment. Adopted by the United Nations, this framework considers causal links, with feedback at the end of the cycle to revisit and reset the start point.

- **'Drivers'** are the primary agents driving change in the environment (e.g. human population).
- **'Pressures'** are the human activities and processes that act on the environment and cause environmental change (e.g. agricultural production).

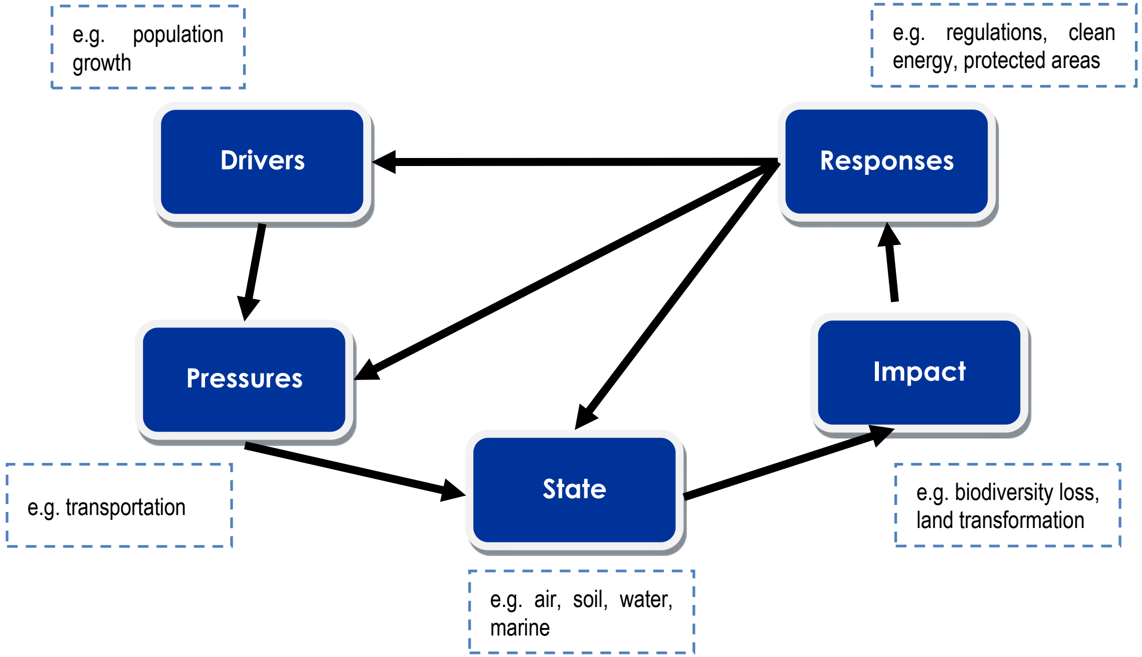


Figure 1: Interpretation of the DPSIR Framework

- **'State'** describes the current condition of the environment which changes over time (e.g. extent of cultivation).
- **'Impacts'** describe the consequences of changes (positive / negative) to the environmental state from a sustainability viewpoint – considering effects to humans, the economy, ecosystems, other environmental sectors, and could include regional or global effects (e.g. fragmentation of natural habitat).
- **'Responses'** are actions (corrective or survival responses) taken to influence drivers and pressures, or to change the state, including easing or preventing negative environmental impacts, correcting damage, or conserving natural resources (e.g. improved monitoring and compliance within extension services). Societal responses act as inputs to all components of the framework.

2.2 Themes and indicators

In order to consider the state of the environment as a whole, yet its constituent systems individually, reporting is done according to a number of summarising themes. This report follows a similar structure to the 2005 report, reflecting on themes related to natural, social and economic aspects of sustainable development. Notably, the number of themes was reduced from fourteen to nine to allow for standardisation across the various levels of State of Environment Reports within South Africa and to reduce overlap between environmental reporting and socio-economic reporting as found in the economic and social outlook reports for the Province (Table 1). This Executive Summary reports on the key findings of each theme, whilst the detailed individual theme chapters are available as electronic publications.

2005 Themes	2013 Themes
Air Quality and climate change	Air Quality
	Climate Change
Biodiversity	Biodiversity and Ecosystem Health
Inland Water and Water Supply	Inland Water
Coastal Zone	Oceans and Coasts
Land	Land
Waste and Sanitation	Waste Management
Energy	Energy
Health	Human Settlements
Education	
Economics and Poverty	
Tourism	
Urban Development	
Transport	
Safety and Security	

Table 1: Themes and indicators for the 2013 Western Cape State of Environment Outlook Report

Within each theme, issues are identified that are representative of the overall state or health of that theme. Each issue is then measured according to quantifiable indicators that will show change to that facet of the environment. Indicators are the key to any environmental reporting as they allow for a baseline to be set against which change can be tracked over time. The selection of indicators for the 2013 State of Environment Outlook Report was informed by the indicators in the 2005 report and similar documents, and by consultation with key stakeholders, so as to meet both current and expected future uses of this tool.

3 DRIVERS OF CHANGE IN THE WESTERN CAPE

Change in environmental parameters is driven at a primary level by population growth and dynamics, consumer behaviour, and in some cases changing natural conditions. However, it is predominantly human actions, including economic activities, transportation, energy production and use, water use, etc., that put pressure on environmental aspects.

The link between pressures on the environment and changes in the environment is not a direct correlation. Instead, the efficiency of resource use and amount of residual waste disposed of in the environment should be considered as the determinants of change.

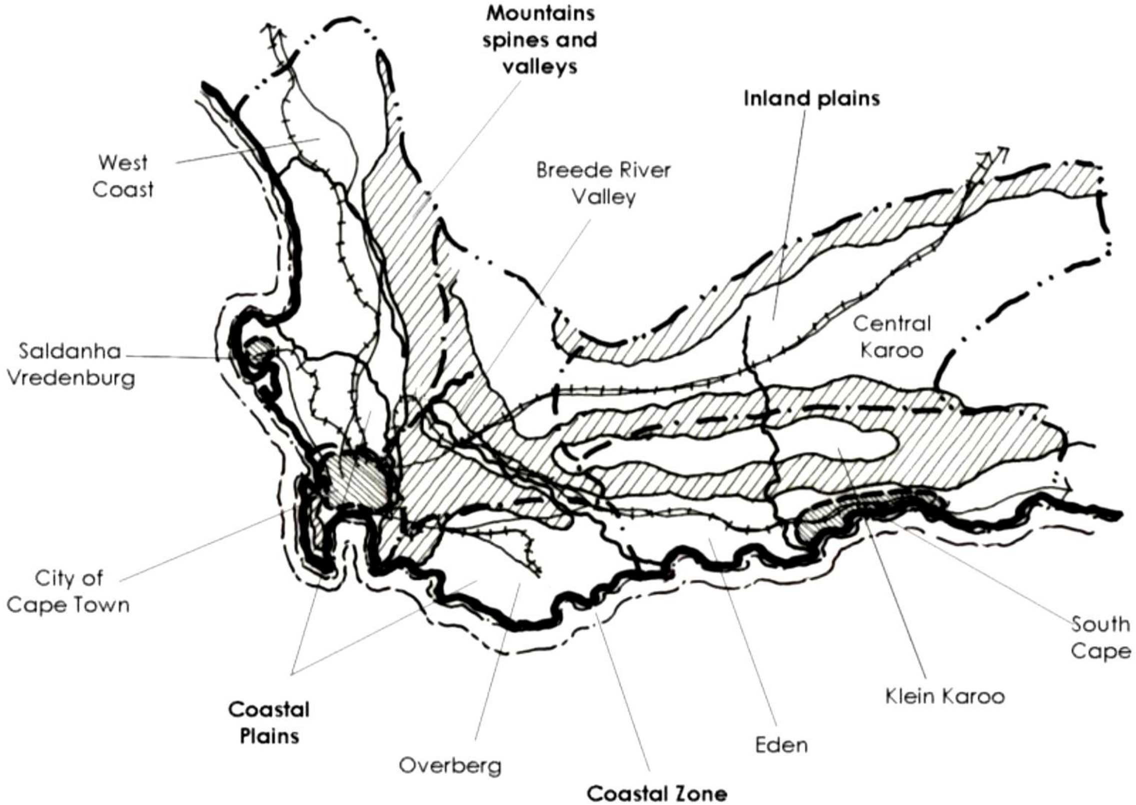


Figure 2: Main regions of the Western Cape (WCG 2009)

3.1 Population dynamics

The Western Cape, and in particular the City of Cape Town region, attracts people from other provinces and countries due to a widespread perception of higher standards of living, better employment opportunities and a quality living environment. The result is significant population growth, nett in-migration and an increase in the number of households. At the same time, there is a noticeable shift towards urbanization from rural areas. According to the Provincial Spatial Development Framework (WCG 2009), 90% of the province is already urbanized, which has implications for planning, service provision and resource consumption.

The increasing population places strain on the resources, specifically in terms of the provision of municipal services, the creation of employment opportunities and increased housing demand. As a result there is an increasing need for increased disaster management planning, food security and household level socio-economic resilience.

3.2 Economic activities & infrastructure

The Western Cape is an integral part of the South African economy. It is a major agricultural export area, centre of the country's fisheries industry and the most valuable international tourism destination in Southern Africa. In addition it is a key logistics node with two major ports as well as being a major source of professional, business and educational services for the national economy.

In 2012, the Western Cape is estimated to have achieved economic growth of 3%, which is marginally higher than the 2.4% achieved nationally. This growth is driven by the secondary and tertiary sectors, namely finance, real estate and business services sector and the wholesale and retail trade, catering and accommodation sector. Primary sectors are not doing very well, with shrinking Gross Domestic Product (GDP) contributions and employment figures. Most job creation takes place in the City of Cape Town and Eden District, however, unemployment is a concern as there are 573 000 unemployed people in the province, most of whom are between the ages of 15 and 34.

Growth potential among the towns of the Western Cape differs markedly. Based on the Growth Potential of Towns Study (WCG 2010), only 6 towns outside of the City of Cape Town are considered to have very high development potential. These are George, Oudtshoorn, Paarl, Stellenbosch, Vredenburg and Worcester. On the other end of the scale, 12 towns are identified as struggling, and as having little in the way of development prospects.

Agriculture contributes only about 4% to the economy of the Western Cape (WCG 2012), but is a crucial employment generator that focuses on rural areas and low or semi-skilled workers. Continued vibrancy in agriculture is therefore a critical requirement for rural economic development, but this could impact on the ecological sustainability of the natural resource base if agricultural areas expand and agricultural practices intensify. The integrity of natural resources is of critical importance to tourism, as most of the tourism in the Western Cape is nature-based and built on a foundation of a high-quality and unique natural environment.

Transportation is considered to be a fundamental requirement for economic activities and growth. The Western Cape has an extensive transportation system that consists of an extended road network, long distance and metropolitan rail systems, international and regional airports, and two major ports. Although this offers a range of different transportation options, a number of structural deficiencies exist (DTPW 2010):

- The transportation network allows for diverse modes of public transport, yet in rural Districts up to 77% of people walk, cycle, hitchhike or use donkey-carts to get to their destinations.
- Public transport faces obstacles such as poor coverage in rural areas, over-reliance on government subsidies, long lead times for service roll-out and poorly maintained infrastructure.
- Rail commuters increase by 20% per year, but current infrastructure

maintenance and expansion as well as rolling provision are not keeping pace.
- The Western Cape is reliant on long distance connections for land, air or sea based movement of people and goods, whether national and international, which adds to the costs of transportation and the province's carbon footprint.

In 2009, transportation was responsible for 52% of the energy consumption in the province. This has rapidly escalated from 35% in 2004. Industry consumes a further 34% of the energy (down from 49% in 2004), whereas the built environment consumes 13%. When considered in terms of the energy carriers preferred by each of these sectors, it becomes clear that the province's carbon footprint is strongly driven by the reliance on coal-derived electricity, the burning of coal in industrial applications and the consumption of liquid fuels (WCG 2013).

Economic growth, in conjunction with population growth, has placed demands on existing infrastructure that can only be satisfied through pro-active maintenance and expansion. This applies throughout the different infrastructure networks, including water provision, sanitation systems, transportation, energy supplies and information communication (DTPW 2013). The Western Cape Infrastructure Framework (2013) notes the following anticipated increases in demand:

- Water demand is expected to increase by 0.6% per annum.
- Wastewater generation will increase faster than the rate of water demand.
- Energy demand will grow at 3% per annum, with electricity specifically growing at 2.2%.
- Motorised trips will increase by 2.8% per annum.
- Housing demand is currently at over 400 000 units, and can be expected to grow along with the population size.
- Waste collection volumes are expected to increase from 5.5 million tons per annum to 8 million tons per annum by 2040.
- A Provincial target of universal access to broadband infrastructure by 2020 has been set.

3.3 Efficiency of resource use

In the face of a growing population and growing demand for consumer goods, the efficiency of resource use becomes the key to sustainable development. Major improvements are required in terms of the value that is derived from resource units consumed in the economy, since several indicators show that current trends are either compromising the long term existence of natural resources or depleting the basic building blocks for economic development.

One of the critical inefficiencies in the province is the use and consumption of energy. Per capita energy use is high, and so is energy intensity per million rand GDP generated. Comparing the Western Cape figures to those of the country is hard, as national energy use and emissions information is outdated.

Land, in the form of suitable space for different land uses, is a natural resource that must be shared equitably between the different spheres of society and the economy in a way that does not compromise our natural assets. Currently, rapid urbanisation means that urban infrastructure and structures are supplanting natural open space, which leads to loss of biodiversity and habitats, as well as fragmentation of continuous areas of natural vegetation, ridges, water courses and wetlands. This compromises ecosystem integrity and results in areas of high natural productivity being lost along with their potential for natural ecosystem function or agricultural production. A balanced approach to land transformation and use is required in order to protect overall economic functioning and social resilience. This could, for example, include an active protection of urban agricultural practices that contribute to social sustainability in marginalised communities.

Conservation of critical biodiversity areas in the form of natural open spaces will ensure that biodiversity is preserved as a resource for both urban and rural communities. Biodiversity contributes to the provision of ecological goods and services such as the prevention of erosion, purification of air and water, flood attenuation, and the storage of carbon to counteract global warming. Different flora and fauna species are also used for medicine or consumed as food or fuel. A loss in biodiversity will compromise the integrity of natural systems, and specifically impact on sections of society that are vulnerable to environmental or economic changes (e.g. flooding, fisheries collapse etc.).

The concern over natural resources and biodiversity extends to both marine and freshwater systems. Oceans and coasts sustain several sectors of the Western Cape economy, and currently, large areas along the West Coast and off the Eden coastline are considered to be endangered or critically endangered as a result of pollution, overexploitation or general disturbance. Surface water resources in the province are also oversubscribed. Although available water resources have increased through catchment management actions, the allocation of water for different uses, predominantly agricultural practices, still exceeds supply. Only the Breede River Water Management Area has a positive water balance, but this is less than the total negative water balance of the rest of the province's river systems.

3.4 Disposal of waste

A growing population and increasing concentration of humans in urban contexts inevitably lead to the accumulation of waste products in the environment. Currently, much of the waste generated in the Western Cape ends up in solid waste disposal facilities (landfills) while the remainder is not controlled, and these waste products enter the air, water, land or marine environments.

Waste accumulation leads to a reduction in the quality and natural functioning of air, water and land systems, and therefore also compromises human health and productivity.

Typically, the worst contamination would take place around industrial activities or in settlements with reduced access to basic services, which is often also where the highest incidence of contact between people and waste-related pollution is likely. Proper waste management is therefore an important component of overall environmental management and sustainable development from both biophysical and social perspectives.

4 ENVIRONMENTAL THEMES

The environmental system in the Western Cape might be unique in terms of composition, but nevertheless represents just a small component of the global earth system. It forms part of all the major hydrological, atmospheric and nutrient cycles, and is inextricably related to its neighbouring provinces, the rest of the country, as well as regional oceanic and atmospheric circulations.

Impacts such as climate change, biodiversity loss, consumption of fresh water, change in land uses and air pollution have global implications. Reaching 'tipping points', or triggers, for cascading systematic adjustments within the Earth's natural systems will necessitate drastic changes to our current way of life.

Figure 3 shows a way of thinking about sustainability that takes our planet's finite resources into consideration. The earth's natural systems' processing capacity forms the 'environmental ceiling' within the bounds of which human activities must operate. At the same time, we strive to meet our basic human needs or 'social foundation' to ensure quality of life to all. Sustainability is about finding a way to remain within the

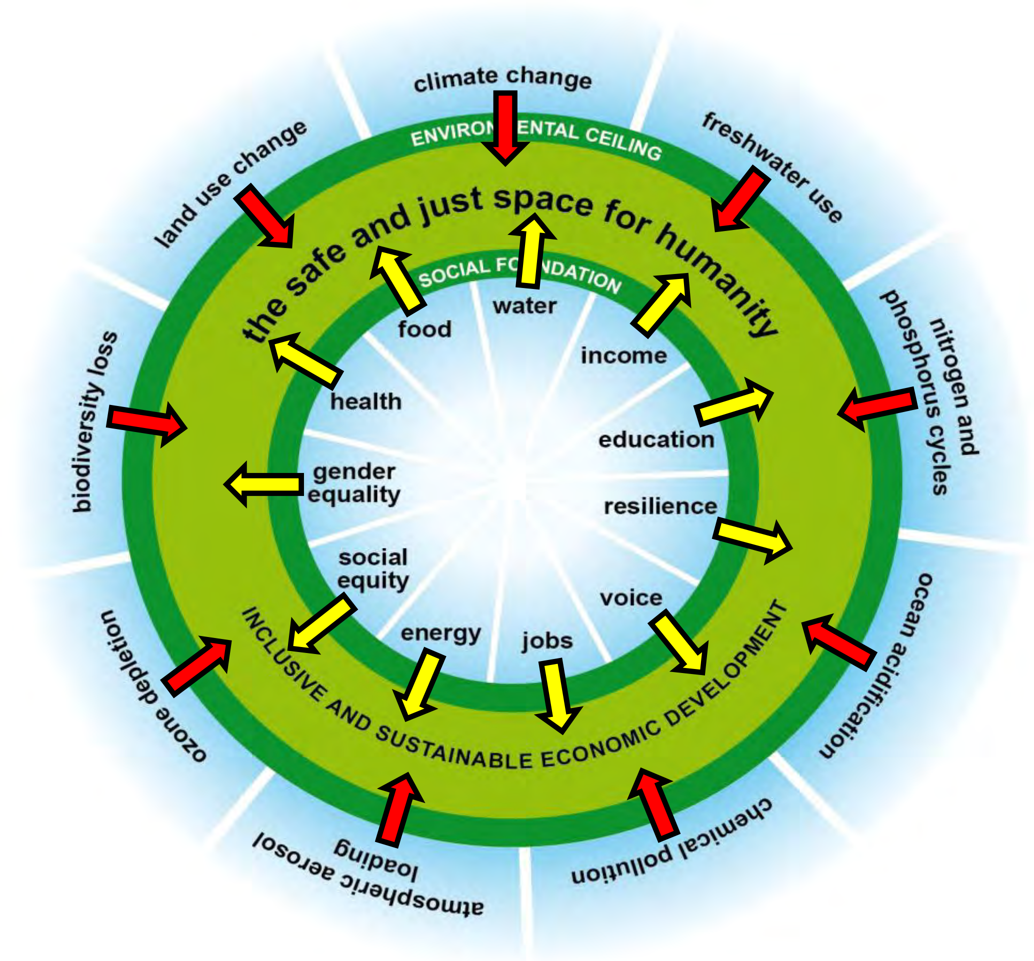


Figure 3: Envisioning a space for humanity (Adapted from Raworth, 2012)

environmental ceiling whilst meeting our social foundation requirements.

The following sections describe the state of each of the environmental themes reported on. The status of the different themes should be regarded as a measure of how well we are doing in terms of keeping our human activities within the bounds of the 'safe and just space' of sustainability.

4.1 Land

OUTLOOK: DECLINING

Land is a critical resource for mining, agriculture, urban development and transportation, and fundamental to the 'sense of place' of the province. The loss of land for agriculture, land degradation, habitat fragmentation and the loss of ecological services all impact on the sustainability of the province, and impact on food security, poverty and livelihoods. Land is therefore the context for much of the State of Environment Outlook.

The Western Cape forms 10.6% of the country's total land area and has a highly urbanised population (>90%). A growing population, increasing number of households, and decreasing household sizes all contribute to the pressure on land resources. Cape Town experiences the most urbanisation pressure, followed by the Eden, Overberg, and Saldanha Bay areas.

As in the rest of the country, historical dispossession and forced removal of people prior to 1994 have resulted in large inequities in access to land and resources as well as insecurity of tenure for a large proportion of the population, particularly in agricultural and rural areas.

Most of the province remains classified as natural, with development taking place along the coastline and in the agricultural lowlands (Figure 4). Urban functions are concentrated in and around the City of Cape Town, Cape Winelands and Mossel Bay. Forestry is found in Eden, the Overberg, and to a lesser extent in the Cape Winelands. Cape Town is a major draw card, not only as a tourist destination but also since it is perceived as having a high quality of living, causing high levels of in-migration, especially from the Eastern and Northern Cape. Valuable land that should be used for agriculture and protection of ecological processes is consequently being fragmented and transformed in order to accommodate the growth.

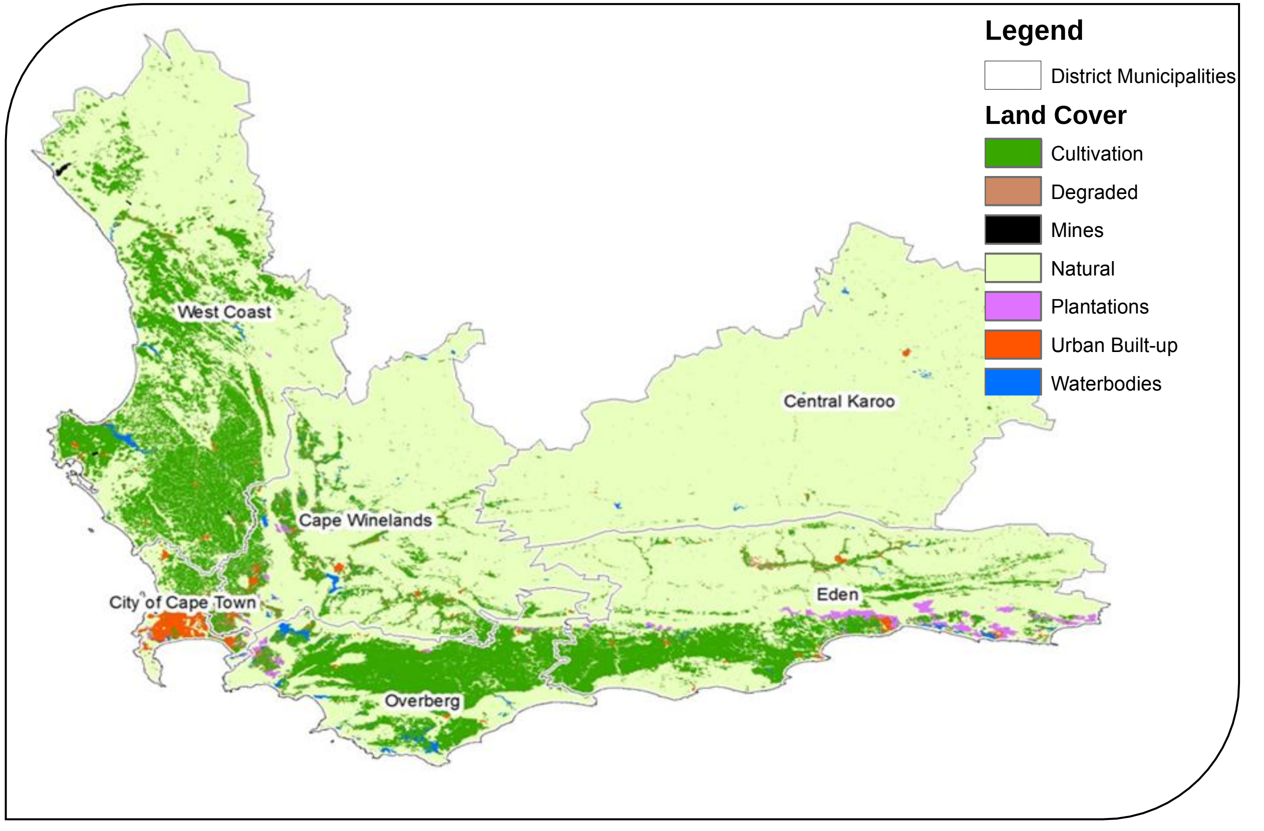


Figure 4: Summarised land cover for the Western Cape

Land transformation is largely driven by urban expansion, agricultural activities and degradation through poor land practices such as over-grazing. However, information on land transformation was found to be inadequate for definitive conclusions about the rate or impacts of transformation. Therefore, it is difficult to say if planning and decision-making around land-use has been positive, and that the resource is being used in the most effective manner. Although the predominant land cover in the province remains 'natural' (78%), agricultural cultivation has expanded since the previous report (now covers 19%), with urban uses constituting around 1%.

Agricultural land uses include cultivated areas, grazing and forestry plantations. The sector contributes to 55-60% of South Africa's agricultural exports, supporting almost 10 000 farms and employing a quarter of a million people. Commercial agriculture forms the greatest component of the agricultural land use with 43% used for animal production and 36% for croplands. Forestry accounts for a small portion of the provincial economic land use. Approximately 88 000 ha of forests, predominately commercial in nature, are spread within the catchments of the Western Cape, especially in the mountainous regions where areas of higher precipitation (>800 mm) occur. Forestry decreases the provincial water yield by 28 million m^3/annum.

Soil degradation is perceived to be increasing in most communal croplands, grazing lands and settlements, while crusting (surface sealing) and soil compaction are increasing in overgrazed, bare patches of land, in irrigated areas and especially in the rain-fed, grain-producing areas. The 2005 State of Environment Report indicated that most of the land under cultivation is not suitable for agriculture, which highlights the need for effective land management plans and the utilisation of land capability maps for the province.

Responses to changes in land use tend to be multi-sectoral due to the wide variety of uses and needs related to land. Environmental governance in terms of land is entrenched in many laws and policies, institutions and stakeholders, yet effective management and control remains elusive due to factors such as policy conflicts, weak implementation or poorly integrated policy hierarchies. It was found that the approach to management and planning tends to be fragmented and reactively driven by land use rather than a clear understanding of soil potential or capability matched to appropriate utilisation.

There is a need for integrated planning that takes cognisance of existing land capability and environmental thresholds, necessarily based on a comprehensive, consistent and current dataset on land cover and land uses. It is only once such comprehensive and recurring mapping is available, that better understanding of this resource can be gained and optimization strategies informed. Collaboration needs to take place between entities that use or manage land resources to ensure accurate, comprehensive mapping takes place on a frequent enough time basis to provide useful information on land use and land transformation.

Table 2 contains a summarised overview of the uncertainty around 'Land' in relation to the various pressures, impacts, challenges, progress and recommendations for future progress in land management. On the balance of evidence, and in consideration of the lack of current data, the outlook for Land is deemed to be 'declining'.

Table 2: Land overview

Land Outlook	*Declining*
Pressures	Agriculture Urban growth Possible warmer, drying climate Access to land Mining on the West Coast
Impacts	Reduced ecosystem services Loss of productive land Declining aquaculture / fisheries (climate change & overuse, poor management)
Challenges	Lack of updated land cover information Looking forward: Changes to land-use planning laws will need to be carefully managed
Progress	Provincial Spatial Development Framework (2013 review underway) 23 Formalised Municipal Spatial Development Frameworks Coastal setback lines in process of being established
Recommendations for action	✓ Secure appropriate updated information sets at regular intervals ✓ Support Conservation Agriculture ✓ Develop and implement Adaptation and Mitigation plans for climate change ✓ Integrated planning approach

4.2 Biodiversity and Ecosystem Health

OUTLOOK: DECLINING

The Western Cape is home to a rich and varied biodiversity consisting of Fynbos, Nama Karoo, Succulent Karoo and Thicket biomes (Figure 5). The Cape Floristic Region (CFR), which includes the Fynbos and Succulent Karoo (nearly 40% endemic), is a globally recognised hotspot of biological diversity or 'biodiversity'. The CFR alone contains more than 13 000 plant species.

In the face of a growing economy, conservation of biodiversity and the preservation of ecosystem functioning has become a focus area in the province. Whilst the tourism industry benefits from this natural abundance, it is not the only economic sector to benefit. Other economic sectors such as agriculture and the green economy all rely on ecological goods and services (or 'ecosystem services') and require a functioning natural environment in order to thrive. In the highly sensitive Western Cape region, maintaining biodiversity, ecological functioning and the related provision of ecosystems services is critical. Degradation or loss of system integrity will alter or destroy the natural resource base, negatively affecting human well-being.

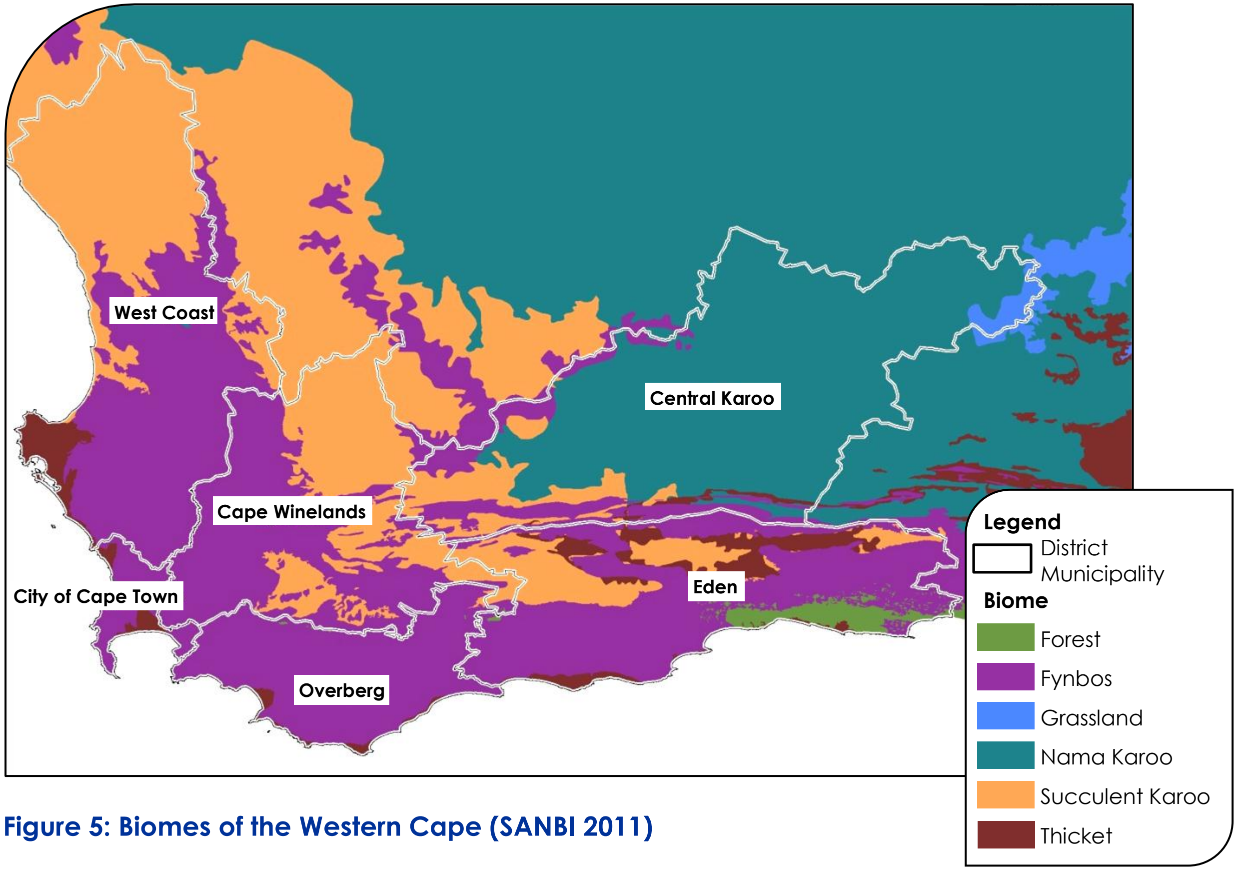


Figure 5: Biomes of the Western Cape (SANBI 2011)

Ecosystem Services include all the value derived from a functional ecosystem. It can include the cleansing of water and the atmosphere, natural carbon sinks, flood attenuation, provision of food (e.g. grazing potential), etc. It is upon these goods and services that food security relies, as do most other human activities or economic sectors.

Actual loss in biodiversity is impossible to measure directly. Measurements of the loss of natural areas that host the most valuable species assemblages are therefore used as proxies. At the same time it is possible to reflect on the current level of threat that species face in the wild.

There are currently 58 threatened terrestrial ecosystems in the Western Cape, of which 21 are critically endangered, 14 are endangered, and the remaining 23 are classified as vulnerable. More than a third (34.6%) of the City of Cape Town area comprises threatened ecosystems; similar to this is the Overberg district at 33.1%. The West Coast comes in at 19.9% and Eden at 13.9%. There are no threatened ecosystems indicated in the Central Karoo region. The most concerning fact is that 10 critically endangered, 6 endangered and 9 vulnerable ecosystems have no official conservation protection. All vegetation types are also considered to be highly fragmented.

In terms of individual species, 70% of all freshwater fish, 13% of plants, 10% of mammals, 5% of reptiles and 5% of birds are considered threatened.

Indigenous freshwater fish species are under severe threat from habitat degradation and the impact of invasive alien fish. This is an aspect that needs urgent attention in conjunction with concerns over water resources in general.

Information on marine fish and invertebrates is severely limited, both in terms of information on marine species assemblages or dynamics, and in terms of species numbers. It is assumed that cartilaginous fishes (sharks, rays, skates and chimaeras) are the most threatened group of marine organisms.

Given the threatened status of a range of species present in the Western Cape, it is imperative that more effort be placed in conservation efforts to ensure proper protection of what is essentially a local, national and global asset. To arrest the loss of biodiversity, sufficient habitat for threatened species need to be protected or conserved. For example, most of the biodiversity conservation targets for fynbos vegetation types are yet to be realised. Time is running out fast though, since for many ecosystems the percentage of remaining natural habitat is already less than the viable biodiversity target.

The findings of the Biodiversity and Ecosystem Health chapter can be summarised as an overall declining outlook. Table 3 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action.

Table 3: Biodiversity and Ecosystem Health overview

Biodiversity Outlook	*Declining*
Pressures	• Agriculture • Urban growth • Invasive alien species • Possible warmer, drying climate
Impacts	• Reduced ecosystem services • Threatened natural wealth
Challenges	• Many critically endangered vegetation types have less remaining spatial extents than what is required for conservation • 'Mandate paralysis'
Progress	• Protected areas being expanded • Extensive conservation planning
Recommendations for action	✓ Protection for Critical Biodiversity Areas and adoption of biodiversity planning into local SDFs ✓ Support and expand Green Infrastructure ✓ Understand the value & contribution of ecosystem services ✓ Ecological Goods and Services - enhance & support functionality of ecosystem through programmes that reduce the vulnerability of the poor ✓ Use overlapping mandates to enhance action, not confuse it

4.3 Inland Water

OUTLOOK: DECLINING

South Africa is a water scarce country and the resource is unevenly distributed across the country's landscape. Importantly for the Western Cape, a strong seasonality and micro-regional differentiation determines the balance between availability of water and the demands from water users.

The *status quo* for surface water availability is currently in a deficit for much of the Western Cape's Water Management Areas, correlating with the degraded ecological condition of the systems. In 2005, a deficit of 115 million m³ existed, an increase from 90 in 2000. Climate change projections identify a progressive drying of the province towards the south-west. This will further reduce surface runoff and slow down the recharge rate of groundwater aquifers. The water shortage is also likely to be exacerbated by the expected increase in temperature and resultant increased evaporation rates.

This situation requires emphasis on the effective management of land use activities, such as human settlement and development expansion, and agriculture. This is particularly important in order to provide food security for the future.

Almost all human activities that require water result in the degradation of the resource and its associated ecosystems. This is a consequence of the modification of natural surface water resources by channel and flow alterations, nutrient loading and pollution. The most noticeable urban impact relates to the increase of impervious surfaces which alters the hydrology and geomorphology of streams and results in increases of runoff and pollution that reaches wetlands, rivers and ultimately the ocean, and limits recharge of groundwater sources.

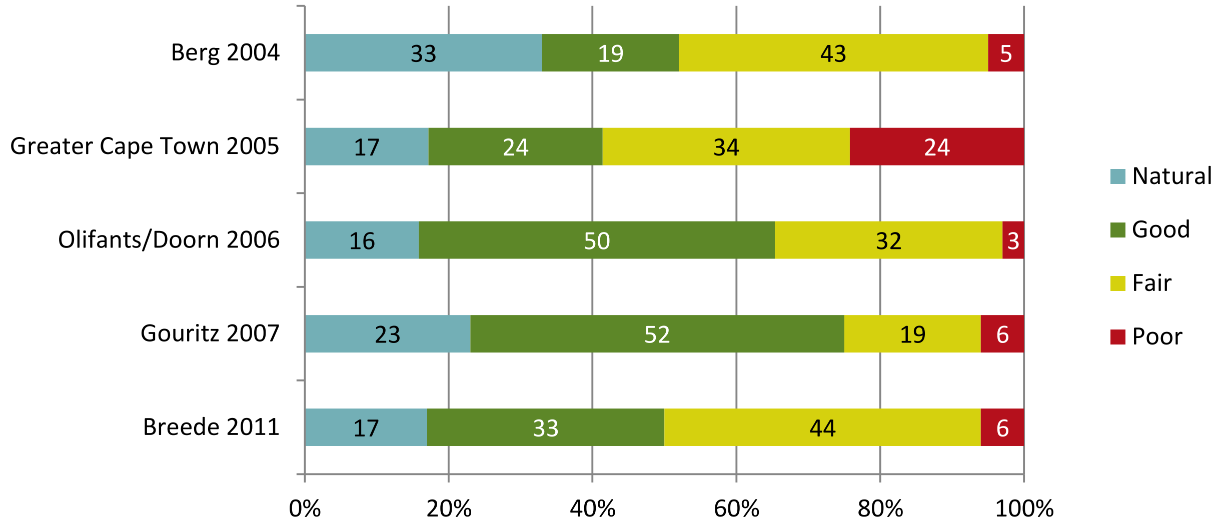


Figure 6: Consolidated River Health Water Quality sampling

The River Health Water Quality assessment (Figure 6) shows that the rivers of the Western Cape largely no longer function in a natural condition, yet are ecologically functional and in fair to good condition. Tributaries are often in a better condition than the main rivers. Furthermore, the findings of the River Health Ecostatus assessment (Figure 7), which provides a reflection of the state of surface water resources based on the monitoring of in-stream and riparian biota and ecological indicators, indicate that although highly modified from natural status, over three-quarters of the rivers are in good or fair condition.

The main water quality concerns relate to river health variability and the trophic status of dams in the province. River health and ecological state vary dramatically within catchments, and despite an overall positive outlook, the fact that many stretches of rivers or streams are classified as 'poor' is unacceptable. The National Eutrophication Monitoring Programme by the Department of Water Affairs further shows that all the large dams in the country, including the Theewaterskloof Dam, is at risk due to high nutrient loads from contaminated surface runoff or water discharges.

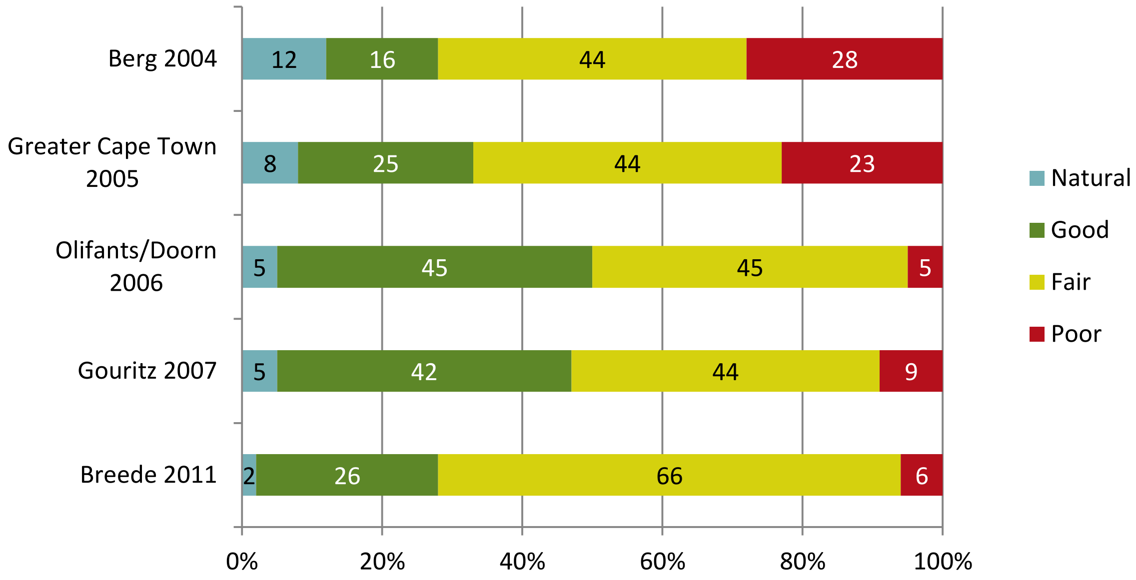


Figure 7: Consolidated River Health EcoStatus Assessment

The implementation of strategic policy and plans from all levels of government will give effect to much needed pressure relief from a water use perspective. The establishment of functioning Catchment Management Agencies and the implementation of direct measures and controls for managing significant water resources of our water management areas is a fundamental step in the right direction. Yet the implementation of the principles of integrated water resource management, shared public responsibility and ownership, greater participation and involvement of all stakeholders and corporative governance remains elusive.

The Sustainable Water Management Plan for the Western Cape Province (2012) aims to give effect to the identified responses to implementation shortcomings, in particular institutional capacity and functioning. The water use verification processes currently underway will be vital in providing the basis for the sound implementation of water reconciliation strategies, climate mitigation measures and support of the establishment of the green economy.

The further prioritisation of ecologically important catchments, the quantification of significant groundwater reserves and the protection of mountain catchment areas are essential for making progress in ensuring resource availability for our future generations. Other initiatives should include increasing alien clearing efforts, more rain water harvesting, water-related restrictions on development, and more watercourse or catchment rehabilitation.

The findings of the Inland Water chapter can be summarised as an overall declining outlook. Table 4 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action.

Table 4: Inland Water overview

Inland Water Outlook	***Declining***
Pressures	• Human settlements • Agriculture • Invasive alien species (fauna & flora) • Climate change
Impacts	• Loss of ecosystem services • Living conditions • Eutrophication • Marine pollution
Challenges	• Water resource deficit • Must allow for ecological reserve • Incomplete reconciliation information
Progress	• Western Cape Water Supply System effectively managed • Berg River Improvement Plan • Water recycling initiatives
Recommendations for action	✓ Increase options for water reuse and curbing of reticulation water losses ✓ Built environment & Urban infrastructure innovations, e.g. rethink sanitation services ✓ Restore riverine habitat and corridors ✓ Manage alien invasive species ✓ Drive adoption of Conservation Agriculture – more "crop per drop"

4.4 Oceans and Coasts

OUTLOOK: DECLINING

The Western Cape has a coastline in excess of 1000 km, the longest coastline of South Africa's four coastal provinces. Primary development nodes along the Western Cape coast include Cape Town, Saldanha Bay, George, Knysna and Plettenberg Bay, while important ports are located at Cape Town, Saldanha Bay (one of only two deepwater ports in South Africa) and to a lesser extent, Mossel Bay.

Biophysically, the coastline of the Western Cape consists of sandy beaches interspersed with occasional rocky outcrops, headlands and wave-cut platforms, and it has a number of important estuaries and coastal lakes, particularly in the Wilderness area. The coast is naturally rich in biodiversity, due in no small part to the conjunction of the warm Agulhas and cold Benguela ocean currents which causes upwelling of nutrients. Notable natural coastal assets include extensive fisheries resources forming the core of South Africa's commercial fishing industry; kelp, penguin and seal colonies; fynbos; and indigenous coastal forests at various points along the coastline.

The oceans and coastal areas are most significantly impacted on by human activities which disturb the equilibrium of the dynamic and sensitive coastal and marine environments. These impacts are exacerbated by global environmental problems such as climate change, resulting in a deteriorating state of the marine and coastal environment.

As shown in Figure 8, critically endangered habitats are found along the West Coast near-shore, Eden and Overberg offshore areas, as well as on the continental shelf edge, due to high levels of multiple pressures in these areas (Sink et al. 2012). Endangered

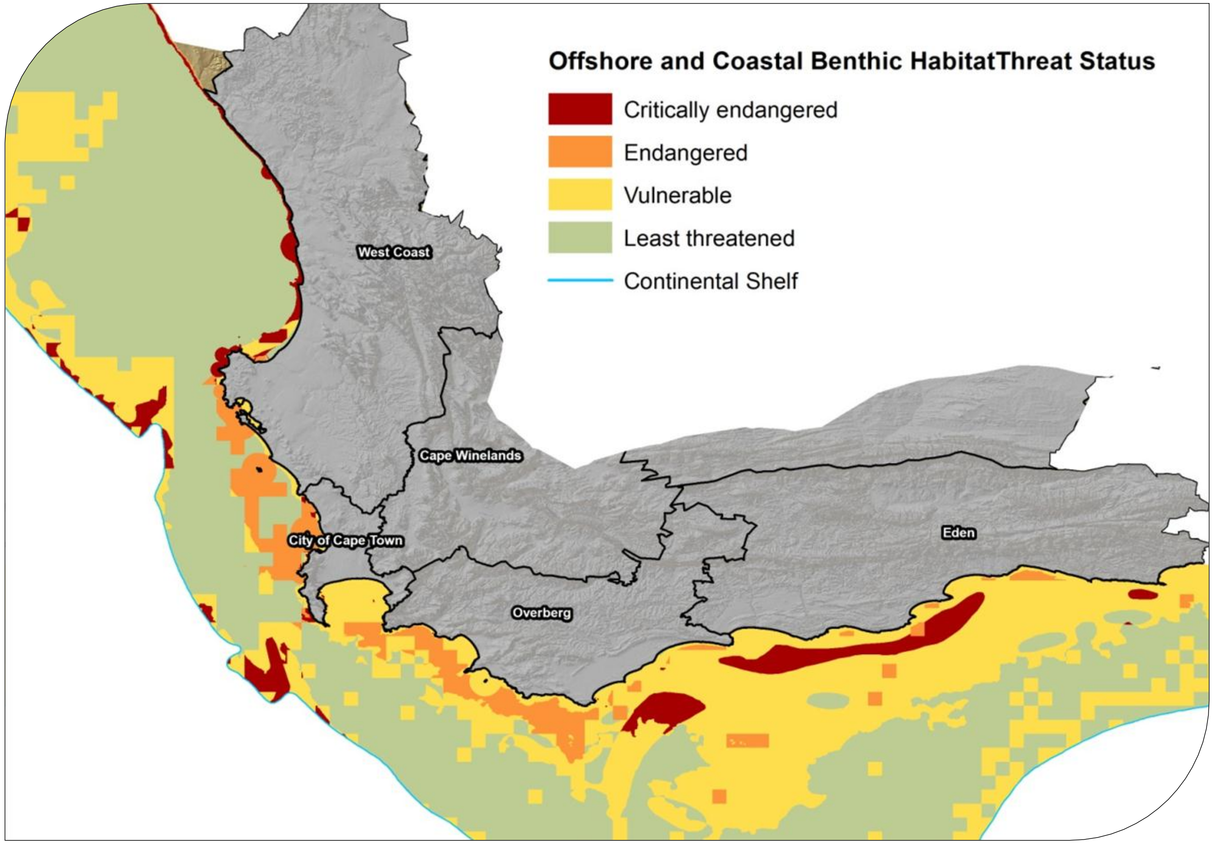


Figure 8: Ecosystem condition for the coastal and offshore benthic environment in the Western Cape region (Adapted from Sink et al. 2012)

areas are concentrated between Langebaan in the northwest and Cape Agulhas in the southeast. All along the coastline, threatened ecosystems are being lost through transformation.

Monitoring done as part of the Blue Flag Beach certification scheme shows that coastal water quality seems to be good and improving over time. While three beaches were above the acceptable limit, the frequency of poor water quality was below 20% of recordings for two of these beaches. From these trends it might appear that the number of beaches with poor water quality has increased with time, however, the frequency of high coliform bacteria counts is lower for the most part. It is thought that poor quality runoff from the rivers and stormwater outlets due to contamination from sewer blockages / overflows and runoff from informal settlements are the main contributing factors to poor water quality at certain bathing beaches, as is decomposing kelp wrack accumulating on beaches.

Estuarine environments are of particular concern. Typically, Western Cape estuaries are highly modified, and characterised by poor health and low levels of protection, except in the Eden District. All Western Cape estuaries are considered to be critically endangered ecosystems.

The concerns identified in the 2005 SOER relating to deteriorating marine and coastal health due to pressures from tourism activities, coastal urban development and over-exploitation of fish stocks remain concerns in 2013. Nevertheless, significant progress has been made since 2005 in terms of conservation and protected areas, monitoring and reporting, as well as legal and institutional responses to coastal issues in the Western Cape. The development of estuary management plans, set-back lines, monitoring programmes and the expansion of Marine Protected Areas (MPA) are just a few examples of the ways in which government is protecting the aforementioned areas of concern. Seven of South Africa's 23 gazetted MPAs are found in the Western Cape, in three different inshore bioregions. While not reflected in the National Biodiversity Assessment 2011, it is noted that the Helderberg MPA has also been demarcated within the City of Cape Town.

Effective responses to the impacts and pressures on the receiving environment are heavily dependent on the available data and information - which is lacking in a number of critical aspects. As indicated in Table 5, advances in gathering of information have been made, however this still requires attention in order to best protect coastal areas.

Climate variability and change is one of the biggest threats to South Africa's coastal regions. Much of the Western Cape coastline consists of sandy shores and is therefore highly susceptible to erosion. Therefore, sea level rise and its interaction with increasing storm frequencies, intensities, wind velocities and local conditions presents a significant threat to the coastline.

The Oceans and Coasts chapter of the 2013 State of Environment Outlook Report describes an overall declining outlook for the theme. A summary of key pressures, impacts, challenges, progress and areas for action is provided in Table 5.

Table 5: Oceans and Coasts overview

Oceans & Coasts Outlook	*Declining*
Pressures	• Human settlements • Tourism • Resource extraction (legal and illegal)
Impacts	• Reduced productivity • Disrupted coastal dynamics • Economic value compromised
Challenges	• 'Mandate paralysis' • Understanding of sustainable resource extraction levels • Climate change
Progress	• Coastal set-back lines • CAPE estuaries programme • Coastal Management Plans
Recommendations for action	✓ Implement coastal management plans ✓ Protect sensitive marine and estuarine ecosystems ✓ Sustainable Coastal livelihoods programmes ✓ Increase certifications under the Blue Flag programme

4.5 Human Settlements

OUTLOOK: IMPROVING

The social dimensions of sustainability cut across fields associated with access to water, energy, food, jobs, education, health, social-ecological resilience, gender equality and social equity. All of these factors have relevance on a local scale, and need to be materially satisfied before environmental sustainability can be achieved.

Results from the 2011 census indicate that there are 5 822 734 people residing in the Western Cape, representing 11.3% of the national count. The population has been growing, with a 2.5% annual growth rate between 2001 and 2011 as compared to a 2.6% annual growth rate between 1996 and 2001. This rapid population growth leads to growth of human settlements and rapid urbanisation, resulting in:

- A housing backlog of approximately 410 000 units, 300 000 of which are in the City of Cape Town;
- The persistence of informal dwellings, estimated at 18.2% of households or 297 017 in total;
- Inefficient urban structure, with apartheid era spatial patterns and a low average density of approximately 12 dwelling units (du) per hectare (ha); and
- A high reliance on inadequate public transport systems, brought on by necessity rather than choice.

The ever expanding cities and towns have a major impact on habitat fragmentation and destruction resulting in biodiversity loss, the insufficient provision of environmental corridors (required to protect and link threatened ecosystems) and an increase in pollution and waste.

Overall, the province is performing well in the arena of service delivery, which proves to be keeping pace with the ongoing in-migration and population growth. The Western Cape outperforms the other provinces in providing sanitation, electricity and refuse removal services. Only in terms of the provision of water to the dwelling or yard does the Western Cape fall behind Gauteng and the Free State (StatsSA 2012). The percentage of households that has access to tap water has increased between 1996 and 2011, and currently 99% of households have access to piped water. The trend for the Western Cape furthermore shows continually improving water quality from 2010 to 2012, ranking second best in terms of Blue Drop (potable water quality) and best in terms of Green Drop (wastewater treatment systems) certification. Access to electricity in the province has shown steady increase during the various Censuses, up from 85.7% in 1996 to 88.1% in 2001 and to 93.4% in 2011. More than 90% of households have flush toilets, but a few instances of bucket systems still persist. More than 91% of households are reached by municipal waste removal services.

Transport is important for social development as it enables the movement of people and fosters economic growth by accessing and creating growth opportunities. The Western Cape planning of the transport system for the future 20 to 30 years is documented in the Provincial Land Transport Framework (DTPW 2011). This framework includes commitment to non-motorised transport services and infrastructure; integrated, efficient and reliable public transport; transport services for people with special needs; public transport in rural areas; and ongoing maintenance of infrastructure.

The housing backlog is a concern throughout the province. One strategy employed to ensure housing provision that alleviates suffering and improves livelihoods for as many people as possible within the shortest possible timeframes, is that of incremental delivery which prioritises provision of services, with the quantitative long term roll-out of housing as final outcome. The importance of alleviating the housing backlog has been highlighted in numerous reports, as the solution to a range of human health, livelihood and environmental health issues. It can also be seen as an opportunity to create jobs, and to invest in sustainable communities for the future.

The Western Cape has responded to the challenges with a Provincial Spatial Development Framework (WCG 2009) which contains the policies and action plans divided into three main areas of intervention: socio-economic development, urban restructuring and environmental sustainability. These areas of intervention aim to minimize the pressures of environmental change caused by human settlements.

The findings of the Human Settlements chapter can be summarised as an overall improving outlook. Table 6 contains a summary of the key pressures, impacts, challenges, progress and recommended critical areas for action.

Table 6: Human Settlements overview

Human Settlements Outlook	*Improving*

Pressures	• Western Cape population changes:
	  ◦ 14.3% (1996-2001)
	  ◦ 28.7% (between 2001-2012)
	  ◦ In-migration
	• Urbanisation

Impacts	• Encroachment on natural habitats • Compromised ecosystem services • Pollution and waste • Demand for resources
Challenges	• Need for integrated planning • Restrictive regulatory and administrative systems • Increasing the rate of delivery
Progress	• Service delivery keeping pace with population growth and migration • 'Blue Drop' and 'Green Drop' improvement • Plans for incremental housing delivery • Green Buildings increasing • Improved Disaster risk management responses
Recommendations for action	✓ Remove obstacles to innovative (green) urban development ✓ Revolutionize transportation systems ✓ Improve climate change adaptation

4.6 Air Quality

OUTLOOK: STABLE

Human activities contributing to the concentration of atmospheric pollutants are focused around the City of Cape Town, at industrial and mining operations in the West Coast, within the intensive agricultural areas of the Cape Winelands and Overberg, as well as at the industrial and petrochemical activities in the Eden District. As indicator, carbon emissions for the City of Cape Town is given in Figure 9, showing that emissions are by-products of transportation (liquid fuels, electricity), domestic energy use (electricity, coal and paraffin) and industrial processes (electricity, coal and diesel). Other pollutants include fugitive emissions from agricultural activities and industry.

Monitoring of air pollution across the province shows that indicative pollutant levels are generally within universally acceptable limits. Air quality is therefore deemed as 'stable' with the most prevalent pollution source noted as traffic within the urban areas, and the most concerning impact being indoor air pollution in low income areas. In these areas, the burning of coal, paraffin and biomass for heating or

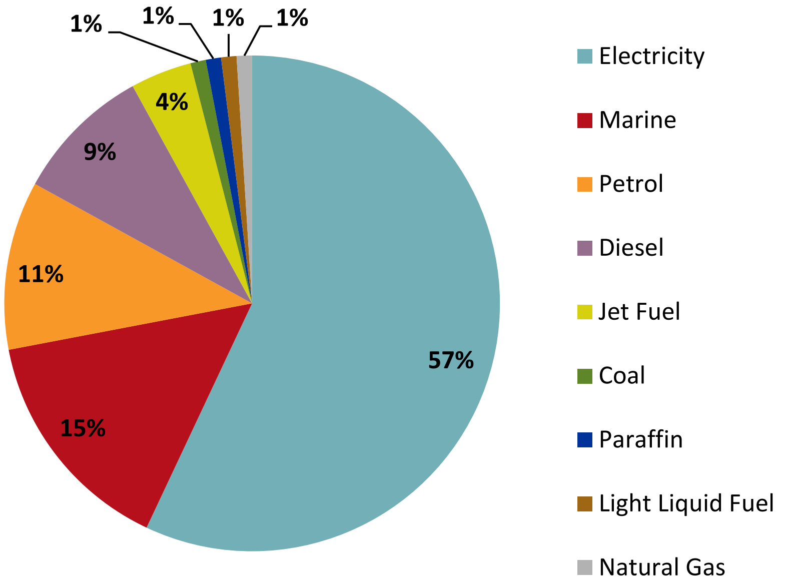


Figure 9: Sources of carbon emissions in the City of Cape Town

cooking lead to exceptionally high levels of indoor air pollution, even though a high percentage of households have access to electricity.

Specific progress has been made in terms of the addition of monitoring stations to the monitoring network; however, the absence of consistent long term air quality monitoring records is a limiting factor for air quality management, with the coverage of the monitoring network and related air quality management plans needing further improvement. Currently eight Local Municipalities have fully developed Air Quality Management Plans. Nine more are in development, and seven municipalities have not commenced with the development of this plan.

Effective air quality management needs effective engagement and co-operation between spheres of government, as well as integration across different planning processes. Cross-process planning will very effectively limit the need for 'after the fact reaction'. For example, good spatial planning leads to an efficient city form, improving transportation efficiency and in turn improving overall air quality.

In order to ensure this is possible, funding at municipal level will need to be made available. This will require planning for air quality management at the IDP level. To aid this process a provincial needs assessment has already been undertaken, which includes a map of communities that have been affected by air pollution.

Table 7 summarises the key pressures, impacts, challenges, progress and recommended critical areas for action related to Air Quality.

Table 7: Air Quality overview

Air Quality Outlook	***Stable***
Pressures	Transportation (esp. diesel) Domestic fuel burning Urbanisation
Impacts	'Brown haze' Indoor air pollution Carbon footprint
Challenges	Future shale gas exploration Transportation Obstacles to implementation of renewable and micro-generation solutions (innovative 'green' projects)
Progress	Ongoing roll-out of monitoring stations Generally good quality
Recommendations for action	✓ Improve coverage of monitoring network ✓ Remove obstacles to innovative 'green' urban development ✓ Revolutionize transportation systems

4.7 Climate Change

OUTLOOK: DECLINING

Scientific consensus holds that if we are to avoid potentially devastating global climate change, we have to ensure that the atmosphere's average temperature does not increase by more than 2˚C by limiting the amount of greenhouse gases (GHG) emitted into the atmosphere. All have a role to play in reducing our global contribution to the greenhouse effect, and clearly the Western Cape has a share in the South African responsibility towards the reduction of national GHG emissions. This will require uncomfortable but necessary paradigm shifts based on a sound policy framework.

Comparison with previous years shows a continued growth in total Carbon Dioxide equivalent (CO_2e) emissions in the Western Cape (Figure 10) with a similarly rising contribution per inhabitant of the province. At 8 tonnes per capita, the Western Cape ranks along with developed European countries rather than developing peers. The intensity is much higher than the average in both Brazil and India, and even that of China.

Carbon emissions attributed to electricity consumption is the dominant contributor to

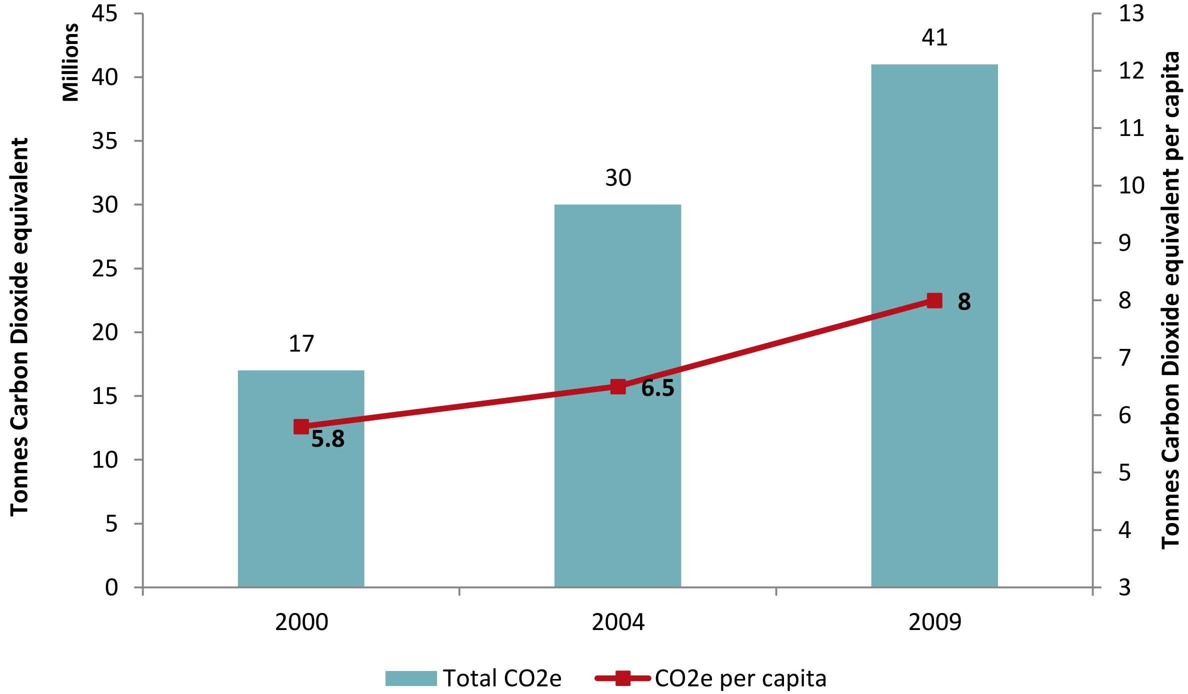


Figure 10: Western Cape emissions as total and per capita Carbon Dioxide Equivalent

the overall carbon footprint of the Districts, with the West Coast (energy intensive industries) and Central Karoo (transportation) being exceptions. As expected, most emissions originate from activities in the City of Cape Town and West Coast District linked to transportation, industrial facilities and urban development. To address the high carbon intensity, efficiencies or alternative sources of energy must be found in the transportation and industrial sectors. The biggest impact would be made by a major switch to renewable energy and more efficient modes in the transport sector. Further efforts should also be directed at improved emissions tracking and carbon accounting in the province.

Although climate change is already taking place, it is still hard to perceive directly due to the scale of the changes and the fact that to a degree it is still being masked by the inherent variability of weather and climate patterns.Broadly speaking however, it is expected that over time Western Cape minimum temperatures in late summer and late winter will be warmer, very hot days will become more frequent, and rainfall could decline. Sea levels will also rise slightly, which, can lead to severe coastal flooding and increased damage when combined with extreme weather. The 'symptoms' of climate change are placing pressures on our daily activities through impacts such as increased intensity of storms, higher average temperatures, water shortages, rising costs of food due to lower crop yields, increasing pressure on public health systems and a compromised fruit and viticulture sector.

Both the Western Cape's contribution to climate change and its vulnerability to the changes need to be recognised and the impacts understood. Adaptation to unavoidable climatic changes and the impacts that will result from those changes is required in order to create a more resilient society that can 'weather the storms'. This includes creating social systems that can cope with increased climate stress, infrastructure with sufficient capacity to compensate for variations in temperature and precipitation, and economic activity that has a built-in resilience to external shocks.

Overall, the Western Cape appears to be responding well to climate change. This can be attributed to the swift development of policy and strategies around this topic. Strategic Provincial strategies have been adopted for climate change responses, and targets for emission reductions have been specified in the Climate Change Strategy and Action Plan. The Provincial Strategic Objectives Work Groups have taken up the energy and emissions reductions targets. Municipal Support Programmes are in place to give direction to municipalities in the development of Climate Adaptation Plans and Sustainable Energy Plans and the City of Cape Town is well advanced in terms of climate change responses and the transition to a green economy and sustainable society. A foundation for the transformation of the energy economy has also been laid in the form of a provincial *Energy Consumption and CO_2 Emissions Database*.

The findings of the Climate Change theme must nevertheless be summarised as an overall declining outlook due to the continued rise in carbon emissions and limited evidence of climate policies being implemented. Table 8 contains a summary of the key pressures, impacts, challenges, progress and recommended critical areas for action.

Darling wind farm. (Photo credit: Bruce Sutherland, City of Cape Town)

Table 8: Climate Change overview

Climate Change Outlook	*Declining*
Pressures	Energy use (grid& coal based industries) Land use change Transportation Built environment
Impacts	Natural disasters Distribution of species (biodiversity, fisheries) Water stress Limitations on agriculture (fruit, viticulture, crop yield) Tourism (climate, coastal, carbon tax) Living conditions
Challenges	Long term, cross-sector interventions(e.g. public transport, renewable energy) Role & impact of private sector Climate projection uncertainty (timing and magnitude)
Progress	Frameworks and planning in place
Recommendations for action	✓ Stimulate large-scale changes to energy and transport systems ✓ Develop adaptive capacity at the local level to specific climate risks ✓ Ecological Goods and Services - enhance & support functionality of ecosystem through programmes that reduce the vulnerability of the poor

4.8 Energy

OUTLOOK: STABLE/DECLINING

Energy supplies to the Western Cape are dominated by coal-based national grid-supplied electricity, coal, liquid fuels and nuclear energy. Local energy generation takes place at the Koeberg Nuclear Power Station (1 800MW), Open Cycle Gas Turbine peaking power stations in Atlantis and Mossel Bay (2 084MW), the Darling and Klipheuwel Wind Farms, oil refineries, as well as natural gas refineries. Four solar (60MW) and four wind farms (317MW) are planned under the Independent Power Producers (IPP) programme, and Eskom is constructing the 100MW Sere wind farm in the Koekenaap/Vredendal area. Other important resources include the Oribi/Oryx oil field that supplies 2% of the country's liquid fuels, and the 580MW Steenbras/Palmiet pumped storage scheme.

According to the *Energy Consumption and CO_2 Emissions Database for the Western Cape* (WCG 2013), energy consumption in the province has grown from 247 742 000 GigaJoule (GJ) in 2004 to 270 887 000 GJ in 2009 (excluding aviation and marine figures). It should however be noted that various data uncertainties remain and there is no consistent collection and analysis of data, but the overall trend can be taken as indicative.

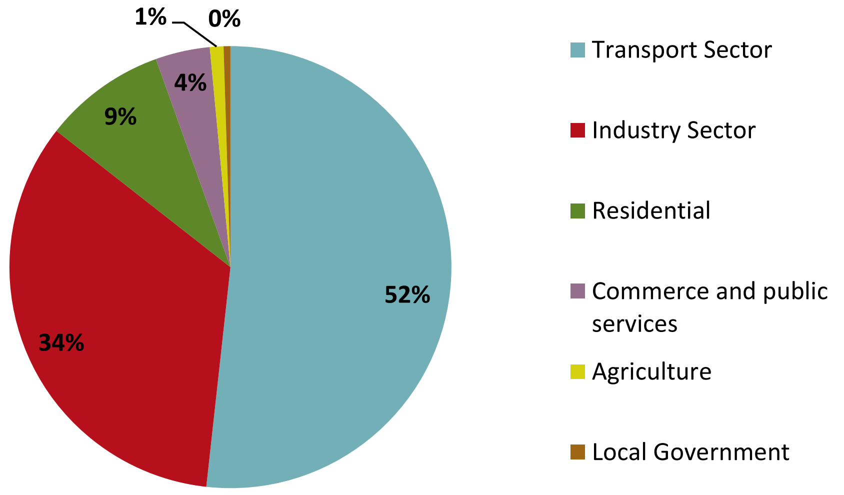


Figure 11: Energy use by sector (WCG 2013)

Transport (at 52%) and Industry (34%) makes up most of the energy use in the province, with the residential or household sector responsible for just under 9%. The energy consumed by the built environment (residential and commercial) represents 13% of the total energy use.

The nature of the energy use in the province results in significant greenhouse gas emissions (coal-based electricity and transportation) and air pollution (transport and domestic fuel burning), as well as effects on water resources (mining and power station operation), biodiversity (infrastructure development and pollution) and land (visual impacts).

The Western Cape is slowly shifting it's focus from the conventional technologies for energy supply to more renewable and environmentally friendly ways. The Western Cape Department of Environmental Affairs and Development Planning published a White Paper on Sustainable Energy for the Western Cape Province (DEADP 2010), and developed a "Strategic Environmental Assessment for the Placement of Wind Turbines". There is also a strong focus on promoting the use of renewable energy and public transport in the transport sector.

The findings of the Energy chapter can be summarised as an overall stable outlook for the future but potentially declining due to the continued dominance of grid and coal based energy usage.

Table 9 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action

Table 9: Energy overview

Energy Outlook	*Stable / Declining*
Pressures	Population growth Growing consumerism Economic growth
Impacts	Carbon footprint Competition for land Air quality Displaced impacts of generation (mining, power station, transmission)
Challenges	Energy dependencies (e.g. Liquid fuels for transport) Grid-based electricity supply Limited information on private sector initiatives Role & impact of natural gas Mandates (role of WCG & Local Municipalities)
Progress	Green Economy initiatives, establishment of WCG's GreenCape Independent Power Producer (IPP) process facilitation
Recommendations for action	✓ Drive renewable energy development within province ✓ Built environment & Urban infrastructure innovations- rethink energy provision ✓ Gather information on private sector initiatives ✓ Address energy intensity and dependencies ✓ Improve understanding of natural gas potential & impacts

4.9 Waste Management

OUTLOOK: IMPROVING

Solid waste in the Western Cape in 2010 amounted to some 3 807 765 tonnes per annum compared to 1 446 500 tonnes in 2001. It is believed that this could rise to 5.2 million tonnes per annum by 2020. The contribution by the City of Cape Town is approximately 70% of all waste produced in the province. This contribution has decreased since 2001, which could be due to a relatively larger proportional increase in waste generation in the Districts, but is more than likely due to an effort on the part of the City of Cape Town related to reduction and reuse of waste.

Refuse removal services in the Western Cape currently reaches 91.7% of households, a significant improvement over the 1996 level of 86.2%. Where waste removal services are still not undertaken, it can be expected that illegal dumping of waste, unlicensed waste disposal sites and burning of waste as a disposal method will take place. In 2006 some 240 waste management facilities were recorded in the Western Cape, the majority being either permitted landfills or illegal waste disposal sites. Of these, 193 are currently operational(92 general waste disposal sites, 54 drop-off facilities, 15 transfer stations and 13 materials recovery facilities), and the others have been closed. Regional waste collection facilities in the less densely settled districts are having a positive impact, with drop-off and transfer stations becoming increasingly prevalent.

Waste disposal facilities are potentially sources of both air and water pollution, respectively through the generation of methane and leachate. Proper design and management practices can restrict the impact of these pollution sources, and it may even be possible to make use of methane and leachate as resources. Many of the waste disposal facilities in the Western Cape were not designed in a way that will prevent pollution, and most are not optimised for waste recovery and re-use.

Municipal solid waste revenues do not cover the full operating costs of service provision for waste management in the province. This results in a deficit of about 15% of all expenditures across municipalities, sometimes higher in smaller municipalities. Strategies have therefore been set up to actively reduce the amount of solid waste reaching landfills. The amount of waste diverted from landfills in the City of Cape Town has been calculated to have been up to 14% for the period 2006 to 2011. The reductions in waste disposal can be attributed to a number of the City's initiatives, including waste sorting facilities like the Kraaifontein Materials Recovery Facility where waste is sorted for recycling, as well as the various composting facilities around the city which utilise organic waste.

The accuracy of general waste generation data in the province is often very low and estimated rather than measured in practice. This is due to lack of recording equipment (weighbridges etc.) and reluctance from operators to disclose sensitive information. It is also acknowledged that legislative compliance for waste disposal facilities is not very good, with many facilities operating without the necessary permits. The Province has committed to a steady improvement of the situation, with a target of a 20% increase in properly licensed facilities by 2014.

Overall, service delivery in Waste Management can be described as improving, but this is off a base of poor information, weak infrastructure and increasing waste quantities. Table 10 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action related to Waste Management.

Table 10: Waste Management overview

Waste Management Outlook	*Improving*
Pressures	• Modernisation/consumerism • Means of disposal
Impacts	• Waste disposal site capacity constraints • Contamination of land, air, water • Health issues
Challenges	• Waste not seen as a resource • Restricted information flows • Restrictive regulatory environment • Landfill space (insufficient planning)
Progress	• Up to 14% waste diversion in CoCT (Materials Recovery Facilities, green waste) • Waste-to-energy initiatives (landfills, biogas) • IPWIS (Integrated Provincial Waste Information System)
Recommendations for action	✓ Remove regulatory constraints limiting appropriate reuse/industrial symbiosis ✓ Transform traditional perceptions of waste and innovate around incentives for reduction of waste ✓ Integrated Waste Management- Proper licensing of facilities and reporting of volumes and types of waste ✓ Waste-to-energy initiatives ✓ Appropriate approach to removing organic material from waste stream

5 SUMMARY OF ENVIRONMENTAL INDICATORS

Land	Key points	Trend	

Land cover	• 4th largest province (10.6% of total) in South Africa
	• 78% natural
	• 22% transformed
	  • 18.7% agriculture
	  • 1% urban
	  • 0.7% forestry
	  • 0.7% degraded
		Declining	↓

Land capability	• No high capability soils – vulnerable agriculture requiring high inputs	*No change*	→
Land transformation	• Intensification of urbanisation sprawl • 1.6% more agriculture	*Declining*	↓
Biodiversity & Ecosystem Health	**Key points**	**Trend**	
Alien invasive species	• 291 invasive plant species • Primary threat to indigenous fish	*Declining*	↓
Biodiversity Priority Areas	• Progress on expansion of conserved areas but only 2.3% of expansion qualifies as formal protection	*High concern*	↓

Protected areas	• Since 2002:
	  • 311 197 ha formally protected (Only 2.4% of which are Critical Biodiversity Areas)
	  • 4 861 ha biodiversity agreements
	• 27 077 ha conserved with no legal protection
		Improving	↑

Habitat fragmentation	• The province contains 15 of the 17 highly fragmented vegetation types in the country	*Insufficient historical data*	✥

Vegetation types	• Existing mapping is from the South African National Biodiversity Institute (SANBI)	*No change*	

Threat status	• Threatened species:
	  • 70% of freshwater fish (16 of 23 indigenous species under threat)
	  • 13% of plants (13 489 species total – 1 709 Threatened + 296 Critically Endangered + 575 Endangered + 801 Vulnerable; 68% of National Threatened species total; 2 984 additional species of concern; 21 species Extinct; 1 695 endemic to Western Cape)
	  • 10% of mammals
	  • 5% of reptiles
	  • 5% of birds
	  • Marine fish and invertebrates – information not available, cartilaginous fishes are assumed most threatened with 4 of 35 species Critically Endangered
	• Threatened terrestrial ecosystems:
	  • 21 critically endangered
	  • 14 endangered
	  • 23 vulnerable
		Insufficient historical data	

Centres of endemism	• 96% of threatened species are endemic	*High concern*	
Inland Water	**Key points**	**Trend**	

Water availability	• Water resource balance (2005):
	  • Supply 2 522 million cumec
	  • Demand 2 637 million cumec
	  • Current deficit of 115 million cumec (was 90 in 2000)
		Declining	

Fitness for use	• River Health Water Quality assessment:
	  • Overall – relatively good shape
	  • 21% natural
	  • 36% good
	  • 34% fair
	  • 9 % poor
		Insufficient historical data	

Freshwater ecosystem health	River Health Ecostatus: • 6% natural • 30% good • 48% fair • 14% poor	*Insufficient historical data*	
Oceans & Coasts	**Key points**	**Trend**	
Coastal water quality	• Blue Flag Beaches monitoring shows acceptable state	*Improving*	
Estuary health	• Poor health, highly modified, poorly protected and highly threatened (Eden District is the exception to this)	*High concern*	
Conservation areas	• 8 marine protected areas • Mixed results in terms of management	*Improving*	

Marine area threats	• Critically endangered marine habitats:
	  • West Coast nearshore
	  • Eden and Overberg offshore areas
	  • Continental shelf edge
	• Endangered habitats:
	  • Langebaan
	  • Cape Agulhas
		High concern	

Transformation	• Loss of threatened ecosystems along 14% of the coastline between 2001 and 2009	*Declining*	
Human Settlements	**Key points**	**Trend**	
Housing	• Informal dwellings constitute 18.2% of households in 2011 (up from 16.7% in 2001) • Housing shortage of 400 000 units	*Backlog increasing*	
Access to basic services	• 99.1% piped water (up 0.8% from 2001) • 93.4% electricity (up 5.3% from 2001) • 90.5% sanitation services (up 2.2% from 2001) • 91.1% refuse removal (up 2.3% from 2001)	*Improving*	

Access to transportation	• Well developed, but historic patterns dominate • New forms of public transport taking off	*Improving*	
Open space provision	• Insufficient and often inappropriate	*Insufficient data*	
Air Quality	**Quantification**	**Trend**	
Atmospheric pollutants	• Particulate matter (PM_{10}) – below threshold but shows steady increase • Nitrogen oxides (NO, NO_x) – acceptable but problems at certain locations • Sulphur dioxide (SO_2) – below threshold • Green House Gases (GHG) – levels increasing	*Insufficient data*	

District breakdown	• City of Cape Town – higher concentrations of all parameters
	  ◦ General problem in the form of smog ('brown haze') – linked to vehicle emissions
	  ◦ Cape Flats – high PM_{10} and volatile organic compounds (VOC) – due to domestic fuel burning, traffic and industry
	• Cape Winelands – high particulate matter (PM) and NO_2, linked to fugitive agricultural spraying
	• Central Karoo – transportation related emissions
	• Eden emissions – concentrations at PetroSA, Oudtshoorn (tanneries and abattoirs)
	• Overberg – has highest per capita vehicle ownership, indicating potential issues over time
	• West Coast – concentrated emissions from industries using coal, red oxide dust from iron ore handling at the Saldanha port, mines (e.g. dust from lime production, Matzikama), and aqua/mariculture industries (e.g. St. Helena Bay fishmeal production)
		No change	

Climate Change	**Key points**	**Trend**	
Projected change	• 1°C warming by late 2030s, warmer minimum and maximum • Highly uncertain, but possibly drying towards the west, and shorter rainy season, stronger winds, and approximate 5cm sea level rise over 25 years	*Declining*	

Carbon footprint	• Total emissions (contribution to greenhouse effect measured in carbon dioxide equivalent (CO_2e) emissions):
	  ◦ 41 303 482 tonnes CO_2e (2009) (compared to ~17 000 000 tonnes CO_2e in 2001)
	  ◦ 53% of provincial total due to electricity consumption
	• Carbon intensity:
	  ◦ Emissions relative to population size - 8 tonnes per capita in 2009 compared to 5.8 tonnes per capita in 2001
	  ◦ 178 tonnes per million Rand contribution of Gross Domestic Product (GDP) (2009)
	• GHG contributions:
	  ◦ 36% from industry, 28% from transport
	  ◦ City of Cape Town 57% of total, West Coast District 22%
		Limited historical data	

Energy	**Key points**	**Trend**	
Energy generation	• Oribi/Oryx oil field (2% of RSA liquid fuels) • PetroSA coal/gas-to-liquid plant • 2x open cycle gas turbines (2 084 MW) • 2x gas turbines (207 MW) • Koeberg nuclear reactor (1 800MW) • Palmiet pumped storage (580MW) • 4x solar, 4x wind farms planned under the Independent Power Producers (IPP) process • Eskom Sere wind farm under construction	***Improving***	

Energy use	• Total excluding marine and aviation:
	  ◦ 247 742 000 GJ in 2004
	  ◦ 270 887 000 GJ in 2009
	• 52% used by transport (previously 35%)
	• Mostly coal based electricity and liquid fuels
	• CoCT consumes 60%, West Coast 24%
		Declining	

Energy intensity	• 64 GJ/capita • 8t CO_2e/cap • Even higher intensity per unit of GDP • West Coast 6x higher intensity than provincial average (industries) • Central Karoo relatively high due to overland transport	***Concern***	↓

Domestic energy use	• Households electrified:
	  ◦ 83.5% in 2005
	  ◦ 93.4% in 2011
	• Decreasing % of households using electricity for heating
	• Energy other than electricity:
	  ◦ 7% for lighting
	  ◦ 13% for cooking
	  ◦ 21% for heating
		Improving	↑

Waste Management	**Key points**	**Trend**	

Waste generation	• Total:
	  ◦ 1 446 500 tonnes per annum in 2001
	  ◦ 3 807 765 tonnes per annum in 2010
	• 70% generated in CoCT, but relative contribution falling
	• Mostly paper, plastic, organic waste and builder's rubble
		Declining	↓

Waste collection	• 94% of households have refuse removal services (82% in 2001)	***Improving***	↑

Waste management	• 193 operational waste management facilities:
	  ◦ 92 general waste disposal
	  ◦ 54 drop-offs
	  ◦ 15 transfer stations
	  ◦ 13 materials recovery facilities
	  ◦ 6 planned/existing regional waste disposal sites
		Improving	↑

6 KEY ACTIONS AND STRATEGIC PRIORITIES

The key areas of action and strategic priorities that need to be responded to in order to address the declining trend of the state of our natural resources and to enhance the gains made in the socio-economic conditions within the Western Cape identified in this State of Environment Report, are as follows:

Built environment and infrastructure

- Remove obstacles to innovative green urban development and off-grid infrastructure
- Stimulate large-scale changes to energy and transport systems (support renewable energy development, waste-to-energy initiatives)
- Apply an integrated planning approach
- Drive renewable energy development
- Utilise green infrastructure
- Actively strengthen ecosystem services
- Ecological goods and services - enhance & support functionality of ecosystem through programmes that reduce the vulnerability of the poor
- Protect Critical Biodiversity Areas and integrate biodiversity planning into local SDFs
- Restore riverine habitat and corridors (e.g. Berg River Improvement Plan)
- Implement coastal management plans to protect sensitive marine and estuarine ecosystems
- Increase Blue Flag certifications

Curb wastage of resources

- Increase options for water reuse and curbing of reticulation water losses
- Drive adoption of conservation agriculture - more "crop per drop"
- Remove regulatory constraints limiting appropriate reuse/industrial symbiosis
- Transform traditional perceptions of waste and create innovative incentives for reduction of waste including organic waste
- Address energy intensity and dependencies

Good Governance

- Improve systems for data collection and analysis, and ensure alignment and integration with national programmes
- Improve land cover, air quality and waste information and gather information on private sector initiatives
- Integrated Waste Management must include proper licensing of facilities and reporting of volumes and types of waste
- Enhance integrated planning and incorporate biodiversity & ecosystem vulnerability into mainstream plans
- Use a comprehensive appraisal of natural resources to understand the value to the economy and social welfare

Build resilient communities who can earn a living

- Promote conservation agriculture
- Sustainable Coastal Livelihoods programmes
- Drive Green Economy development
- Develop and implement local Mitigation and Adaptation plans for climate change

7 CONCLUSION

The national and provincial economic and social outlook highlights the growth aspirations and social development needs of the province which are set to place tremendous pressure on the sensitive natural resources in the Western Cape. This overview of the state of the environment shows that although the natural systems are still in a state that can sustain the current levels of social development and economic activity, the socio-economic gains being made currently are at the expense of our natural resources. The outlook for all our natural resources is declining, our land and energy aspects are relatively stable but in need of revision and we have slightly more positive outlooks for our waste management and human settlement indicators. More needs to be done to protect critically sensitive or important environmental features, and the ability of the region to adapt to impacts from climate change is uncertain.

A radical shift in the modus operandi is required throughout the province to respond to these findings. If we do not change our approach to environmental resource management as well as service provision and economic activity, we will see increasing costs of doing business. This will be due to disaster management expenditure rises, failures of vulnerable economies (e.g. fisheries, small-scale agriculture) and ecosystem services having to be replaced by man-made interventions. Moving forward, service delivery and economic growth must be resource efficient, low carbon based and enhance societal resilience if we are to find a more balanced approach to using our limited resources.

The time has come for concrete implementation of the vision reflected in National and Provincial strategic documents. The key objectives and actions of the National Development Plan, the New Growth Plan and the National Strategy for Sustainable Development highlight the need to achieve a sustainable future for all South Africans. This vision of a sustainable future is reiterated in the high level Western Cape

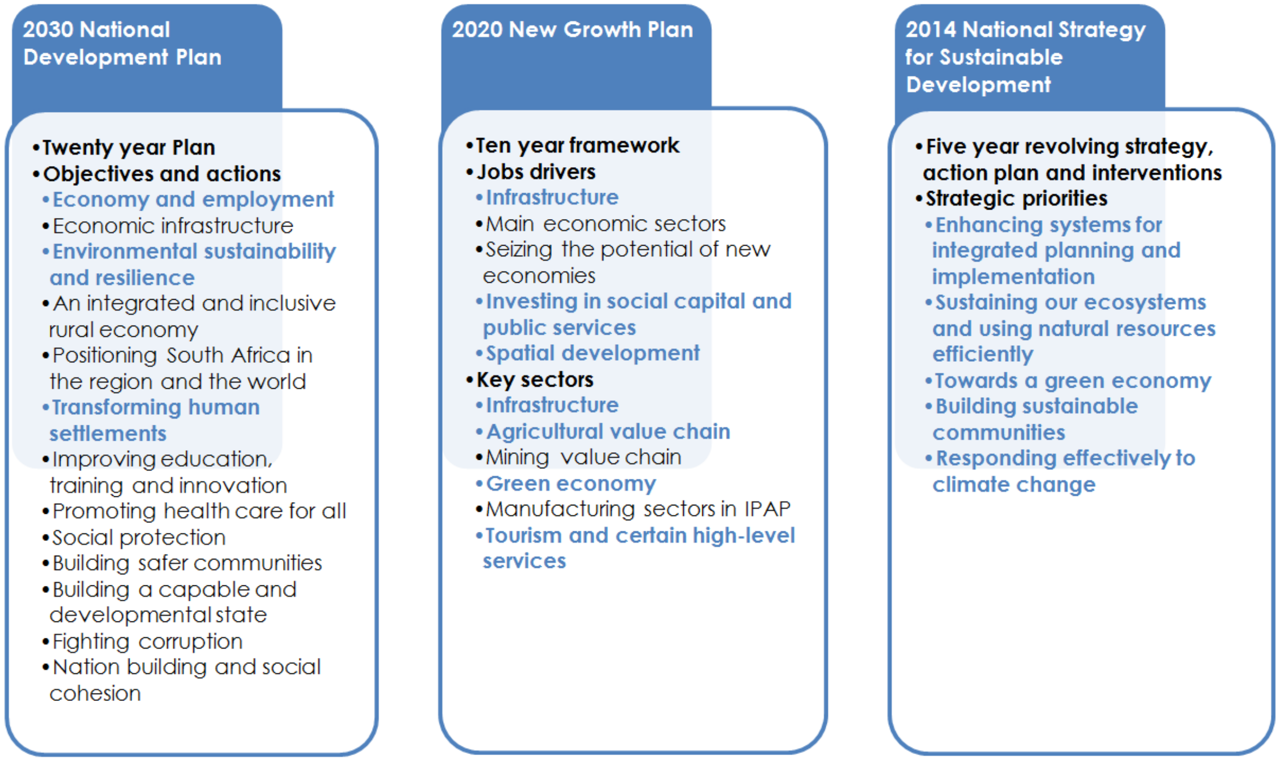


Figure 12: National policy directives

ONE CAPE 2040

- **Thirty year Plan**
- **Vision & priority actions**
- High skills, connected and collaborative & innovation driven
  - **Resource efficient & resilient**
  - An inclusive and competitive economy
  - High employment rate & growing incomes
  - **Improved quality of life overcoming legacy issues**
  - **Responsive to environmental risks**
- **Priority actions**
  - **Transition from a dirty to a clean economy is paramount**
  - **Safe and efficient public transport and embracing of non-motorised transport**
  - **Energy security from renewable sources**
  - **Upgrading low income rental stock, gap housing and private-sector driven integrative efforts**
  - Consciously empowered community leaders are required
  - **Enhance municipal service delivery in poor settlements**

2014 Provincial Strategic Objectives

- **PSO1: Increasing opportunities for growth and jobs**
- **PSO2:** Improving education outcomes
- **PSO3: Increasing access to safe and efficient transport**
- **PSO4: Increasing wellness**
- **PSO5:** Increasing safety
- **PSO6: Developing integrated and sustainable human settlements**
- **PSO7: Mainstreaming sustainability and optimising resource-use efficiency**
- **PSO8:** Increasing social cohesion
- **PSO9: Reducing and alleviating poverty.**
- **PSO10: Integrating service delivery for maximum impact.**
- **PSO11: Creating opportunities for growth and development in rural areas.**
- **PSO12:** Building the best run provincial government in the world

2013 State of Environment Outlook Report

- **Strategic priorities**
  - **Green Built Environment – infrastructure, services, human settlement (innovate)**
  - **Actively strengthen ecological goods and services to enhance resilience & limit impact on the poor**
  - **Enhance Systems for Integrated Planning and Implementation incorporating biodiversity & ecosystem vulnerability**
  - **Good governance- environmental monitoring, waste management, integrated planning**
  - **Build resilient communities who can earn a living- conservation agriculture, coastal livelihoods, Green Economy**
  - **Responding Effectively to Climate Change**

Figure 13: Provincial policy and the State of Environment Outlook

Government planning processes namely the OneCape 2040 Vision and the Provincial Strategic Objectives, as well as in initiatives such as the Green Economy Framework and Skills Programme.

Respectively, Figure 12 (previous page) and Figure 13 show National and Provincial policy directives related to future planning and development in summarised form. Directives related to themes also identified in the Western Cape State of Environment Outlook Report 2013 have been presented in blue text. The high degree of overlap highlights the convergence of thinking on key priorities.

As is evident, most policy convergence lies in stimulating development that is based on resource use efficiency, ecosystem health, functional and well planned human settlements, good governance and regulation, as well as a good education system. Resource use efficiency incorporates the efficient and effective use of all natural resources, including water, energy, land, soil, biodiversity, fauna and flora, air and marine resources. Specific environmental programmes include responses to climate change, a transformed transportation system, green growth and development, and a focus on agriculture and food security.

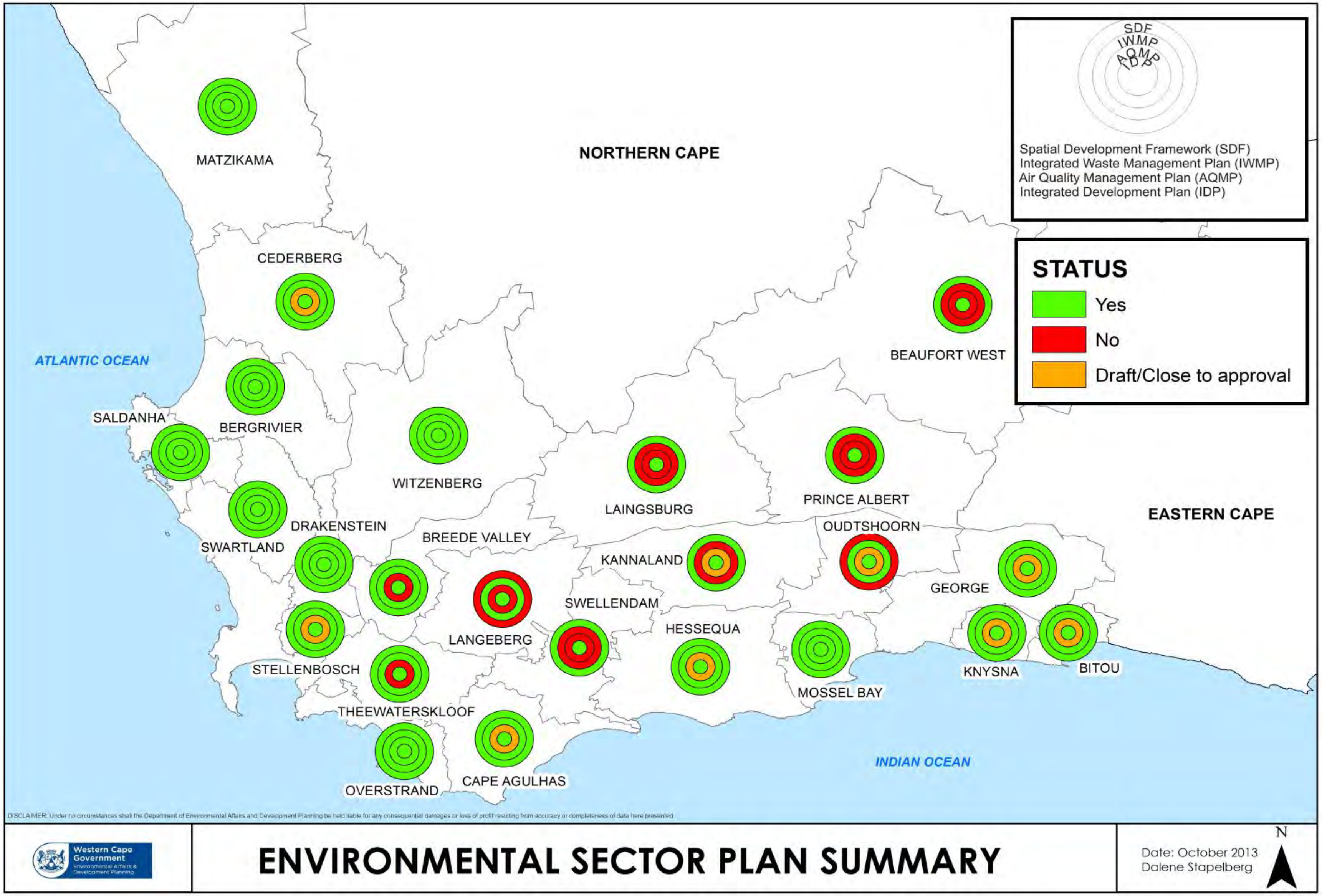


Figure 14: Status of Western Cape local Municipalities' environmental sector plans

One method of measuring the inclusivity of environmental matters within planning at municipal level is to track the inclusion of environmental sector plans in IDPs. Figure 14 is a radial diagram illustrating which environmental sector plans are completed and up to date (shown as green rings), and those that are not (as red rings). Each ring represents a different plan (e.g. Air Quality Management Plans, Waste Management Plans, Coastal Management Programmes, etc.) which are legal requirements. The diagram therefore shows that there is significant work to be done to ensure all required plans are in place to mainstream environmental issues into municipal planning and governance structures.

Whilst State of Environment reporting is to become a regular reporting tool for tracking our resource utilisation trends, it is critical for us to focus on undertaking all activities within government and private sector in a more resource optimal manner on a day-to-day basis.

We cannot rely only on large scale conservation or environmental management interventions. It is our actions, our services, and our consumption patterns which will influence the downward trends in the state of our natural resources.

Day-to-day private business and government decisions and implementation will cumulatively change how we use or abuse our environment. The change needs to start with each of us today.

Let us make it Better Together.

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BETTER TOGETHER.

State of Environment Outlook Report for the Western Cape Province

Introductory Matter

September 2013

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September 2013

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ABBREVIATIONS

$\mu g/m^3$	Micrograms per cubic meter
AQMP	Air Quality Management Plan
ARI	Acute Respiratory Illness
bbl/d	barrels per day
CBA	Critical Biodiversity Area
CFC	Chlorofluorocarbon
CFR	Cape Floristic Region
CKDM	Central Karoo District Municipality
CMA	Catchment Management Agency
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CoCT	City of Cape Town
CR	Critically Endangered
CSP	concentrated solar power
CWDM	Cape Winelands District Municipality
DAFF	Department of Agriculture, Forestry and Fisheries
DD	Data Deficient
DEA	Department of Environmental Affairs (previously DEAT)
DEADP	Western Cape Department of Environmental Affairs and Development Planning
DEAT	National Department of Environmental Affairs and Tourism (see DEA)
DPSIR	Driver-Pressure-State-Impact-Response
DWA	Department of Water Affairs
EDM	Eden District Municipality
EN	Endangered
EPWP	Extended Public Works Scheme
FEPA	Freshwater Ecosystem Priority Area (See NFEPA)
FI	Fish Index
GDP	Gross Domestic Product
GHG	greenhouse gas
GI	geomorphologic index
GJ	gigajoule
GRDP	gross regional domestic product
GWh	gigawatt hour
ha	hectare
IAAQS	International Ambient Air Quality Standard
IAP	invasive alien plants
IHI	Index of Habitat Integrity
IRP 2010	Integrated Electricity Resource Plan for South Africa - 2010 to 2030
IUCN	International Union for Conservation of Nature and Natural Resources
km^2	square kilometre
kWh	kilowatt hour
LC	Least Concern
LPG	liquefied petroleum gas
m^3	cubic metre
mm	millimetre
MMscf	million standard cubic feet
MPA	marine protected area
MW	megawatt
MWh	megawatt hour

NAAQS	National Ambient Air Quality Standard
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NEM:AQA	National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEM:BA	National Environmental Management: Biodiversity Act
NEMP	National Eutrophication Monitoring Programme
NFEPA	National Freshwater Ecosystem Priority Area (shortened to FEPA)
NO	nitrogen oxide
NO_2	nitrogen dioxide
NSBA	National Spatial Biodiversity Assessment (2004)
NT	Near Threatened
NWA	National Water Act
O_3	ozone
OCGT	Open Cycle Gas Turbine
ODM	Overberg District Municipality
PA	Protected Area
PAH	polycyclic aromatic hydrocarbons
PES	Present Ecological State
PM	Particulate Matter
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 µm
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 µm
PRASA	Passenger Rail Association of South Africa
PV	Solar Photovoltaic
RHP	River Health Programme
RQO	Resource Quality Objective
RVI	Riparian Vegetation Index
SANBI	South African National Biodiversity Institute
SANRCBD	South Africa's National Report to the Convention on Biological Diversity
SASS5	South African Scoring System version 5
SKEP	Succulent Karoo Ecosystem Programme
SO_2	sulphur dioxide
StatsSA	Statistics South Africa
SWH	solar water heating
tcf	trillion cubic feet
tpa	tonnes per annum
UGEP	Utilizable Groundwater Exploitable Potential
VOC	volatile organic compounds
VU	Vulnerable
WAAS	Water Availability Assessment Study
WCCC	Western Cape Conservation Category
WCDM	West Coast District Municipality
WCG	Western Cape Government
WCWSS	Western Cape Water Supply System
WESSA	Wildlife and Environment Society of South Africa
WHO	World Health Organization
WMA	Water Management Area
WWTW	waste water treatment works

1 INTRODUCTION

The Western Cape State of Environment Outlook Report 2013 is the second comprehensive report on environmental trends in the province. The first iteration, the 'Western Cape State of Environment Report – Year One' baseline report was published in 2005. The aim of the 2013 report is to not only report on the current state of environmental resources, but also to compare the findings with those reported on in the 2005 baseline report.

The 2005 report reflected on fourteen themes related to natural, social and economic aspects of sustainable development. This 2013 report builds on the reporting for the various themes. However, due to ongoing refinements to reporting on environmental and sustainable development aspects, and the need for standardisation between different '*State of...*' reports, this 2013 report reduced the number of themes to nine. As shown in Table 1, the extent of socio-economic reporting was scaled down from what was represented in the 2005 report to avoid overlap with social and economic reporting in the Province, and the themes rearranged to match the reporting structure in the National Environmental Outlook project as well as aspects from the previous State of Environment Report, the National Strategy for Sustainable Development, and the National Outcomes 10 Objectives.

Table 1: Themes for the 2013 Western Cape State of Environment Outlook Report

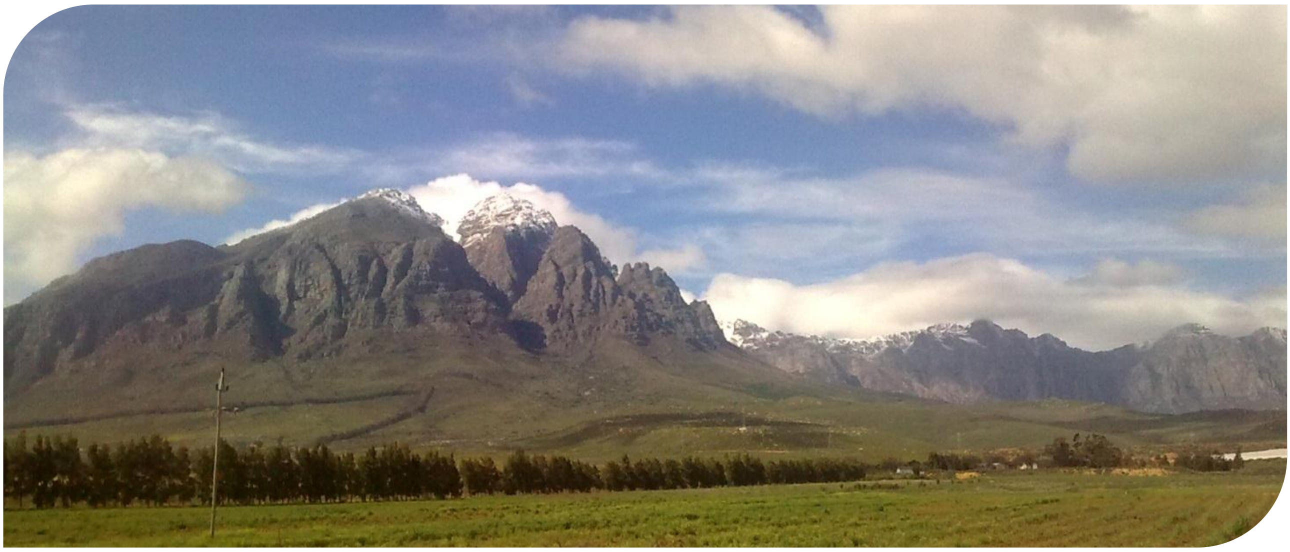
2005	2013
Air Quality and climate change	Air Quality
	Climate Change
Biodiversity	Biodiversity and Ecosystem Health
Inland Water and Water Supply	Inland Water
Coastal Zone	Oceans and Coasts
Land	Land
Waste and Sanitation	Waste Management
Energy	Energy
Health	Human Settlements
Education	
Economics and Poverty	
Tourism	
Urban Development	
Transport	
Safety and Security	

Not only does State of Environment reporting provide a snapshot of environmental conditions, but it also records the efforts made to respond to environmental conditions and provides an opportunity to influence and guide policy development and decision making for the Western Cape. The effect of this guidance will then be reflected on in the next round of reporting for the Province. This continual comparison provides an ongoing analysis of trends within the province, and an indication of the success or failure of efforts to shift towards more sustainable, efficient development and living.

During the course of 2012, a Provincial visioning exercise undertaken under the name 'OneCape 2040' expressed the statement of direction for the regional economy as a "*highly-skilled, innovation driven, resource-efficient, connected, high opportunity and collaborative society*"*;* while recognising the challenge of creating "*a resilient, inclusive and competitive Western Cape with high rates of employment, growing incomes, greater equality and an improved quality of life for all our citizens and residents that addresses the crisis of joblessness, overcomes our legacy of skills and asset deficits and responds to environmental risk*" (OneCape 2040 2012). This strategic vision for the Western Cape Province is affirmed by the Provincial Strategic Objectives captured in the Western Cape Strategic Plan (Western Cape Government 2010). This plan provides for a unified articulated vision that incorporates both the Provincial objectives and development strategy of the City of Cape Town.

Importantly, one of the key transitions that will make the achievement of the Vision possible is a sustainable balance between economic access, cultural diversity, human activities and, importantly, sustained integrity of the delicate ecological system that the Western Cape is custodian of. This links to the promise enshrined in the South African Bill of Rights 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*" as well as the responsibility of Government to action this provision.

The findings of the Western Cape State of Environment Outlook Report 2013 needs to support this Provincial visioning and developmental planning exercise by highlighting key environmental trends, identifying existing governmental and private sector responses under the different themes, and reflecting on environmentally responsible and sustainable growth and development for the future of the province.



2 STATE OF ENVIRONMENT REPORTING

2.1 State of Environment reporting and audience

State of Environment Reporting provides information on changes to the environment within a region. This knowledge provides a baseline on current conditions, and assists decision makers to make more informed decisions for sustainable development. State of Environment Reports are compiled at different scales, depending on the required resolution and level of application. South Africa, for example, features within a regional report, the Southern Africa Environment Outlook (a SADC publication), and then to a lesser extent in the Africa Environmental Outlook compiled by UNEP. State of Environment reporting at a national scale is the responsibility of the National Department of Environmental Affairs (DEA). DEA is currently busy with an update to the National Environmental Outlook, and the Western Cape State of Environment Outlook will tie into the National reporting scheme by providing a regional scale assessment and outlook.

This State of Environment Outlook report also aims to provide a platform for future compliance with State of Environment reporting requirements proposed under the National Environmental Management Act, 1998. Current proposed amendments to NEMA included under the National Environmental Management Laws Amendment Bill, 2012, make the compilation of five-yearly State of Environment Reports a mandatory obligation for national and provincial tiers of Government. The proposed regular reporting cycles are intended to correspond with the need for Environmental Implementation and Management Plans, thereby ensuring that there is integration between environmental reporting and management response actions. The Bill also provides for the establishment of standards for such reports, thereby creating uniformity in reporting.

On a technical level, the Western Cape State of Environment Outlook report consolidates a large variety of environmental data sets in order to measure the state of environmental resources in the province according to a predetermined suite of indicators. The consolidated depiction of the state of the environment is then presented in a summarised and highly visual format.

The audience for this report is intended to be local decision makers who need updated information on which to base development decision-making, as well as investors across all sectors and the general public who are interested in environmental and developmental issues. Sector specific specialists or scientists who seek more detailed information on particular chapters are advised to use the information in the State of Environment Outlook Report as guidance on where further information can be sourced.

2.2 DPSIR framework

The internationally recognised 'Driver-Pressure-State-Impact-Response' (DPSIR) framework is used for the Western Cape State of Environment Outlook Report. The DPSIR framework is also currently the preferred national framework for environmental reporting and is followed by all provinces and the National Department of Environmental Affairs for environmental reporting.

The framework is illustrated in the figure below. As shown, the DPSIR components represent a cyclical process of causal links. Each component can be traced back to its precursor, and also to its effect in the overall scheme. Importantly though, societal responses have the potential to affect all other components of the framework, and not just its neighbours in the scheme.

The DPSIR framework uses the causal network effectively to not only describe the state of a particular environmental feature, but also the causes of environmental change as well as the impacts of change and the societal responses to the changes.

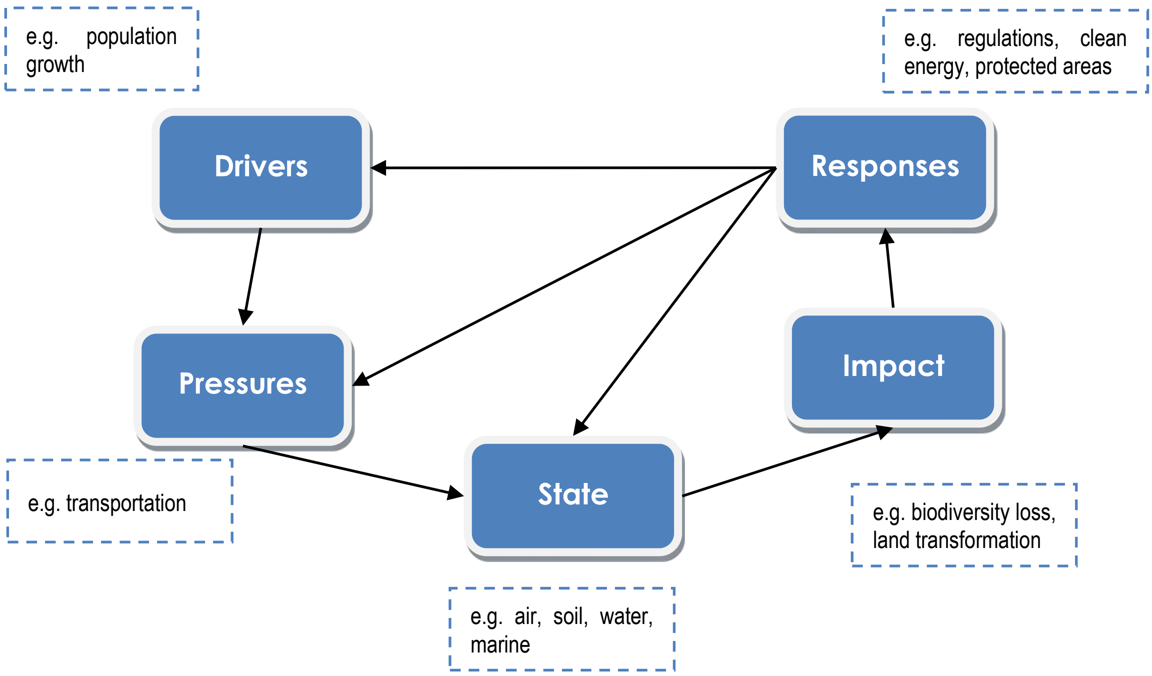


Figure 1: The DPSIR Framework

Accordingly, the descriptions proposed in Table 2 will be used to populate the DPSIR framework components in the different theme chapters that collectively constitute the State of Environment Outlook Report.

Table 2: Explanation of the DPSIR Framework

DPSIR framework	Description	Example
Drivers	Drivers (human induced or natural) are the primary agents driving change in the environment. These are the underlying socioeconomic and political agents of change, such as population growth and a need for increased consumption. Drivers can also be described as 'needs'. Driving forces emanating from natural processes (e.g. solar cycles) are possible, but are typically too infrequent or operate over scales that do not relate easily to the 5-yearly reporting framework of the Environmental Outlook process.	Human population
Pressures	The human activities and processes that act on the environment and cause environmental change are considered 'pressures'. They are distinct from the driving forces since they relate directly to the use and exploitation of natural resources, as opposed to the driving forces that	Agricultural production

DPSIR framework	Description	Example
	determine the scope or extent of the pressures. Effectively, the pressures satisfy the 'needs' or driving forces. Pressures can be divided into three main types: (i) excessive use of environmental resources, (ii) changes in land use, and (iii) emissions (of chemicals, waste, radiation, noise) to air, water and/or soil.	
State	The 'State' describes the actual condition of the environment resulting from the pressures outlined above. For example, air quality in terms of the level of air pollution, and extent of degraded land. The 'State' is described both in terms of current state and trends over time. A study of environmental trends will reveal whether the state of the environment is getting better or worse. It also gives an indication of how quickly changes are happening (the rate of change) and whether rates of change are increasing or decreasing.	Extent of cultivation
Impact	'Impacts' describe the consequences of the good or bad state of the environment for sustainability, specifically on humans, the economy, ecosystems, as well as other environmental sectors, and could include regional or global effects. For example: high levels of indoor air pollution may result in respiratory tract infections; land degradation may lead to decreased food production, increased food imports, increased fertilizer use, malnutrition and siltation of aquatic systems. The impacts should be seen as changes to environmental, economic or social systems and their ability to perform functions or services for society.	Fragmentation of natural habitat
Responses	The societal actions taken collectively or individually to ease or prevent negative environmental impacts, correct damage or conserve natural resources can be seen as 'Responses'. Responses may include regulatory action, environmental or research expenditures, public opinion and consumer preferences, changes in management strategies and the provision of environmental information.	Improved monitoring and compliance within extension services

2.3 Indicators

Particular environmental aspects or features that can act as a proxy indicator or representative for a range of other features are used to infer the overall state of environmental resources. Representative 'indicators' are therefore selected to provide an overview of the state of various environmental themes, as well as detail related to drivers, pressures, impacts and responses. These indicators must be selected carefully in order to provide an accurate reflection of the state of the environment, since no report can ever precisely and comprehensively describe the whole of the natural environment and all its constituent systems. By tracking indicators over time, state of environment reports can also assess the effectiveness of responses to environmental challenges.

Each iteration of the state of environment report attempts to keep the reporting on indicators consistent in order to maintain consistency. However, contextual changes often necessitate ongoing adjustment to the set of indicators being reported against. For the 2013 Western Cape State of Environment Outlook Report, as many of the indicators from the 2005 report as possible have again been reported on. An effort was made however to reflect similar indicators as used by the National Environmental Outlook compilation process to allow for consistent analysis and comparison between levels of reporting. The indicators sets are listed within each of the themed chapters.

3 WESTERN CAPE PROVINCE PROFILE

3.1 Location and climate

The Western Cape lies on the southern tip of Africa and represents 10.6% of the country's total land area, with 129 462km^2 under its jurisdiction. It stretches from beyond Strandfontein on the West Coast around the Cape Peninsula and Cape Point, to Nature's Valley along the Garden Route on the South Coast.

The province is also the meeting point of the Atlantic and Indian Oceans, with the cold Benguela current running up the west coast and the warmer Agulhas current flowing westwards along the southern coast. The interaction between these currents, and the location in the mid-latitudes, results in a mild Mediterranean climate.

The Western Cape is blessed with natural beauty that includes the unique fynbos vegetation, mountain ranges and beautiful shorelines, but also possesses a cultural diversity with a long and rich history. These factors, along with internationally recognised wine and fruit industries, make the Western Cape one of the world's greatest tourist attractions.

3.2 Municipal Profiles

The Western Cape Province comprises five district municipalities namely Central Karoo, Eden, Overberg, Cape Winelands and West Coast, and one Metropolitan Municipality, the City of Cape Town (Figure 3). The District jurisdictions, in turn, incorporate 24 smaller Local Municipalities.

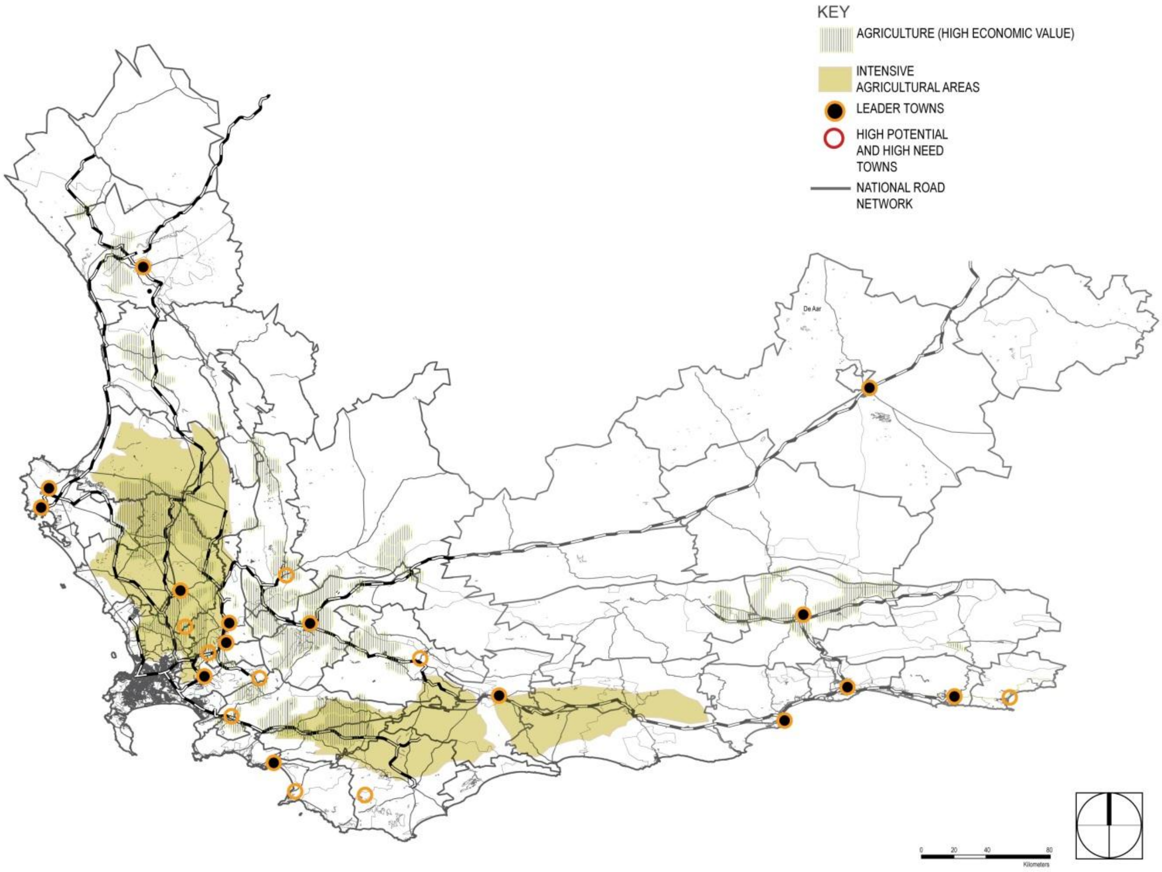


Figure 2: Spatial Structure of the Western Cape (DTPW 2011)

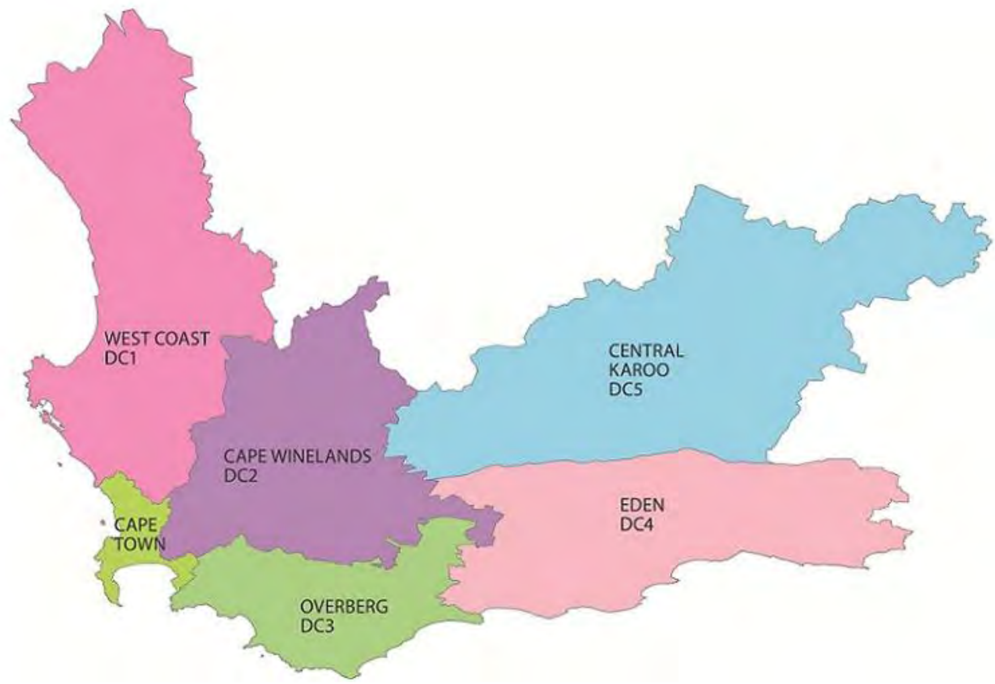


Figure 3: Western Cape District Municipalities Locality Map

3.2.1 Urban concentration – City of Cape Town and Cape Winelands

The overwhelming majority (>80%) of the population and economic activity of the Western Cape is located in the City of Cape town and its immediate District neighbour, the Cape Winelands. This conglomeration of urban settlements includes Cape Town, Stellenbosch, Paarl, Wellington and Franschhoek, and is located at the confluence of three national roads, the N1, N2, and N7, as well as the main rail link from Gauteng. The Cape Town International Airport is also found here, along with Cape Town harbour.

The region is consequently well suited to urban development and activities, such as extensive residential settlement and industrial hubs. Notwithstanding, the urban setting the Western Cape incorporates important agricultural areas, and specifically the core of the wine industry with its extensive vineyards and multitude of wine cellars. The attractive setting and diverse landscapes also contribute to a thriving tourism industry built upon both urban and rural attractions.

3.2.2 Karoo

The area inland of the Cape Fold mountains, including the inland areas of the Cape Winelands District, the Little (Klein) Karoo between the Swartberg and Langeberg/Outeniqua mountain range of the Eden District, and the entire Central Karoo District, represent the least populated, least urbanised and least transformed sub-region of the Western Cape. The Karoo is characterised by a dry landscape, with dispersed settlements and towns. Economic activity in the area is limited to groundwater-based agriculture, especially livestock farming, and some niche industries such as ostrich farming in the Oudtshoorn area.

The Karoo hosts unique vegetation in the form of highly specialised succulents and low scrub adapted to the semiarid climate that assists in attracting visitors to its stark beauty.

3.2.3 West Coast

The West Coast area is characterised by irrigated agriculture on the sandy plains of the Sandveld and along the fertile river valleys, rich marine resources along the coastline, and the rugged and dry Cederberg area inland.

The main activity centre of the West Coast District is around Langebaan lagoon with Saldanha, Langebaan and Vredenburg being the main towns in the area. Saldanha is a port town, which is a natural deepwater port that handles large volumes of iron ore railed from the Sishen area.

Langebaan lagoon, the Cederberg mountains and the renowned semi-arid vegetation of the West Coast, and in particular the spring wildflowers, attract visitors from all over the world.

3.2.4 South Coast

Like the West Coast, the southern parts of the province comprising the coastal plains and mountains of the Overberg and Eden Districts, are characterised by extensive agriculture, a scenic coastline and rugged mountains further inland. Agriculture is especially prominent in the Overberg, where wheat and canola production dominate. Eden District is more undulating and forested, with the area between the Western Cape escarpment (Langeberg and Outeniqua mountains) and the coastline narrowing to combine mountain and coastal wetland features into a popular tourist mecca known as the Garden Route.

The Mossel Bay and George area is the most industrialised, and is home to the PetroSA refinery associated with the offshore oil and gas fields.

3.3 Population demographics

Results from the 2011 census indicate that there are 5 822 734 people residing in the Western Cape, representing 11.2% of the national population (StatsSA 2012c). For historical reasons, the Western Cape's population composition is dissimilar from that of most other provinces. The coloured population group constitutes about half (49%) of the provincial population, Africans about a third (33%) and whites just over one-sixth (16%) (StatsSA 2012c). The biggest share of the population lives in or around the City of Cape Town.

Principal languages spoken are Afrikaans (48%), isiXhosa (24%) and English (20%) (StatsSA 2012c).

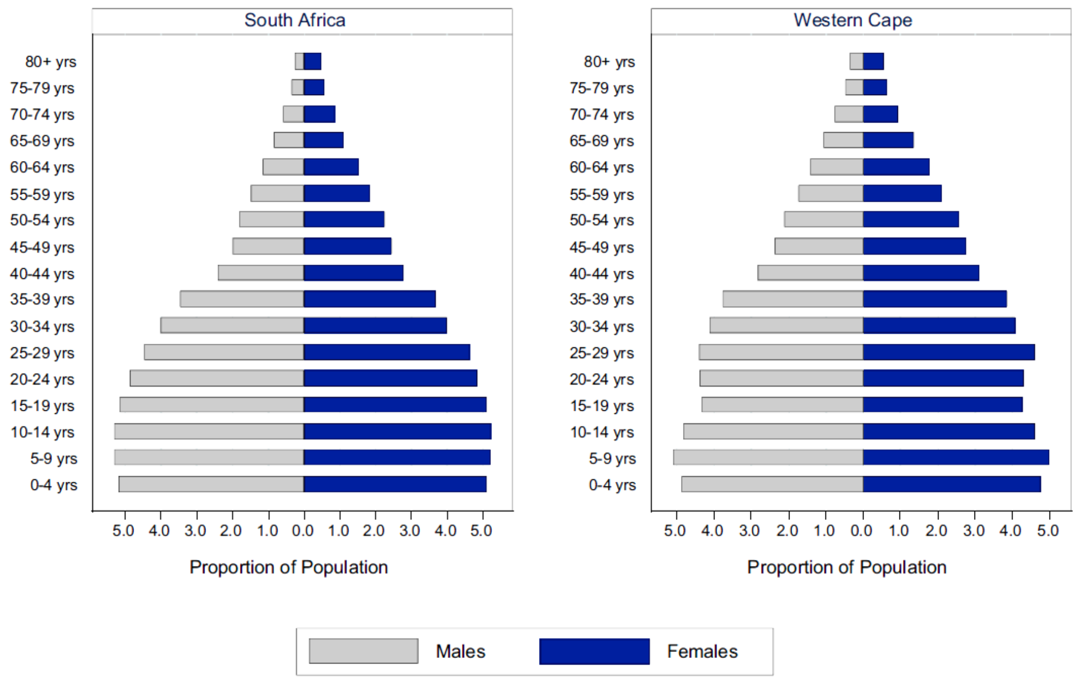
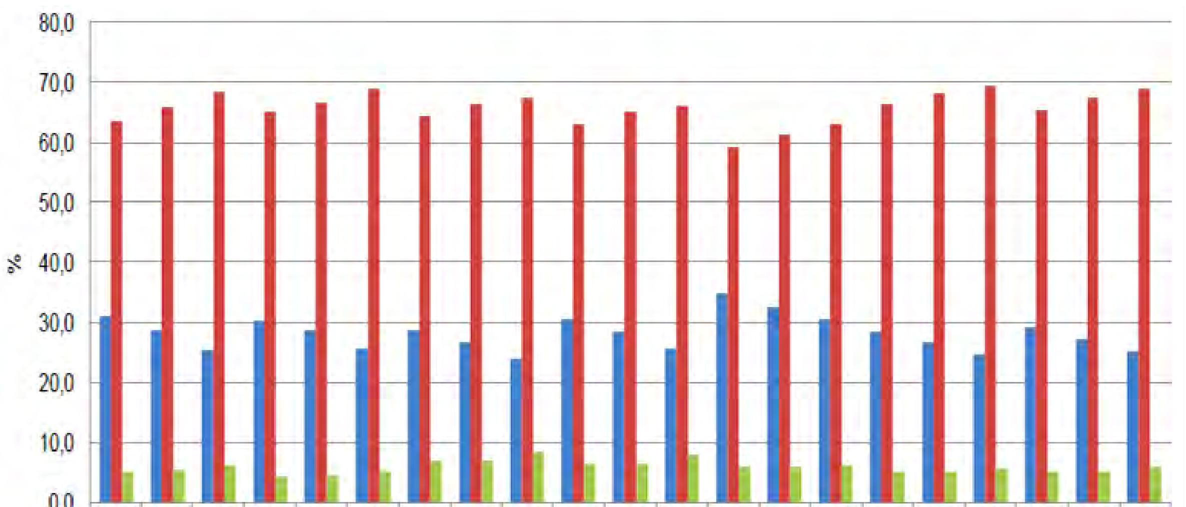


Figure 4: Age structure of the South African and Western Cape and populations (WCG 2012)

As seen from an analysis of age structure in the Western Cape, the province has a relatively young population, similar to the rest of South Africa. This gives rise to a dependency factor of 0.45, indicating that there are 45 dependants to each 100 working age adults (WCG 2012).

A municipal comparison of functional age groups, i.e. 0-14, 15-64 and 65+, shows that the population is aging in all Districts, but that the Central Karoo has a markedly higher 'young' population component than the other districts (Figure 5).

Western Cape life expectancy is still quite low, due to high mortality stemming from the mixture of diseases of affluence and of poverty combined with many deaths from HIV/AIDS and from injuries (mainly homicides and traffic accidents). Tuberculosis is extremely wide-spread amongst the lower income groups. Deaths from inter-personal violence are particularly high amongst male youths. Almost 2 500 homicides occur annually, many perpetrated on acquaintances. Infant mortality in the region remains much higher than in regions in comparable middle-income countries (WCG 2012).



	West Coast 1996	West Coast 2001	West Coast 2011	Cape Winelands 1996	Cape Winelands 2001	Cape Winelands 2011	Overberg 1996	Overberg 2001	Overberg 2011	Eden 1996	Eden 2001	Eden 2011	Central Karoo 1996	Central Karoo 2001	Central Karoo 2011	City of Cape Town 1996	City of Cape Town 2001	City of Cape Town 2011	Western Cape 1996	Western Cape 2001	Western Cape 2011
0 - 14	31,1	28,7	25,5	30,4	28,7	25,8	28,7	26,7	24,1	30,5	28,5	25,9	34,8	32,7	30,5	28,5	26,6	24,8	29,2	27,3	25,1
15 - 64	63,8	66,1	68,5	65,2	66,7	69,0	64,5	66,6	67,6	63,2	65,1	66,3	59,3	61,4	63,3	66,4	68,4	69,6	65,6	67,5	69,0
65+	5,1	5,2	6,0	4,4	4,6	5,1	6,8	6,8	8,3	6,3	6,4	7,8	5,9	6,0	6,2	5,1	5,0	5,5	5,2	5,2	5,9

Figure 5: Population distribution by functional age groups and district municipality as percentage of total population (StatsSA 2012c)

Population growth in the Western Cape is relatively stable, with a 2.5% growth rate between 2001 and 2011 as compared to a 2.6% growth rate between 1996 and 2001. The latest national data shows that the Western Cape receives a net inflow of people from other areas, with 300 000 people having moved to the province over the past 10 years (StatsSA 2012c). Population growth rates for the different Districts are shown in Table 3.

Table 3: Population growth rates by District Municipality – 2001 to 2011 (StatsSA 2012c)

West Coast	Cape Winelands	Overberg	Eden	Central Karoo	City of Cape Town
3,3	2,2	2,4	2,3	1,6	2,6

The trend towards net inwards migration, if not the actual numbers, is confirmed by data on transfers of learners to Western Cape schools. There are about 25 000 annual transfers to Western Cape schools from other provinces (about 2.8 per cent of learners), especially concentrated in grades 1, 6 and 8 (WCG 2012).

3.4 Socio-economic indicators

3.4.1 Social conditions

Socio-economic conditions in the Western Cape are considered to be marginally better than the other provinces; something that is borne out by the results of the 2011 national census (StatsSA 2012c) and the self-perceptions of residents of the Western Cape (StatsSA 2012b). Especially notable is the performance in terms of basic service delivery and the higher average income when compared to other provinces. The relative prosperity is ascribed to the high rate of urbanisation, high average income and reduced inequality (WCG 2012).

The province is not exempt from social ills however, as several socio-economic problems remain pervasive, especially in historically marginalised communities. This includes inter-personal violence, with a very high homicide rate of 47 per 100 000 population, high levels of violent crime, housebreaking and other crimes, wide-spread alcohol and substance abuse, abuse of women and high rates of child abuse (WCG 2012). Of particular concern is the disintegration of family and community structures.

3.4.2 Education

In the Western Cape, most (95%) children aged between seven and 14 go to school, but sadly there is a high dropout rate. Nevertheless, it is the province with the highest number of persons older than 20 years who have had some form of education (97.3%), and 14.4% of adults in the province have post-school qualifications. This is higher than the national average (12%), but lower than Gauteng (18%) (StatsSA 2012c). Improvements to the education system show promise, since in 2012 the record number of 36 992 candidates passing the National Senior Certificate examinations implied a 10% increase from the previous year and the highest number of passes ever achieved in the province. There has also been a steady increase in the number of candidates who achieved access to Bachelor Degree or diploma studies, significant improvements in the pass rates for mathematics and physical science, as well as a reduction in the number of underperforming schools (WCG 2013).

3.4.3 Living conditions

Taking into account the large in-migration to the province, survey data points to a housing shortage of about 400 000 units (DHS 2010). This goes hand-in-hand with a growth in informal dwellings between 1996 and 2011 – from 16.7% of households living in informal structures, to 18.2% (StatsSA 2012). The Western Cape is, however, ahead of all other provinces in providing municipal services namely sanitation, electricity and refuse removal. Only in terms of the provision of water to the dwelling or yard is the Western Cape outdone by both Gauteng and Free State (StatsSA 2012).

3.4.4 Poverty

According to the Living Conditions Survey 2008/2009 results, using a R577 poverty line Limpopo was the poorest province (74.3% of people) in South Africa, with the Western Cape second most affluent at 30.6% (StatsSA 2012b). Corresponding self-perception or subjective responses, however, show that a smaller percentage of the Western Cape populace view themselves poor – only 23% as compared to 29% in Gauteng and 53.5% in the Eastern Cape. The Western Cape and Gauteng are also the two provinces with the best performance in terms of poverty gap and severity of poverty. However, subjective multi-dimensional poverty indicators show that in terms of households that are deprived of at least 3 of 5 basic determinants of the quality of living, the Western Cape ranks lower than the Northern Cape, Free State and Gauteng (StatsSA 2012b).

3.4.5 Employment

Of the working age population of the Western Cape, 68.4% had employment in 2012 according to the narrow definition of employment (i.e. not counting discouraged work seekers who are not looking for employment). This is somewhat higher than the national average of 54.5% (WCG 2012).

Employment in the province has increased in absolute numbers between 2000 and 2010 by 14 466 jobs, with only the City of Cape Town and Eden District showing growth. These two regions produced 78 000 new job opportunities, but the other districts unfortunately shed enough jobs to effectively erase most of the gains (WCG 2012). This points towards a current path of 'jobless growth' with growth trends not being matched to the profile of the available labour.

"There are two important points to note as far as labour force participation by race is concerned. The first is that, as already noted, labour force participation rates across all three race groups are higher in the Western Cape than is the case nationally, although it is only in the case of Africans that this difference is statistically significant. The second is that Labour force participation rates are much more similar across race groups in the Western Cape than they are nationally. In the Western Cape, Labour force participation rates for Africans and Whites are not statistically different from each other, while that of Coloureds is slightly lower. This pattern provides some corroboration for the assertion earlier that it is a lack of deep rural areas that differentiates the Western Cape from South Africa as a whole in terms of non-searching unemployment. Africans in the Western Cape are far more likely to participate in the labour force, while Coloureds, who are more likely to be located in the more isolated rural areas of the Province, have a slightly lower rate of participation".

(Provincial Economic Review & Outlook 2012) (WCG 2012: 112)

3.4.6 Social equality in the Cape Town metropolitan area

According to the State of the World's Cities 2012/2013 report of the UN Human Settlements Programme (UN Habitat), the Western Cape is home to South Africa's 'least unequal' metropolitan city (UN Habitat 2012). Specifically, the study compares world cities across five indices, namely productivity, infrastructure development, quality of life, environmental sustainability and equity. It finds that although both Cape Town and Johannesburg rates along with peers such as Manila (Philippines), Jakarta (Indonesia) and Beijing (China) in terms of four dimensions, their performance rating for equity is particularly poor, placing Cape Town on par with cities such as Nairobi (Kenya), Kampala (Uganda) and Kathmandu (Nepal). Equity is considered as a combination of income disparity and differential access to infrastructure and services, and the rating therefore points to the fact that many of the social and economic ills found in Cape Town (and other South African cities) can be attributed to inequalities.

A similar comparison between Cape Town and other South African cities is found in the 2010/2011 State of the World's Cities Report (UN Habitat 2010). This report lists Cape Town as the best performer of South African metros, but warns that all the cities demonstrate poor scores in terms of equity. Cape Town should be concerned that progress in reducing its Gini Coefficient rating (representing the income gap between the rich and poor) is slower than in other local cities.

3.5 Economy

3.5.1 Economic growth

In the wake of the 2008 global economic recession, the general South African economy remains under strain. On the one hand, the European Union, United Kingdom and USA, traditionally strong trade partners, have not found sustainable solutions to their respective economic problems and therefore are not providing the necessary financial investment and spending lifeblood to South Africa and the Western Cape. On the other, strong competition for goods and services is present from other large developing economies such as China and India. As a result, the Western Cape economy, which relies strongly on exports and tourism spending, is at risk (WCG 2012).

Nevertheless, the economy of the Western Cape has been growing slightly faster than the rest of South Africa, specifically due to strong growth in the tertiary sector. The GDP grew by 3% in 2010, driven by finance, real estate and business (3.6% growth) and manufacturing (5% growth). The sectors that constrained overall growth were agriculture, forestry and fisheries (WCG 2012). The dominant sectors of the Western Cape are similar to the national economic structure, except for the emphasis on tertiary services and near complete absence of mining and quarrying.

Understandably, the economic activities of the City of Cape Town overshadow the relative contribution of the other District Municipalities. According to the Western Cape Province (2012), Cape Town contributes nearly three quarters of the provincial GDP (see

Table 4 below). In addition, the adjoining Cape Winelands contribute a further 11.4% to the GDP, making the metropolitan area economically dominant in the province.

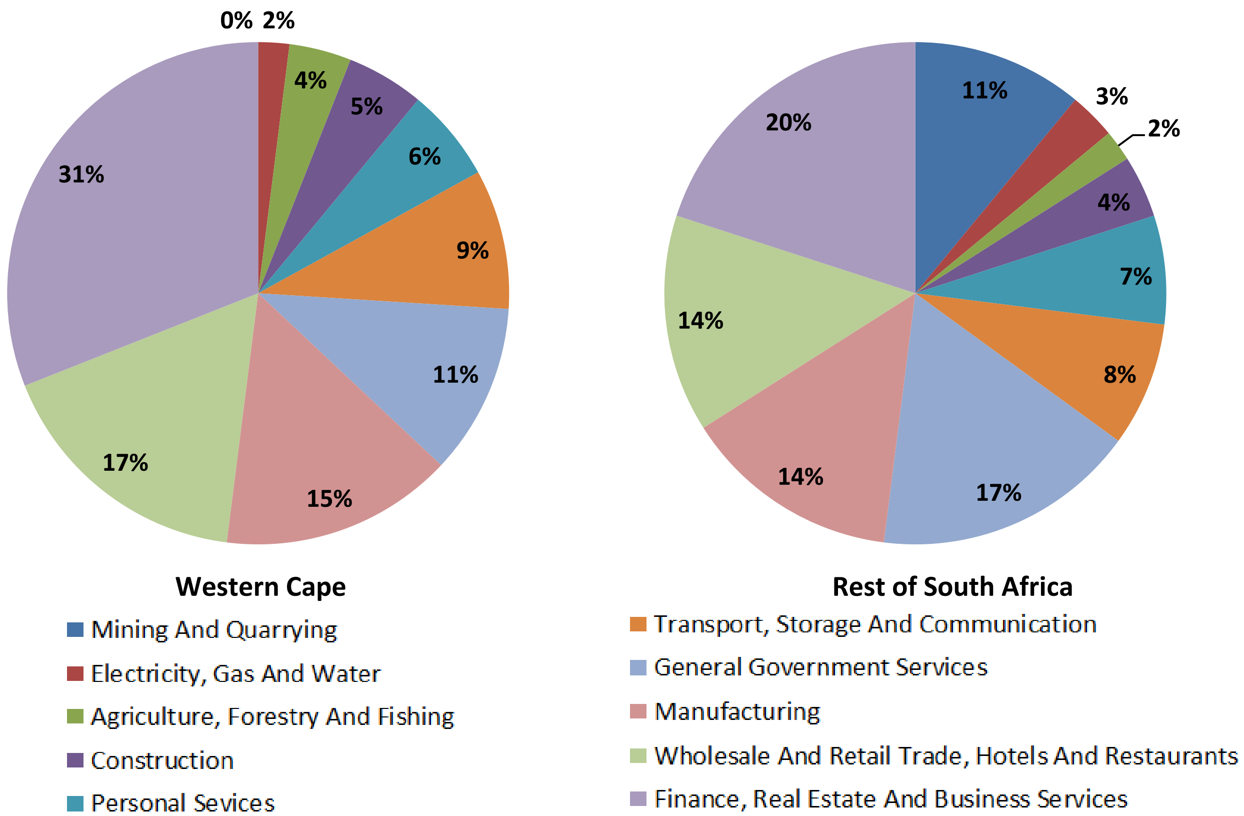


Figure 6: Structure of the Western Cape and South African economies (WCG 2012)

Table 4: Real regional GDP and employment trends by District – 2010 (WCG 2012)

District	2010 GDP (% share)
City of Cape Town	73.6
Cape Winelands	11.4
Eden	7.3
West Coast	4.2
Overberg	2.9
Central Karoo	0.6

3.5.2 Growth potential of urban areas outside Cape Town

In support of the Provincial Spatial Development Framework, the Province commissioned a Growth Potential study in 2010 (WCG 2010). This study looked at the characterisation of towns outside the City of Cape Town, in order to identify growth opportunities and development needs in the 131 smaller settlements of the province. There is a great diversity in the character and potential of the various towns, with some showing strong growth whilst others are stagnating, or some being primarily residential and other strongly focussed on a particular industry. The results of the 2010 study largely confirmed the findings of a similar study conducted for 2004 with half the towns remaining in the same category, 40 improving and 24 declining in potential.

The 2010 results show that six settlements can be classified as having a very high development potential. These are George, Oudtshoorn, Paarl, Stellenbosch, Vredenburg and Worcester. Twenty others fall in the high development potential category and 45 in the medium development potential category (stable settlements). Forty-eight of the remaining settlements have low development potential and 12 very low potential (struggling settlements). The geographic location of the different development locations are shown in Figure 7.

In terms of functional role, or overriding identity, it can be seen that tourism and fisheries are located along the coast, with agriculture being evenly spread throughout the Districts. Various small towns have managed to carve out a multi-purpose or niche identity, which necessarily helps in maintaining viability.

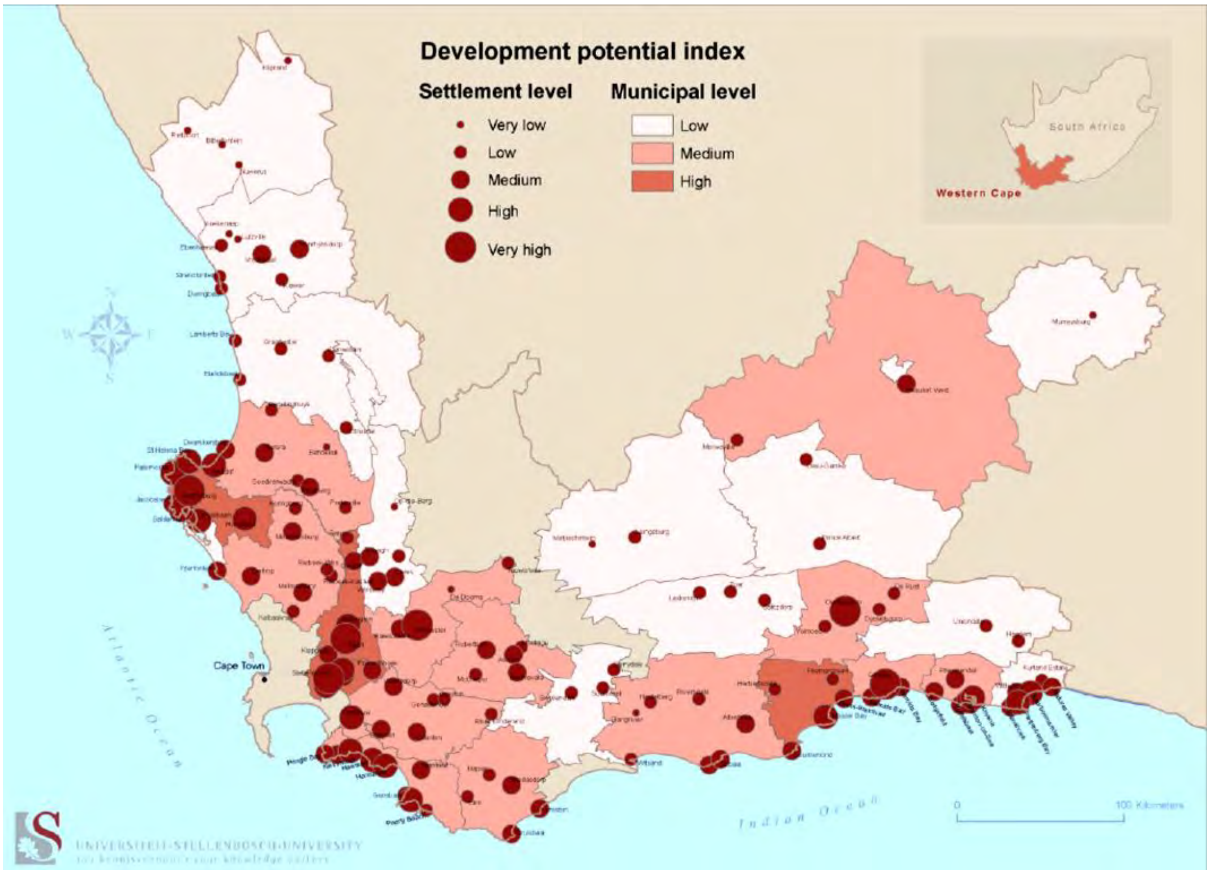


Figure 7: Development potential index (WCG 2010)

From the analysis of function (WCG 2010) the following points are notable:

- Regional centres generally have high levels of development potential and comparatively lower social needs.
- Agricultural service centres mostly achieved low scores on the composite development potential index and are characterised by medium to high values on the social needs index.
- The fishing/industrial settlements are generally classified as having medium to high levels of development potential, and medium levels of social needs.

- The social needs of the residential settlements are mainly within the high to very high range, and with low to medium levels of development potential.
- The tourism settlements have a wide range of development potential, ranging from low to high and are generally characterised by low or very low levels of social needs.

4 OVERVIEW OF KNOWN DRIVERS AND PRESSURES

The environment that we live in is in a constant state of flux, yet maintains an overall level of equilibrium with different components generally contributing to a steady state. However, humans have the ability to influence the balance, and introduce elements and forces into the natural system that throw things into disarray. These forces are described as either drivers or pressures in state of environment reporting.

Drivers, or the primary agents determining change in the environment, are those aspects that determine the extent to which human activities influence the environment. Pressures, on the other hand, refer to actual activities or interaction between humans and the environment.

The most common and obvious primary agent driving change in the environment is human population growth and migration, which is closely tied to changes in consumption patterns.

Drivers translate into the need to supply increasing quantities of energy in the form of fuel and electricity; increased harvesting of resources including mining; resource consumption and the rate thereof and pollution in the form of greenhouse gas (GHG) emissions, effluent discharge and solid waste. These affect the state of environmental variables directly and are referred to as 'pressures'.

4.1 Primary drivers

4.1.1 Population & consumption

The number of individuals dependent on the environment inevitably places pressure on the resources offered by the environment and on the quality of the human living environment. The impact on the environment is not necessarily directly related to the number of individuals though. Population dynamics such as residential density, household character, population age structure, socio-economic welfare and cultural affiliations all contribute or detract from the overall impact.

As reported earlier in this chapter, there are close to 6 million people residing in the Western Cape, and this number is increasing at a rate of 2.5% due to both a positive growth rate and the effect of a positive in-migration from other provinces and other countries (StatsSA 2012d). This positive growth has increased the pressure on the environment simply to provide for the basic needs of the people, to accommodate people in space and to process their waste products.

Most households have access to basic services as well as a radio, television, refrigerator, landline telephone and at least one cellular telephone (StatsSA 2012d). At the same time the province has a dependency ratio of 0.45, and an unemployment rate around 30%. The Gini Coefficient for the Western Cape is at a high 0.63, which is lower than the South African average, but still ranks effectively as one of the most unequal societies in the World (WCG 2012). Most social indicators are on the rise, however.

The social indicators paint a picture of a slowly maturing society. This means that the adult portion of the population is growing in size, which brings about a corresponding growth in the demand for material goods. It is also at the stage of formal employment that dependence on transport increases. These escalations in consumption, combined with a growing absolute number of people imply that increasing and unrelenting pressure will be placed on the environment unless patterns of consumption change. Ultimately, a lower per capita impact will be required in order to slow down the pace of consumptive growth to a steady state before it overreaches sustainable levels.

4.1.2 Governance

Governance refers to the practice of using authoritative structures to determine strategic direction and regulate practice in society. Good governance will involve governmental and non-governmental partners creating an economically and environmentally sustainable social and developmental state. It follows that environmental governance, as a subset, involves the responsible management of environmental assets and resources on behalf of society.

Policies, strategies, regulatory controls etc. that are produced and implemented by governance structures determine much of how societies operate, and consequently have material impacts on the pressures that are exerted on the natural environment. Importantly, this influence extends to many aspects of governance that are not necessarily directly related to environmental aspects. Social welfare interventions, for example, can influence the need for self-reliance in communities or households, and consequently the pressures placed on natural resources.

Governance functions that are, however, naturally more important to environmental management include sectors related to Environmental Management or direct exploitation of natural resources, Social Services, Infrastructure Development, Spatial Planning and the different economic sectors. The strategic direction, relative socio-political value, and perceived importance to social stability and economic progress determine how much conservation and protection will be afforded to the ecosystem services derived from the natural environment and how sustainable the levels of exploitation will be.

It is therefore important to recognise governance in State of Environment reporting as a key determinant of environmental change.

4.1.1 Natural forces

Some basic forces of nature or natural processes have the ability to drive changes in the environment we live in. These include climate change, extreme events and natural events of global significance.

Extreme events such as large storms, pest outbreaks or earthquakes can also lead to large-scale changes in the environment. These events can lead to changes in the productivity of the land and water, or render particular areas unsuitable for specific purposes. It might also result in indirect effects on unaffected areas through the displacement of people.

4.1.2 Climate change

Climate change has been occurring as a natural phenomenon over millennia, and we have evidence of various climate change cycles occurring such as ice ages and relative warmer periods. Most cycles take place on geological time scales (millions of years) and are therefore not important on human time scales (decades). Anthropogenic (human) forcing of the earth's climate system during the past 50 years or so has now led to an accelerated climatic change towards a warmer global atmosphere. It can be considered as an indirect driver of change since the anthropogenic forcing and human adaptation to climate change are both completely dependent on systems of governance and societal responses.

4.2 Pressures

Pressures on the environment can be seen as the activities that take place where drivers of change interact with environmental components. In the Western Cape, some of the most significant pressures are economic activities such as agriculture and industry that involve a range of other resource hungry activities, such as transportation, which drives changes to the environment such as changes in land cover or increases in pollution.

4.2.1 Economic activities

The economic activities in the Western Cape Province lead to various effects and levels of pressure on the environment. Whilst agriculture is inherently space intensive and much of it dependent on artificial irrigation and chemicals, tourism leaves its environmental mark in the form of consumables, energy use and transportation. It is therefore necessary to carefully look at the different sectors when considering the impacts that they have on the different environmental components evaluated for the State of Environment Outlook Report. Particular aspects to consider in terms of economic activities are:

- Energy dependencies in terms of amounts, sources and scope for changes in consumption patterns
- Transportation dependencies in terms of transport mode, cost-effectiveness and relative locations between the source and destination
- Waste products and opportunities for diverting waste from the waste stream
- Space and location dependencies in terms of where resources are located and how extensively they need to be exploited

4.2.2 Overexploitation

Overexploitation refers to the utilisation or exploitation of a resource to the point where diminishing returns are obtained from the same level of effort. This means that a resource has been exploited at unsustainable levels for long enough that the demand outstrips supply and is affecting the ability of the resource to regain positive rates of regeneration. Just about every renewable natural resource has levels of regeneration which, if overexploited, will lead to a depletion of the resource. Typically, this will also have knock-on or cumulative effects on components of the natural system that are directly dependent on the dwindling resource. Once overexploited, recovery rates are usually lower than at normal regeneration rates due to the high vulnerability of the remaining resource stock.

4.2.3 Land (habitat) transformation

Transformation of land has many impacts on the environment – it replaces natural systems, changes microclimates, fragments habitats, affects surface runoff, etc., and depending on the nature of the introduced land use will also bring about land use specific impacts. The two leading forms of land transformation are urbanisation and agriculture, although the natural processes of deforestation and desertification may also be accelerated or introduced artificially.

Urbanisation is generally bad for the environment, since it creates a virtually completely artificial land surface, often replacing or modifying functional natural systems and creates a concentration of humans that cannot be sustained from within the boundaries of the urban area. Nevertheless, the urban environment can offer good opportunities to satisfy human needs in an efficient manner through the application of economies of scale. Appropriately designed urban areas can therefore accommodate a high number of people at a high density, which makes the provision of transport and other services, and the organised distribution of commodities more efficient than similar systems in a distributed rural setting.

Rural activities can also lead to environmental impacts. Cultivation agriculture tends to replace natural habitat with single crops, which undermines the functioning of natural ecosystem processes and creates opportunities for pests and diseases to multiply in the absence of natural controls. Typically, the alteration of the natural species composition necessitates a reliance on agricultural chemicals which further compromises natural ecosystem functions and have the potential to accumulate in food chains. Agriculture may also involve irrigation, which diverts water from either surface resources or groundwater aquifers.

4.2.4 Marine resources

As with most coastal areas, human activities in the Western Cape tend to concentrate along the coastline. This also concentrates a wide range of human activities that inevitably places strain on marine resources and ecosystems. These activities take place on land and in the ocean, and are both consumptive, such as fisheries, and non-consumptive, such as tourism. Along with the significant land use change through urbanisation or physical development, the coastal activities tend to exploit resources at or beyond their rates of replenishment and may result in high levels of pollution and disturbance of the natural equilibrium.

The effects on coastal resources can be seen in declining marine resources stocks, changes to marine species assemblages, water pollution and alteration of the natural coastal processes such as alongshore sand transportation.

4.2.5 Invasive species

The spread of invasive species can be seen on land, in surface water, as well as in marine systems. This happens wherever the natural balance of an ecosystem has been compromised, either through the lowering of the natural ability to absorb or accommodate changes or shocks or through the introduction of an element that has no natural control mechanisms present. The invasion will typically cause progressive supplanting of biotic diversity and other negative effects such as decreased groundwater availability. Invasive alien trees and shrubs, for example, are blamed for excessive water use, reduced agricultural productivity, soil erosion, increased fire risk and compromised functioning of natural systems. The control of invasive species is cost and time intensive, which restricts the availability of financial resources for other applications.

4.2.6 Pollution

Pollution, or the unacceptable accumulation of substances in certain locations, is a typical consequence of the concentration of humans. Human activities generate waste as by-products of resource extraction, materials processing, goods transportation and consumables use, and ultimately through the disposal of waste products. This accumulation of waste tends to affect the state of the environment where accumulation is faster than the rate at which natural systems can break down the contaminants. Polluted environments have lower or even no naturally functional ecosystems present, and therefore lose productivity and ability to provide ecosystem services on which humans rely e.g. flood water retention.

5 A SUSTAINABLE SOCIETY

5.1 Human needs vs. human wants

At the heart of the sustainability philosophy lies the idea that ecosystem services, such as natural water filtration, generation of biomass and food etc., represents a basic foundation for both economic activities and social welfare. Conversely though, how well society protects the integrity of the natural environment is dependent on the 'health' or level of functionality of the social and economic systems since it has been shown that desperate societies place environmental protection last on the list of priorities.

The National Strategy for Sustainable Development (NSSD) conceptualises the concept of sustainability as a nested model, with the natural environment, social context and economic activities as overlapping spheres, underpinned by a governance system (shown below) (DEA 2011). This conceptualisation recognises the interdependence between the three main spheres, and importantly, the fact that a compromise of any one sphere will impact on the others.

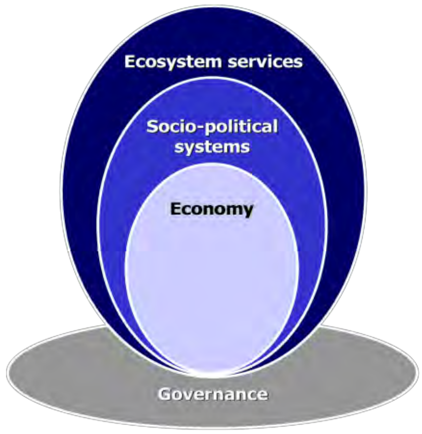


Figure 8: Sustainable development as a nested model

It is important that the three components of 'sustainability' should not be seen as being in conflict over the same resources or spaces. Because of the interdependencies between the components – each sphere being dependent on the *full extent and functionality* of the others – trade-offs between the spheres are not possible. Trade-offs will result in compromised functionality of particular spheres, with subsequent detrimental knock-on effects in the other spheres. Instead, sustainability should be seen as an operational space which does not exceed the capacities and capabilities of the natural environment, but which fully satisfies basic human needs at the same time.

Oxfam (Raworth 2012) dubbed this ideal operational space the 'sustainability doughnut'. It is shown graphically in Figure 9. On the inside, a social foundation is depicted as the outside ring of a radar graph. The idea is that each dimension needs to be fully satisfied to the social foundation threshold before humanity can consider itself socially sustainable and in a position to look after the natural environment. Another radar graph is found behind the social dimensions. In contrast to the social measure though, performance on this chart must remain below the 'environmental ceiling' threshold. Once the threshold is crossed, sustainability is compromised from an environmental perspective.

The dimensions listed as components of the environmental ceiling are derived from work done on environmental planetary boundaries at the Stockholm Resilience Centre (Rockström *et al*., 2009). According to the studies, we have already exceeded the environmental ceiling for climate change, nitrogen cycles and biodiversity loss on a global scale (Figure 10).

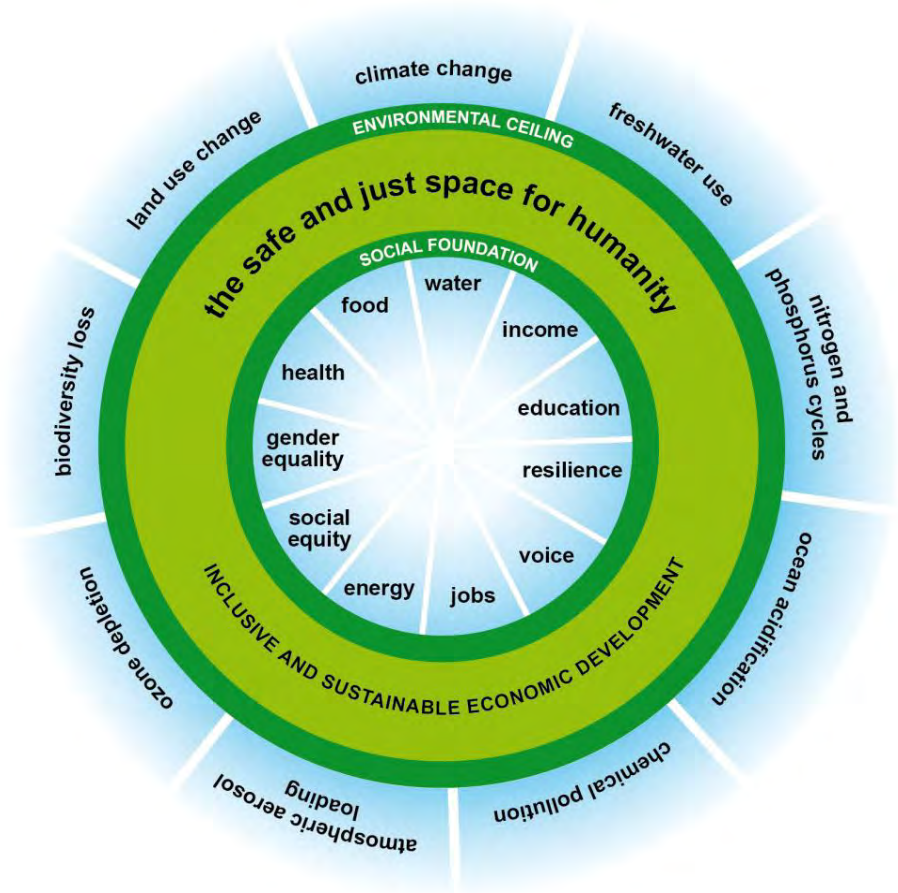


Figure 9: The Oxfam sustainability doughnut (Raworth, 2011)

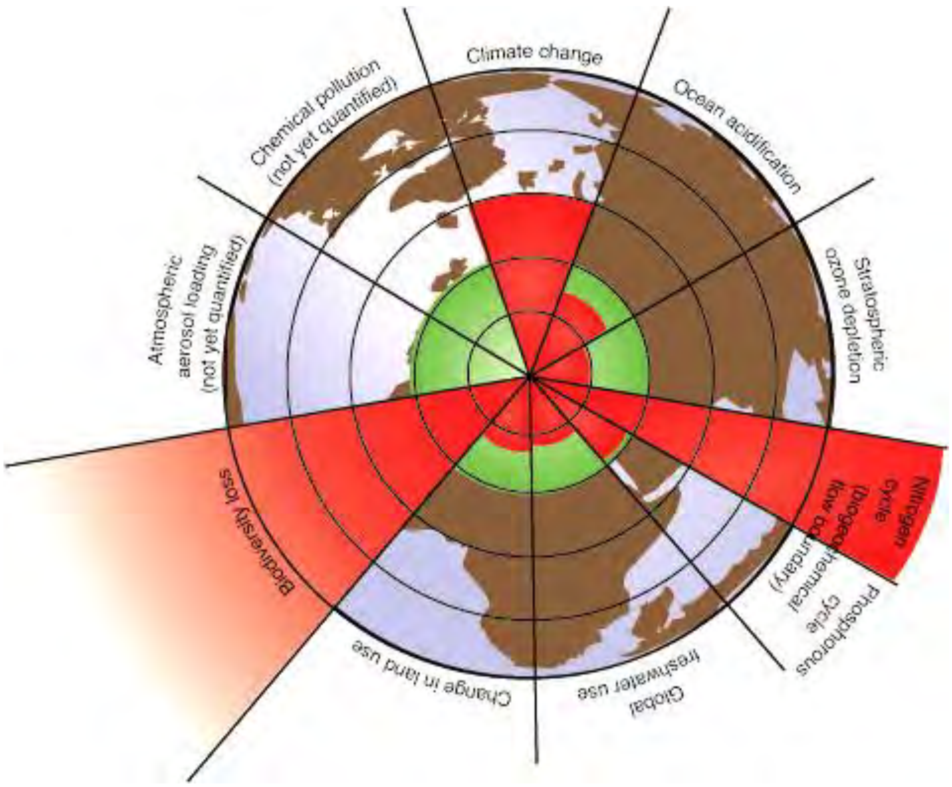


Figure 10: Global performance in terms of environmental planetary boundaries (Rockström *et al.*, 2009)

To ensure that development remains within the "sustainability doughnut", we have to decouple environmental deterioration from economic activity and population growth. Typically, an increase in population numbers or an increase in economic output tends to result in an increase in environmental compromise. However, if ways can be found to reduce per capita consumption or resource intensity, then the overall effect on the environment will not be directly related to human needs and wants. What seems to be required is a change in *how* we do things rather than *how much* we do. Opportunities for decoupling require new technologies (e.g. renewable energy), new methods (micro generation of electricity), new consumption patterns (shift to public transport) and less residual pollution (closed loop materialism).

Importantly though, it must be recognised that economic development does not equate to social welfare unless it is underpinned by environmental sustainability.

5.2 How does the State of Environment Outlook Report steer us towards sustainability?

Our knowledge of changes within the environment will enable us to better manage change effectively. Sustainable development is a broad and encompassing framework that recognises the interdependency of economic growth, social equity and environmental integrity. Achieving the goals of sustainable development can be difficult without a set of measures to understand progress towards these targets. State of Environment reports play a critical role in providing measurable indicators with information and trends that allows us to measure progress and successes on the path to sustainability.

The indicators used in this report are aligned with the national sustainability indicators which are in turn linked to the monitoring and evaluation framework for sustainable development contained within the National Strategy for Sustainable Development and Action Plan (NSSD) 2011-2014. Effective environmental governance will make use of these indicators and trends, as the trends show how well we are taking care of our environmental resources or how well the environment is coping with the pressures heaped on it.

The Western Cape Government includes sustainable development targets and indicators within its strategic development planning and operational targets. At municipal level, Councils should include the indicators within their annual service delivery budget implementation plans which are linked to Integrated Development Plans (IDPs). These sustainability targets may differ slightly as they are monitored on a quarterly basis with annual targets.

This report consequently provides a snapshot of the current state of the environment and analyses environmental trends present within the Western Cape.

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BETTER TOGETHER.

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1 INTRODUCTION

The Western Cape is the fourth largest province in South Africa (after the Northern Cape, Eastern Cape and Free State Provinces), comprising 10.6% of the country's total land area (or 129 462 square kilometres). The landscape of the province varies greatly, from large majestic mountains to mosaics of farmland in valleys, long fertile and developed coastlines and, further inland, the wide-open vistas of the semi-desert Karoo. The major land uses in the province includes urban areas (with the City of Cape Town forming the largest urban node), agriculture, industry, subsistence areas and large areas of natural landscapes, protected areas and coastal belts.

This chapter provides discussion on the issue of land use, spatial patterns of human activities, access to land resources and the dynamics that both shape land use and the value of land. The various pressures on land resources are considered, and the state of land as a resource described in terms of three indicators: land cover, land capability and land transformation. The chapter also considers that impacts of changes to the state of land resources, and identifies various responses to these impacts.

With the term 'land', it is understood that it refers to "*the terrestrial bio productive system that comprises soil, vegetation, other biota, and the ecological and hydrological processes that operate within the system*" (DEAT 2005). Land resources are under pressure from spatial development activities related to social, political, and environmental drivers. South Africa experiences population growth, increasing household numbers, high levels of migration and urbanisation which are all driving changes to rural and urban environments (see Human Settlements Chapter for details). In addition, many of the issues surrounding land and land use also emanate from the past inequitable access to land and unsustainable land use practices. Agricultural productivity is also closely linked to environmental factors, including soil quality and water availability.

The importance of land

"Land in Africa is used for many activities: agriculture and forestry; urban expansion and infrastructural development including transportation; mining and oil extraction; tourism and recreation; and also as a sink for domestic and industrial waste. It is critical in the cradle-to-grave cycle of both living and non-living things, providing habitats and other ecological goods and- services, sustaining investment and human livelihoods, and absorbing solid and liquid waste, pollutants and pesticides.

Land is critical to all aspects of human well-being. It provides material resources for livelihoods, food and health, provides security against environmental shocks and future uncertainties, and underlies many social and cultural systems. Access to land and the resources it offers is at the core of enhancing opportunities and choices, particularly for those who depend more directly on it" (UNEP 2006).

An analysis of spatial patterns and issues related to land in the Western Cape Province has to recognise the defined topographical elements that shape land use in the province. Notably, the Western Cape consists of a series of distinct landscapes (Figure 1):

- A long, rugged and scenic coastline;
- Fertile coastal plains (the West Coast, Agulhas Plain and Southern Cape);
- A spine of mountains (Franschoekberg, Witzenberg and Cederberg and the Riviersonderend, Outeniqua and Swartberg Mountains, containing river valleys such as the Bitou, Hex, and Breede Valleys, Gamkaskloof, the Little Karoo and the Langkloof) ;
- A series of inland plains (the Tankwa Karoo and Great Karoo);
- A second range of mountains (the Bokkeveld, Roggeveld and Nuweveld Mountains); and
- Great plains extending into the northern cape province.

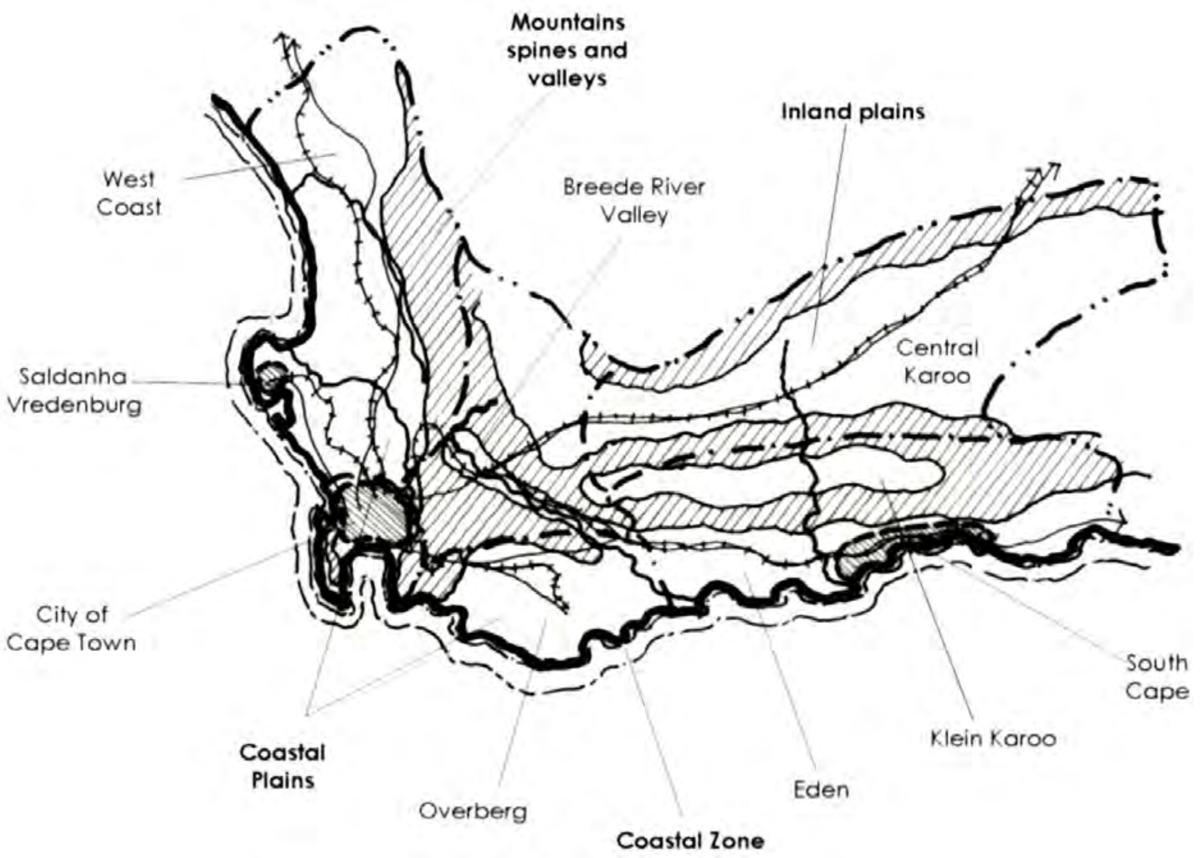

Figure 1: Spatial synthesis of the Western Cape Province showing how the infrastructure network is shaped by the landscape (WCG 2009)

The major land uses in the Western Cape are agriculture (including cultivated areas, grazing and plantations), urban areas, wetlands and natural areas. Most of the larger urban areas are located close to the coastal areas and near agricultural resources. As one moves inland settlements become smaller and more isolated as the land becomes less productive.

2 PRESSURES

For land resources in the Western Cape, there are three main drivers of environmental change, namely an increasing population especially along the coast, inappropriate development in and around sensitive areas as well as habitat destruction, which leads to erosion and loss of the aesthetic value of land. Three key pressures on land are (Gibson *et al.* 2005):

- Land use and productivity, which includes:
    - Land use and land transformation
    - Intensification of land use
    - Agricultural production systems
- Access to land and land rights
- Land degradation and desertification

Besides complications from global climate change that impact on the resource value to be derived from land, these pressures all relate to human activities that take spatial form.

2.1 Infrastructure development

Land cover maps and remote sensing images clearly show how development in the Western Cape is concentrated in the coastal areas and within the productive agricultural areas. Major infrastructure development has subsequently been developed in these areas of high economic development opportunity.

The primary area of opportunity, and which also has the highest levels of social problems including massive housing backlogs, crime, unemployment and ill-health, is the City of Cape Town. The city is beginning to experience resource constraints, especially with regard to water and to a lesser extent electricity, sewage treatment, and solid waste disposal. It’s inefficient low density urban structure, coupled with a decline in road and especially rail public transport services, also leads to longer and longer congested peak hours. The western part of the Winelands district, especially the towns of Paarl, Wellington and Stellenbosch, function as part of the Cape Town metropolis and enjoy similar location advantages with regard to access to the airport and the metropolitan freeway system.

Saldanha Bay and adjacent towns to the north of Cape Town are situated around one of the largest natural harbours in the world and large port development plans are being implemented with the aim to broaden the industrial base and host a number of smaller scale downstream industries. This industrial development potential contrasts strongly with Saldanha Bay's location at the mouth of the Langebaan wetland and lagoon system that is of international significance. Extremely sensitive planning will be required to ensure that industrial development does not degrade the marine and coastal systems. Such planning should also address the urban sprawl that is enveloping the Cape Columbine and Britannia Bay Peninsula (WCG 2009).

Another development area is the Southern Cape region of Mossel Bay, George, Knysna and Plettenberg Bay. This region's economy is relatively well diversified, with some significant industrial activity in George and Mossel Bay and a strong tourism and construction sector along the coast. The latter is mainly driven by exclusive residential developments such as golf and polo estates, or other large construction projects related to influx of better-off segments of society. However, the economy is also rather fragile in that much of it is seasonal, based on agriculture, tourism and holiday homes. The region attracts a similar broad cross section of migrants as Cape Town, with migrants being attracted by its scenery, its perceived small-town friendliness and the mild climate. It is also the closest area of urban opportunity for job seekers from the Eastern Cape.

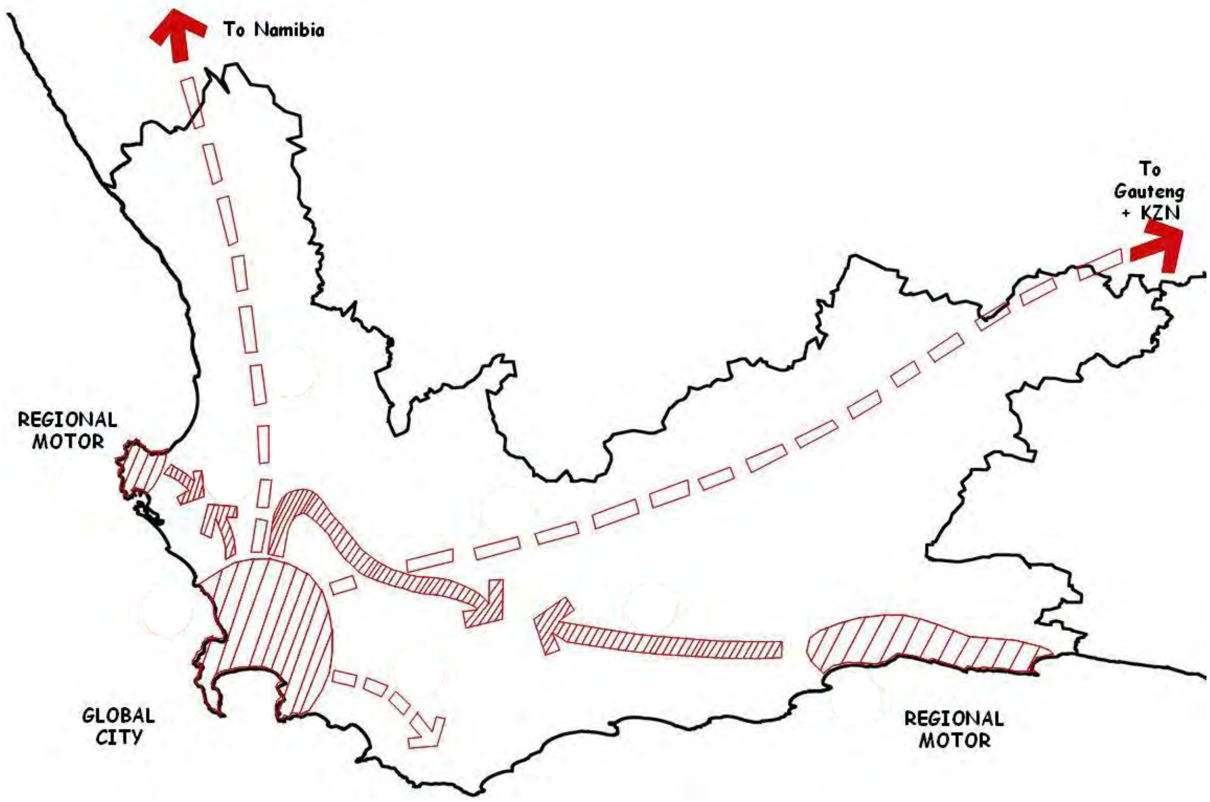

Figure 2: Patterns of economic development and major infrastructure. Hatched areas indicate development nodes and arrows show the main movement routes (adapted from WCG 2009)

2.2 Urban development

Despite a strong agricultural focus, the Western Cape is one of the most urbanised provinces within South Africa, with a rapidly growing population which places strain on resources in the province. The four major productive sectors within the Western Cape are agriculture, manufacturing, finance and tourism. Cape Town is a major city that is both a tourist destination and has the reputation of having a high quality of living which attracts many migrants, especially from the Eastern and Northern Cape (WCG 2009). Valuable land that may be used for agriculture and protection of ecological processes are consequently being fragmented and transformed in order to accommodate growth within the province.

Urban development and pressures for urban expansion are currently concentrated in the coastal areas of the Western Cape. As the landscape becomes more arid towards the interior town sizes tend to decrease. Most human activities in the Western Cape occur within the moist grasslands and mountain valley areas where the land is used for supporting economic activities, like agriculture.

More than 90% of the Western Cape population is already highly urbanised, with continued pressure for urban-rural migration as well as in-migration from other provinces (WCG 2009). The population of the Province continues to grow, and household numbers are increasing and household sizes decrease (See Human Settlements chapter for details). This creates pressure on land resources as more land is transformed for urban use. Although Cape Town experiences the most pressure, the Eden, Overberg and Saldanha Bay areas are also under increasing pressure.

From an analysis conducted as part of the "Growth Potential of Towns in the Western Cape" study (DEADP 2010), the following functional differentiation between towns is apparent in the province:

Table 1: Functional classification of settlements in the Western Cape (after DEADP 2010)

Function Classification	Settlements
Urban core	Cape Town
Agricultural service centre	Albertinia, Ashton, Aurora, Barrydale, Bitterfontein, Bonnievale, Botrivier, Caledon, Calitzdorp, Ceres, Citrusdal, Clanwilliam, Darling, De Doorns, Eendekuil, Gouda, Graafwater, Grabouw, Heidelberg, Herbertsdale, Hopefield, Klawer, Ladismith, Laingsburg, Lutzville, Merweville, Moorreesburg, Murraysburg, Nuwerus, Piketberg, Porterville, Rawsonville, Redelinghuys, Riversdale, Riviersonderend, Robertson, Uniondale, Vanrhynsdorp, Villiersdorp, Volmoed, Vredendal, Wellington, Wolseley
Agricultural service centre/Tourism	Franschhoek, Prince Albert, Riebeek-Wes, Swellendam, Tulbagh,
Fishing/Industrial	Saldanha
Fishing/Residential	Hawston, St Helena Bay
Fishing/Tourism	Elandsbaai, Gansbaai, Lamberts Bay, Velddrift
Regional centre	Beaufort West, Bredasdorp, George, Hermanus, Malmesbury, Mossel Bay, Oudtshoorn, Paarl, Stellenbosch, Vredenburg, Worcester
Residential	Dysselsdorp, Ebenhaeser, Friemersheim, Goedverwacht, Haarlem, Jamestown, Kalbaskraal, Klapmuts, Kliprand, Koekenaap, Koringberg, Kranshoek, Kurland, Kylemore, Leeu Gamka, Op-die-Berg, Pniel, Prince Alfred Hamlet, Rheenendal, Rietpoort, Saron, Slangrivier, Struisbaai, Suurbraak, Touwsrivier, Wittedrift, Zoar
Residential/Tourism	Doringbaai, Elim, Genadendal, Greyton, Groot Brakrivier, Herolds Bay, McGregor, Montagu, Napier, Riebeek-Kasteel, Sedgefield, Stanford, Stilbaai, Wilderness
Tourism	Arniston, Betty's Bay, Brenton-on-Sea, Buffelsbaai, De Rust, Dwarskersbos, Franskraalstrand, Gouritsmond, Jacobsbaai, Jongensfontein, Keurboomsrivier, Kleinmond, Knysna, Langebaan, Matjiesfontein, Nature's Valley, Onrus, Paternoster, Pearly Beach, Plettenberg Bay, Pringle Bay, Strandfontein, Witsand, Yzerfontein

2.3 Agriculture

"Agriculture comprises crops, livestock and the utilisation of forestry and fishery resources and encompasses the production of food, fibre and related products" (StatsSA 2012). The Western Cape has nearly 20% of its land area under agriculture and produces between 55% and 60% of South Africa's agricultural exports (StatsSA 2007). The sector supports almost 10 000 farms and employs a quarter of a million people. The contribution of the Western Cape to South African commercial agriculture is calculated by StatsSA (2007) to be 21.4%.

The combined contribution of agriculture and fishing to the gross regional domestic product (GRDP) of the Western Cape is just under 5%, but these sectors continue to be important from spatial extent and job creation points of view. While the cultivation and export of fruit and vegetables form a major part of the economy, steps are being taken to add more value to the products before exporting them.

Agriculture is the greatest land use (2.5 million ha) in the province, with 43% of the agriculture used for animal production and 36% for croplands. According to the 2005 Western Cape State of Environment Report (DEADP 2005) most of the land under cultivation was not suitable for agriculture, which emphasises the need for effective land management plans and the utilisation of land capability maps for the province.

Overall, croplands have decreased in the Karoo and increased in the western region where vineyards have flourished in the Southern Cape and the West Coast. The precipitation of the region is a restricting factor to agriculture, whilst the diversity of soils within the region determines the types of crop that can be grown. It is important that the right crop is grown on the right soils so to conserve the soil and to reduce the pressure on water resources (DEADP 2012).

Assessing agricultural potential, or determining the land most suitable for agricultural use, is extremely complex in the Western Cape where farming practices are possible in certain areas which have productive values that are not commonly defined by concepts of agricultural potential (for example Agricultural Resource Council land capability data). Examples include "boutique" vineyards on steep slopes & rocky soils, which would most certainly be classified as low potential agricultural areas in a traditional sense, yet yield a very high value product. Also, some of the most prized wheat fields in the Overberg are located on very shallow, stony soils, yet their yields are well above the predictions of any land capability assessment. The Karoo has little or no potential for grain cropping, yet has considerable potential for extensive sheep farming.

Forestry accounts for a small portion of the provincial economic land use. Approximately 88 000ha of forest plantations, predominately commercial in nature, are spread within the lowland catchments with numerous small commercial plantations located in the mountainous regions where areas of higher precipitation (>800mm) occur. The largest plantation is situated within the Palmiet catchment in the western Overberg region of the Breede Water Management Area (WMA) and has an approximate area of 3 300 ha. According to the Berg, Breede, Gouritz and Olifants-Doorn Internal Strategic Perspectives (DWA 2005a and 2005b) an estimated reduction of 28 million m^3/annum of water is estimated to be due to forestry activities.

There are a number of options available for forestry plantations once they have been decommissioned. These areas can be used for farming if there is still value in the soils, but the most appropriate form of cultivation will need to be determined. Considering that the forestry areas are typically located in mountainous areas, the potential future land use must also ensure that there are no negative impacts experienced in downstream catchments. The Inland Water chapter of this report contains further details on catchments and water management in the Western Cape.

2.4 Access to land

The dispossession and forced removal of people prior to 1994 has resulted in large inequities in access to land and resources, as well as insecurity of tenure for a large proportion of the population, particularly in agricultural and rural areas. There are social, economic, and environmental consequences to this inequity (Gibson *et al*. 2005). These include:

- Continued pressure on resources including soil productivity and biodiversity, where unsustainable land use practices, lack of basic services like electricity and sanitation facilities are contributing to increased land degradation and desertification.

- On private farms, workers and their families face continued tenure insecurity and lack of basic services.
- Increasing urbanization leads to the expansion of informal settlements that are characterised by poverty, crime and a lack of basic services.

Land restitution involves returning land, or providing compensation, to those who were dispossessed after the passing of the 1913 Land Act. Approximately 17 000 claims were lodged in the Western Cape and these are dealt with by the Land Claims Court and Commission (Restitution of Land Rights Act, Act 22 of 1994). Land restitution for the Western Cape peaked in 2007 with a cumulative total of approximately 15 500 claims settled. Between 2008 and 2012 a further 286 cases were settled (DRDLR 2013).

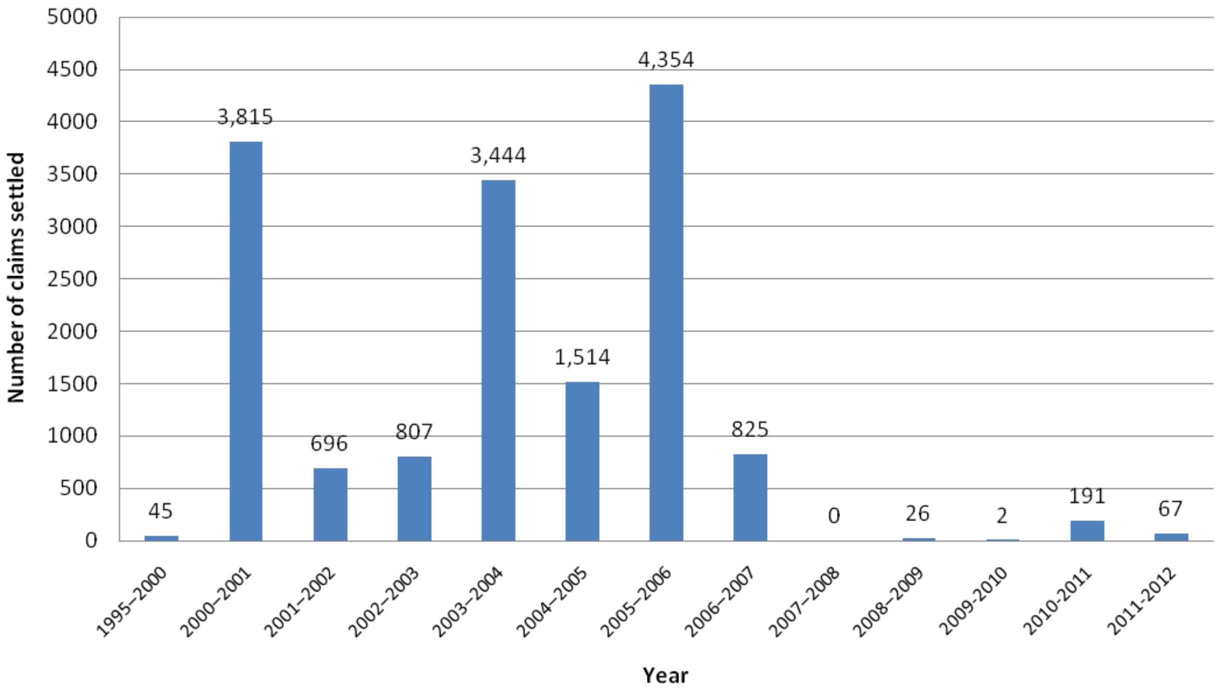

Figure 3: Restitution claims settled in the Western Cape, 2000–2012 (DRDLR 2013)

Even with the number of land restitution claims completed, the land reform programme has had a limited impact on land redistribution, securing of tenure rights, reducing poverty and developing financially viable agrarian enterprises (Gibson *et al*. 2005). Land redistribution and land reform have to work in tandem to enhance rural livelihoods by relieving the pressure on land in communal areas and enhancing the flow of benefits from under-utilized land.

2.5 Mineral resources

The Western Cape has limited mineral resources when compared to the gold and platinum rich provinces in the north east of South Africa. However, the province has rich limestone and dolomite resources which are used for cement manufacture, quicklime, hydrated lime, paper coating, water purification, acidity control, chemical manufacture, metallurgical flux, glass flux, agricultural lime, animal feed and stone aggregate (Council for Geoscience 2013). There are currently about 200 mining operations at varying scales operating within the region. Elements that are actively mined include diamond, sand, gypsum, cement, limestone, salt, gravel, clay, stone and oil offshore. The locations of the various mineral resources are indicated in Figure 4.

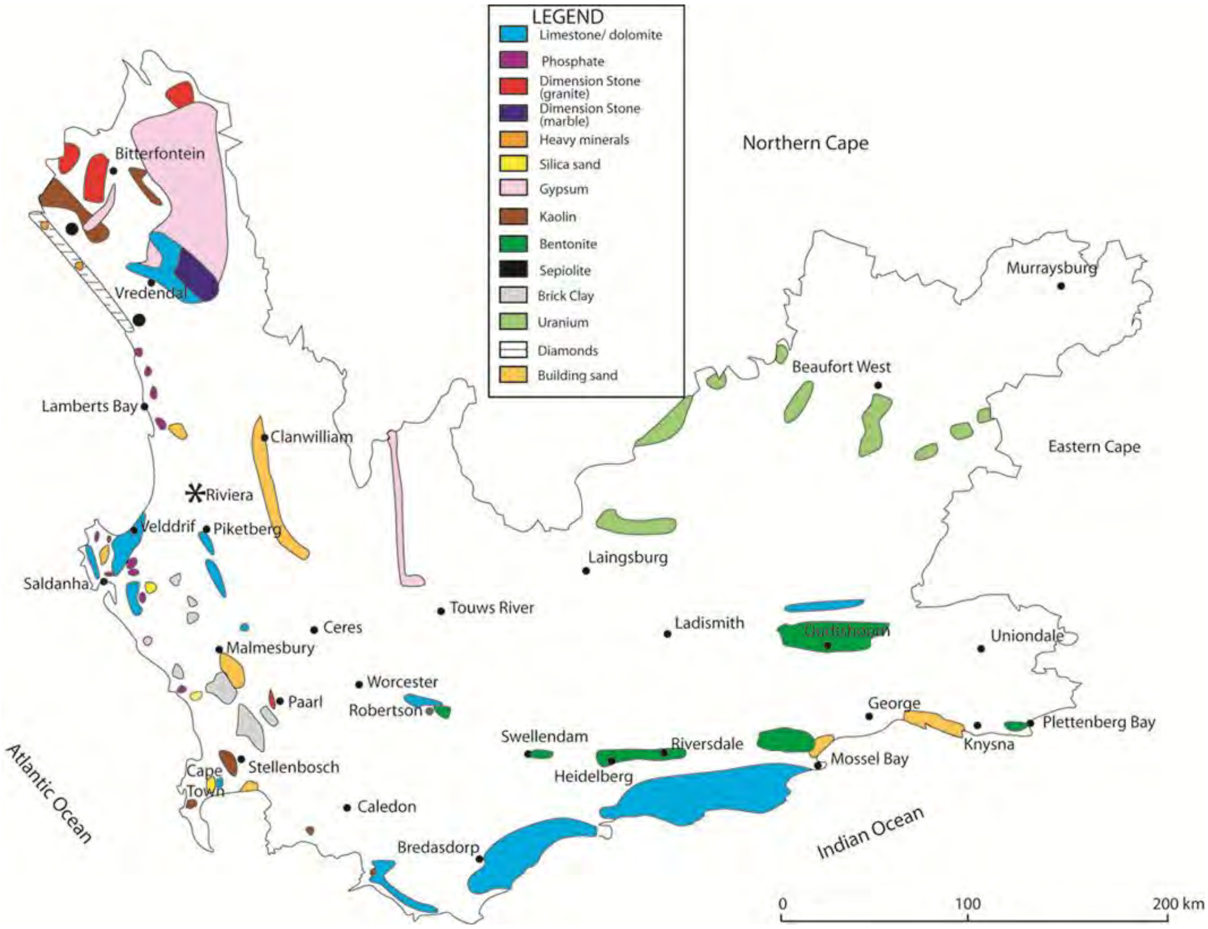

Figure 4: Location of mineral resources in the Western Cape (Council for Geoscience 2013)

Diamonds are present in the north western part of the province and are mined from shoreline and sea-floor placers along the coastline north of Doring Bay. Karoo Uranium deposits extend into the Western Cape northeast of Laingsburg, and while the deposits have not been exploited, an increasing uranium price is resulting in some exploration and there is a potential for economic development. Illegal sand mining is an emerging issue within the province which is a response to construction pressures (Council for Geoscience 2013).

Recent off-shore oil and gas resource finds along the West Coast District are likely to increase the contribution of mining to the economy in the Western Cape. The resources are to be piped onshore to Saldanha and then onwards to Cape Town (DEADP 2007). Existing offshore oil and gas extraction takes place off the Mossel Bay coast.

Large shale gas deposits discovered in the Karoo have caused a great deal of debate on how and where mining of these reserves may take place. Shale gas is a natural gas found in underground shale deposits which underlie large areas of the Karoo. A number of companies have been given permission through Technical Cooperation Permits to explore for gas and some of these areas fall within the Western Cape.

Sand mining has an effect on a number of environmental attributes; it impacts not only on water resources but also soil stability and yield. The mining operations are concentrated along the West Coast and along the False Bay dunefields in the City of Cape Town. Mining of heavy metals is also present in the West Coast, and has to be managed delicately and stringently to protect topsoil and water resources in an already marginal environment.

Mining is likely to increase in the Western Cape in the future. Of the land use change applications that CapeNature have commented on since 2009, 12% have been for mining activities (CapeNature 2012). Most of the applications for mining and prospecting are located in the West Coast District Municipality and specifically in the Matzikama Local Municipality. Whilst mining is an important contributor to the South African economy, its relatively minor contribution to the economy of the Western Cape means that the environmental costs of mining can be large in terms of impacts such as land conversion and degradation, habitat conversion and water pollution when compared to the economic gains. This is an aspect of development that needs close monitoring in future.

2.6 Climate and rainfall

The Western Cape, and particularly areas towards the west of the province, has been identified as being particularly vulnerable to climate change; projections suggest that there will be a steady decline in rainfall with increased droughts and extreme events such as flooding and storms (WCG 2009). These events will increase the pressures on Land as it will be more susceptible to over-exploitation and erosion if not managed properly.

Land degradation is a critical environmental issue. It is intricately linked with issues of food security, poverty, urbanization, climate change, and biodiversity. A changing climate will most likely have a high effect where land is already degraded and compound the pressures already being experienced.

"Land use" vs. "land cover"

The terms Land Use and Land Cover are often confused, but there are differences. *Land use* refers to the purpose for which land may be developed or used in terms of a zoning scheme, and includes any conditions relating to such a land use. It refers to the socio-economic use to which land is put (for example commercial use, industrial or residential)

Land cover refers to the vegetation, configuration, or structures that cover the land (for example is the land covered by forest, natural vegetation, roads or water).

From a State of Environment perspective it is important to note that two land parcels may have a similar land use but a different land cover. For example, an industrial land use type may refer to a large warehouse or a smaller manufacturing building surrounded by landscaped areas. The later would have some land cover of grass or landscaping, while the former would only be built up.

3 STATE

The state of land is largely informed by how people have used and managed the land resources for various activities over time. Information on the current state of land resources is used to help inform decisions on spatial planning and how to allocate resources and activities within the landscape. This section deals with the state of land from an environmental perspective by looking at:

- Land cover
- Land capability (for agricultural purposes)
- Land transformation

3.1 Land cover

Land-cover change, which reflects an underlying change in land use, is an indicator for the condition of land and biodiversity. Changes in land use and land cover impacts on environmental quality and consequently also on the quality of life.

Figure 5 indicates that a vast amount of the Western Cape is still considered to be natural, with most human activity occurring along the coast. Urban land uses, especially, are present along the coastal areas, i.e. within the West Coast, Cape Winelands, Eden and Overberg Districts, but particularly in and around the City of Cape Town. Cultivation decreases as the landscape transitions from coastal plains into arid Karoo biomes. The other clearly visible land cover is plantations, especially towards the East of the province.

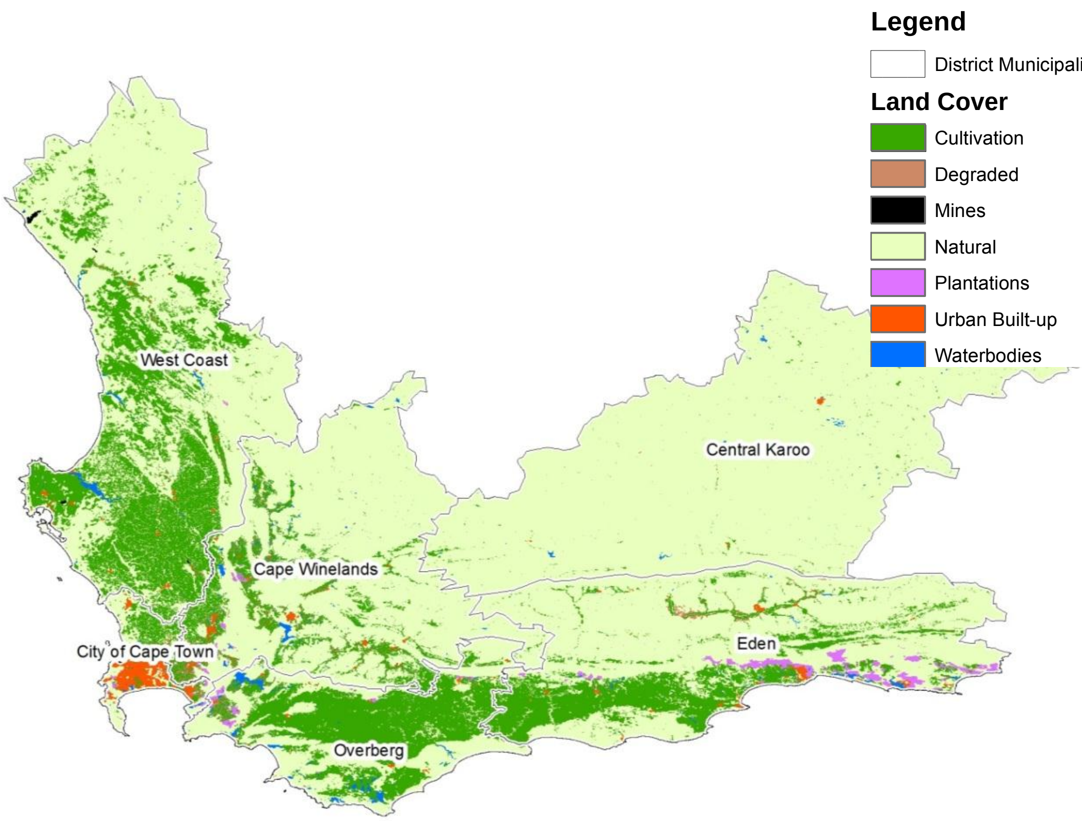

Figure 5: Summarised land cover for the Western Cape (SANBI 2009)

Patterns of land cover derived from the most recent land cover layer for South Africa (SANBI 2009) show that that over 21% of the Western Cape's landscape is transformed, mainly by cultivation (18.65%), urban areas (1.03%), forestry (0.69%) and degraded areas (0.65%) (Figure 6).

Table 2: Detailed land cover information for the Western Cape Province (SANBI 2009)

	Description	Cultivation	Degraded	Mines	Natural	Plantations	Urban Built-up	Water bodies	Total
City of Cape Town	Area (ha)	56 682.46	4 417.19	215.39	97 486.10	4 959.72	72 565.38	4 466.17	**240 792.40**
	%	23.5%	1.8%	0.1%	40.5%	2.1%	30.1%	1.9%	
West Coast	ha	963 971.33	8 500.58	4 710.22	2 100 960.42	503.80	11 304.71	20 390.37	**3 110 341.44**
	%	31.0%	0.3%	0.2%	67.5%	0.0%	0.4%	0.7%	
Cape Winelands	ha	303 832.23	42 959.36	24.09	1 835 593.15	9 156.80	15 261.26	24 674.43	**2 231 501.31**
	%	13.6%	1.9%	0.0%	82.3%	0.4%	0.7%	1.1%	
Overberg	ha	563 787.61	9 688.47	72.46	514 095.11	10 343.58	9 775.05	28 141.00	**1 135 903.29**
	%	49.6%	0.9%	0.0%	45.3%	0.9%	0.9%	2.5%	
Eden	ha	503 452.01	16 640.81		1 710 094.74	63 944.77	21 504.33	15 756.69	**2 331 393.35**
	%	21.6%	0.7%	0.0%	73.4%	2.7%	0.9%	0.7%	
Central Karoo	ha	20 151.30	1 421.34	47.72	3 853 763.71		2 301.89	9 299.38	**3 886 985.35**
	%	0.5%	0.0%	0.0%	99.1%	0.0%	0.1%	0.2%	
Western Cape	ha	2 411 876.94	83 627.75	5 069.89	10 111 993.23	88 908.67	132 712.63	102 728.04	**12 936 917.14**
	%	18.6%	0.6%	0.0%	78.2%	0.7%	1.0%	0.8%	

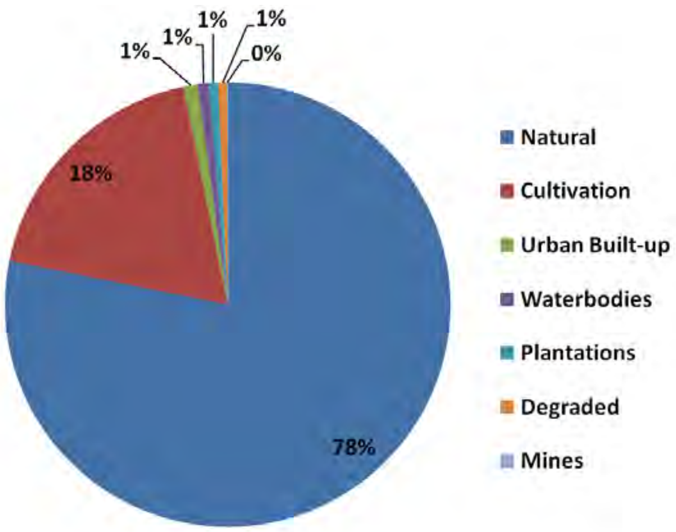

Figure 6: Land Cover type percentages for the Western Cape (SANBI 2009)

Table 2 summarises the key land cover types per district municipality. The 2005 Western Cape State of Environment Report (DEADP 2005) showed that in 1999 there was approximately 16.97% of the province under agriculture. According to the 2009 land cover layer produced by SANBI this figure has increased to 18.6% of the province. Most agricultural land is located within the Overberg and West Coast Municipal areas. The data unfortunately does not contain information on changes in productivity of the land under agriculture.

The land cover statistics provided in the table above are based on a national land cover layer generated by SANBI (2009) and is based on previously available land cover data. The data is fairly coarse and misses some of the important land activities within the Western Cape like grazing and rural settlements.

Trends in land cover change are difficult to assess due to low data availability and limitations of the available data. Three land cover layers are available for South Africa and can be extracted for the Western Cape. These data layers are from 1994/5, 2001 (CSIR) and 2009 (SANBI). The data layers cannot be accurately compared, as there are differences in the definitions of the land cover classes (including the number of classes) as well as differences in the data mapping scales. A finding from the previous Western Cape State of Environment Report was the need to source a land cover layer specific to the Western Cape to overcome many of these problems and to accurately map land transformation. The recommendation remains valid and should be a priority for data mapping.

3.2 Land Capability

Land Capability can be described as "*the fitness of a given tract of land to sustain a defined use; differences in the degree of capability are determined by the present state of associated attributes of the area in question*" (Schoeman *et al.* 2002). It specifically refers to the ability of given soil and contextual conditions to sustain productive agricultural cultivation. Land Capability is increasingly becoming a valuable tool in land use planning as many users of land have difficulty interpreting and understanding soil information. Land Capability is expressed as a map and is assessed using land capability classes, which indicates the best use for the land.

The main limiting factor to agricultural expansion in the Western Cape is considered to be water availability. According to the Integrated Water Resource Strategy Action Plan for the Western Cape (DEADP 2012), croplands have decreased in the Karoo region but increased in the western districts. The relative percentage of vineyards has also increased in the Southern Cape and along the West Coast. Since different soil types are suitable for different crops, cognisance must be taken of the need for appropriate crop selection which can have a substantial influence on water requirements and the sustainable use thereof. For example, the dry sandy soils of the Sandveld on the West Coast are generally not suitable for cultivation due to water restrictions, but are highly suited to seed potato farming under irrigation. The West Coast is, however, a low rainfall area, and irrigation of these potato crops is therefore heavily reliant on groundwater. Cultivation also relies on pesticides and fertilisers which can contaminate the freshwater resources in the area.

Land Capability can therefore be used to determine what the best utilisation of the land would be in order to sustainably use the resource without compromising the quality. Figure 7 below shows the different land capability classes as defined by the Agricultural Resource

Council, and Table 3 provides a description of where that particular class is found in the Western Cape.

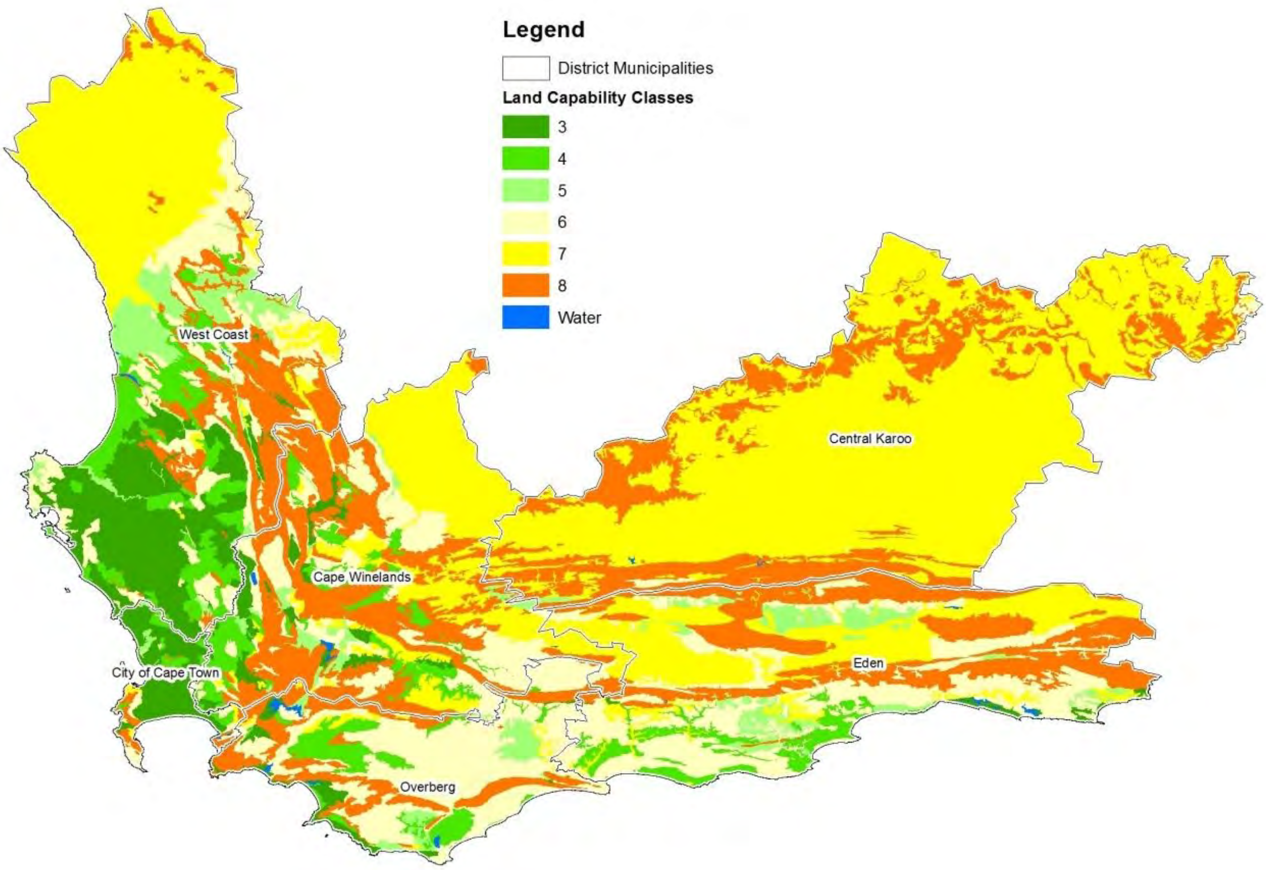

Figure 7: Land capability classes within the Western Cape (excluding already transformed and degraded areas) (ARC 2002)

Table 3: Categories of agricultural potential (ARC 2001)

	Class	Characteristics	Western Cape
Land suitable for Cultivation	1	Land has few limitations that restrict its use. It may be safely and profitably used for cultivation	No land present in this class
	2	Land has some limitations that reduce the choice of plants or require moderate conservation practices	No land present in this class
	3	Land has severe limitations that reduce the choice of plants or require special conservation or both	Mostly limited to the West Coast District and City of Cape Town areas
	4	Land has very severe limitations that restrict the choice of plants, require very careful management or both	Mostly limited to the West Coast, Overberg, Cape Winelands and City of Cape Town areas with some land in the Eden District. Restricted to fertile valleys
Land not suitable for cultivation	5	Land in Class V has little or no erosion hazard but have other limitations impractical to remove that limit its use largely to pasture, range,	Mostly present in the inland areas

	Class	Characteristics	Western Cape
		woodland or wildlife food and cover. These limitations restrict the kind of plants that can be grown and prevent normal tillage of cultivated crops. Pastures can be improved and benefits from proper management can be expected.	
	6	Land has severe limitations that make it generally unsuited to cultivation and limit its use largely to pasture and range, woodland or wildlife food and cover	
	7	Land has very severe limitations that makes it unsuited to cultivation and that restrict its use largely to grazing, woodland or wildlife.	Dominates in the Karoo and interior areas of the province
	8	Land has limitations that preclude its use for commercial plant production and restrict its use to recreation, wildlife, water supply or aesthetic purposes.	

Land Capability data has not changed or been updated since the values included in the 2005 Western Cape State of Environment Report.

3.3 Land transformation

Land transformation is largely informed by urban expansion, agricultural activities and degradation of land through poor land practices or overstocking. Land use is the single most important driver of land degradation as it focuses on interventions on the land which directly affect its status and impacts on goods and services.

The spatial extent of land transformation in the Western Cape is shown in Figure 8. Information on land transformation is derived from the 2009 summarised land cover layer developed by SANBI (SANBI 2009). Figure 9 shows the level of transformation per District.

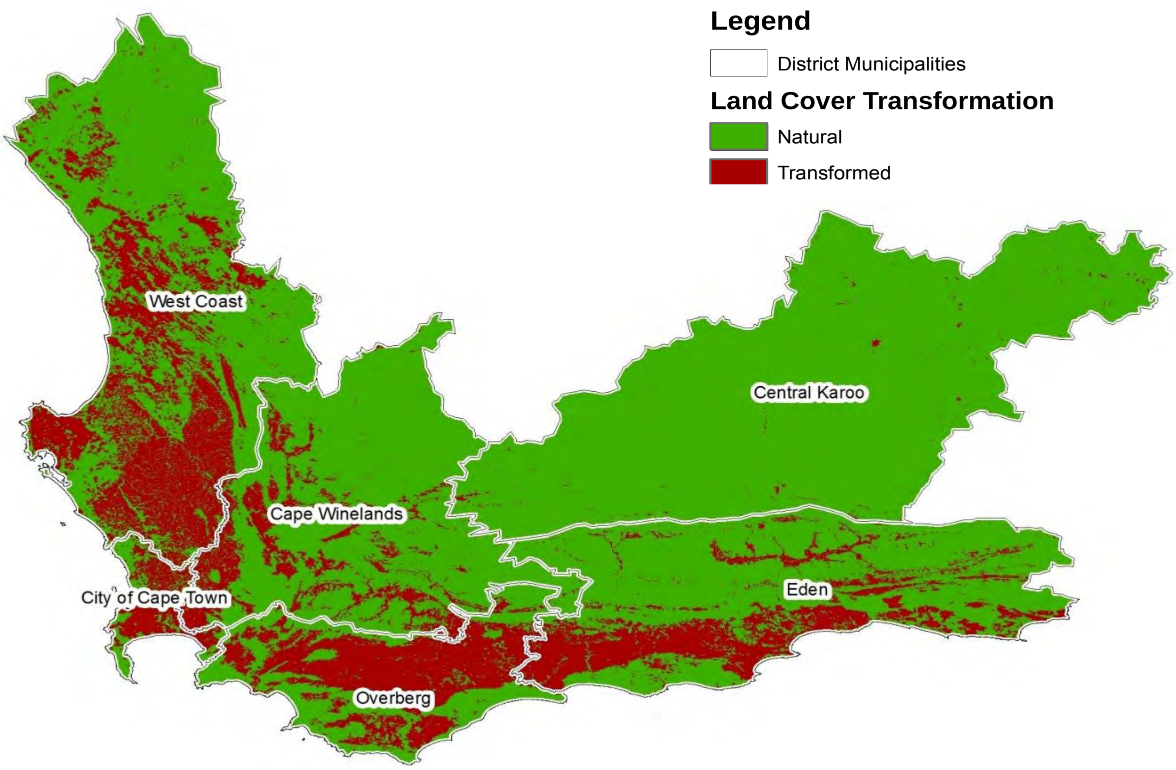

Figure 8: Land transformation in 2009 (SANBI 2009)

It is clear that the Western Cape is a predominantly untransformed province with the entire Central Karoo deemed to be untransformed, whilst the majority of the transformed land within the Western Cape occurs in the coastal Districts. The most transformed area is the City of Cape Town which is to be expected as it is one of the most prominent cities within South Africa and is the most urbanised area in the Western Cape.

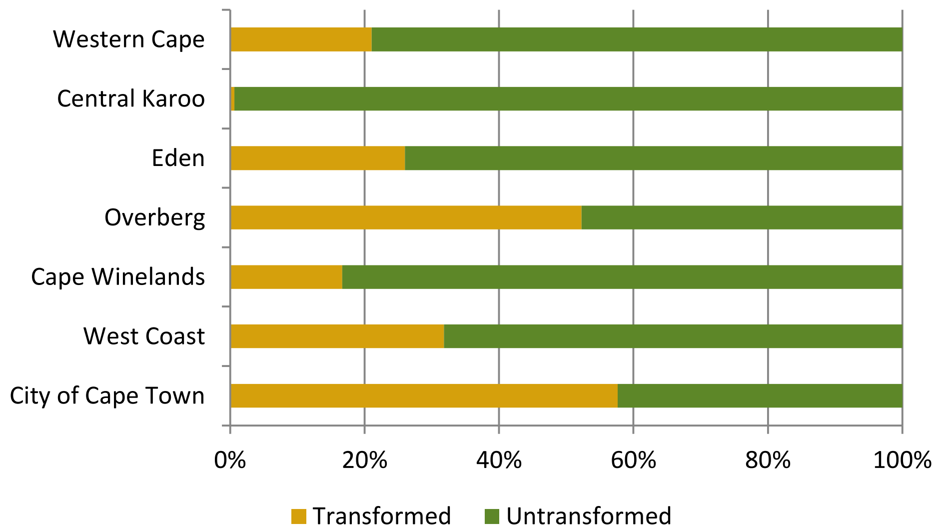

Figure 9: Levels of transformation per District Municipality (SANBI 2009)

A further indication of the areas where the highest rates of change have occurred is demonstrated by the NASA Nightlights data shown in the Human Settlements chapter. The data provides an indicator of the development of electrical infrastructure most commonly associated with urban development and provides a useful additional indicator of the rates of change in the absence of recent land cover data to monitor trends. However, this data gives no indication of the transformation of agricultural land or habitat. The highest rates of change in nightlights are in the Cape Winelands, City of Cape Town and Overberg Districts and this correlates with areas where the most land transformation, particularly from natural to built-up areas, has occurred. Most land transformation in the province is driven by anthropogenic causes (primarily urban expansion) and often where there are already environmentally sensitive areas and/or important agricultural lands.

It should however be noted that although the NASA Nightlights Data is useful, it does not cover transformation of agriculture or habitat transformation. This data should therefore be used in conjunction with other indicators.

4 IMPACTS

Land and its value are closely related to the environment, with the sustainability of one being a product of the other (UNEP 2006). The value of land resources does not only have a direct monetary value but includes values such as ecosystems function and non-use values. Such non-use values include intrinsic significance in terms of culture, aesthetics, heritage and bequests. Some of these values are shown in Table 4. Agriculture is a crucial food security, economic activity, providing employment and livelihoods for many and serving as the basis for many industries. Thus, for many, their livelihoods are directly affected by environmental changes, both sudden and gradual, which impact on agricultural productivity.

Agriculture is a crucial economic activity, providing employment and livelihoods for many and serving as the basis for many industries. Thus, for many, their livelihoods are directly affected by environmental changes, both sudden and gradual, which impact on agricultural productivity.

Table 4: Direct and indirect value of land (UNEP 2006)

Direct values Consumptive and non-consumptive use of resources:	Indirect values Ecosystem functions and services such as:	Option values Premium placed on possible future uses, including:	Non-use values Intrinsic significance in terms of:
Domestic use Industrial input Commercial use Mining Oil extraction Growing crops Human settlements Wood fuel Wild plants Wild animals Tourism Waste disposal etc.	Land quality Soils Micro-organisms Water flow Water storage Water recharge Flood control Storm protection Nutrient retention Moisture retention Microclimate Natural sink etc.	Pharmaceutical Agricultural Industrial Mining Tourism Forestry Human settlements Leisure etc.	Culture Aesthetic Heritage Bequest etc.

4.1 Erosion and degradation

Agriculture is a key contributor to the economy of the Western Cape and the protection of agricultural resources is paramount in ensuring food security and financial stability. Degradation of land resources is therefore an important consideration for the province. 'Land degradation' commonly refers to the steady decrease in functioning ecosystem productivity due to a transformation in soil and vegetation and is inclusive of deforestation and drought (DEAT 2005).

There are two types of degradation that are of concern to the state of land; soil and vegetation degradation. Soil degradation is mostly caused by wind and water erosion, while change in species composition, loss of plant cover through land transformation and bush encroachment are the most frequent forms of vegetation degradation (Gibson *et al*. 2005). Soil erosion is the most widespread form of land degradation, and one of the biggest threats to agricultural productivity. An erosion hazard can be predicted using a number of soil factors and is described as "*the likelihood of serious erosion occurring in the near future*". Soil loss is an important indicator that must be factored into planning as it has a direct link to agricultural potential.

The key to combating land degradation is the implementation of sustainable land management which is an outcome for the United Nation Convention to Combat Desertification, which South Africa endorses (DEAT 2005). The National Action Programme for Combating Land Degradation to Alleviate Rural Poverty noted that desertification is not merely the transformation of other land types into desert but also refers to the impoverishment of the land (DEAT 2005). Desertification is one of the main forms of degradation in rural areas due to poor agricultural practices.

No significant new data has been published on the indicators of degradation since the 2005 Western Cape State of Environment Report. This despite soil degradation being perceived as increasing in most communal croplands, grazing lands and settlements, and therefore being a pervasive problem in these areas. Crusting (surface sealing) and soil compaction is also becoming an increasing problem in overgrazed, bare patches of land and in irrigated areas and is a serious problem in the rainfed, grain-producing areas of the Western Cape (Gibson *et al*. 2005).

The consequences of land degradation can be quite severe and have social and economic impacts. The main consequences of degradation include (adapted from Gibson *et al*. 2005):

- Siltation of dams due to eroded soil washing down water courses. This reduces the capacity of the reservoirs and greatly increases the costs of managing dam infrastructure.
- Soil loss may cause farmers to abandon the land especially communal areas as there is no longer any productive capacity and the costs of fertilizers may be too high.
- The loss of nutrients from soils within South Africa is estimated to cost R1.5 billion annually (DEAT 2005). As a consequence farmers would then apply additional fertilizers driving up the costs of food production.

- Decreasing grazing and arable potential mostly by bush encroachment and loss of topsoil through erosion.
- Invasive alien plants can result in 7% decrease in water runoff, threats to biodiversity, and a decrease in the productivity of agricultural lands.
- Increased costs of water treatment from poor water quality, especially due to increasing siltation, fertiliser use and poor land management practices.
- Land degradation may cause a decline in the availability of wood fuel and reduce access to woodland products and medicinal plants. These are resources the poorest portion of the population is often dependant on.
- Lower productivity will affect food security, specifically in subsistence agricultural areas where human vulnerability is higher.
- Tourism potentials will be reduced due to a loss of landscape quality and the visual impact of eroded lands.

4.2 Development applications

Development itself is almost never positive for the environment, but the significance of many of these impacts can be reduced (minimised or mitigated) through enforceable conditions of development authorisation, specifically in relation to Environmental Impact Assessment (EIA) processes. In theory, this introduces a level of environmental oversight that is otherwise absent. The level of conservation protection and management that arises from land set aside can vary depending on the type of development, the willingness of the landowner and the impacts on the environment. Depending on the significance of the impacts (and therefore the mitigation required) conservation measures may be either voluntary recommendations or enforced conditions of approval. The EIA process therefore requires a careful balancing of losses and gains; the aim is to reduce the negative impacts through avoiding habitat loss, but also provide an incentive to increase the conservation security of the remaining habitat.

Figure 10 provides an overview of the development applications that were commented on by CapeNature since 2009. CapeNature would be asked for comment on authorisation processes within the Western Cape including those under the National Environmental Management Act (NEMA) Environmental Impact Assessment regulations, and permissions under the Land Use Planning Ordinance (for example to subdivide or rezone land applications to cultivate new land and mining permits) (CapeNature 2012). Since 2009 they have commented on over 1700 applications at an average of 550 per year. The aim with commenting on development applications is to positively influence the type of development or to restrict development in sensitive Critical Biodiversity Areas.

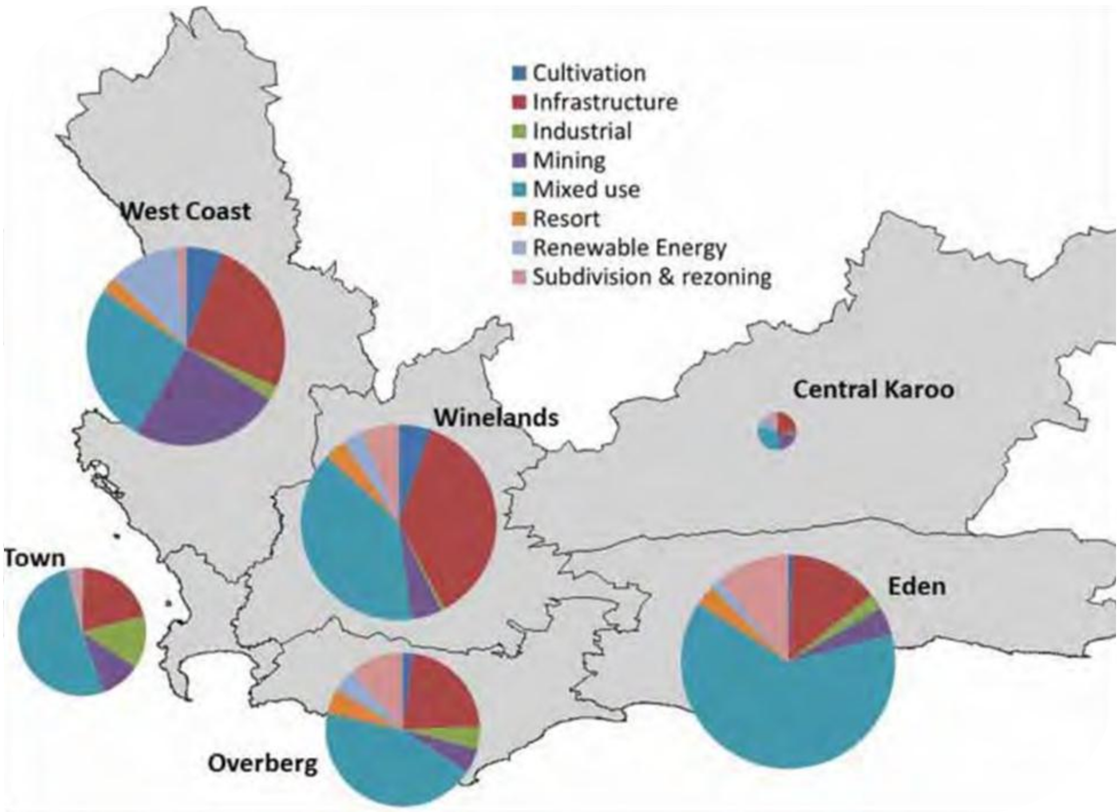

Figure 10: Type of development applications per district municipality (Maree & Ralston 2012)

As is evident from the analysis, mixed use and infrastructure developments dominate all Districts, with mining an additional pressure in the West Coast.

4.3 Invasive alien plant species

Alien plant invasion is an important environmental issue in the Western Cape and contributes to vegetation degradation and loss of productivity of land. Invasive alien plants take up large amounts of resources especially water resources; they cover over 170000 ha in the Western Cape and are found predominantly in the riparian zones (DEADP 2012). The infestations are not always significant but in the mountainous areas can be expensive to clear. The Breede and the Gouritz Water Management Areas are the most severely affected although the rest of the Western Cape also experiences low to moderate invasion (Figure 11). The clearing of these invasive alien plants will make land available for use, but subsequent uses must be sensitive towards the ecological integrity of the area as well as to unnecessary urban expansion.

Population growth in the region places stress on land resources, especially through the need to provide basic services to the growing population. Invasive alien plants therefore add another unnecessary stressor to an already vulnerable resource. Further information on invasive alien plants within the Western Cape is provided in the Biodiversity Chapter.

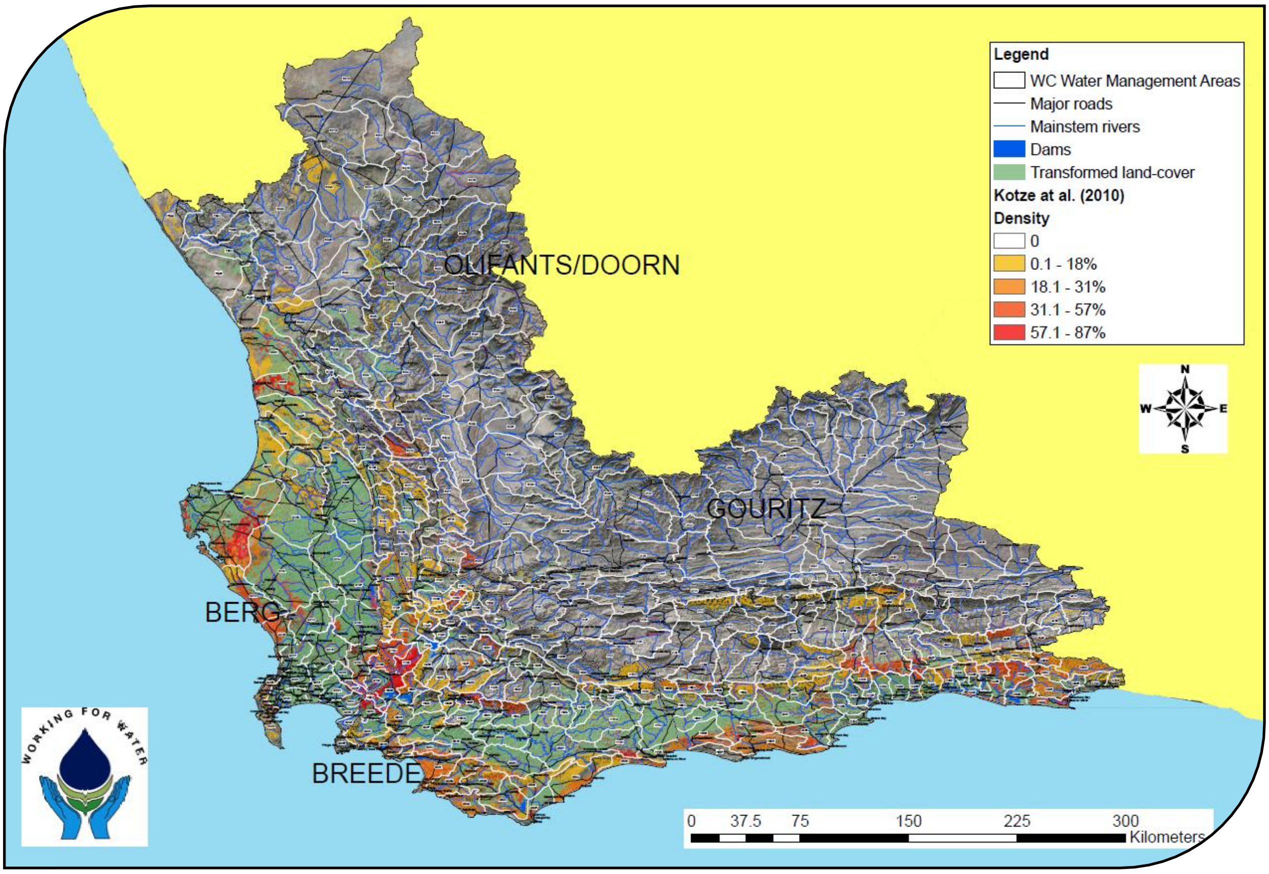

Figure 11: Location and density of Invasive Alien Plant species in the Western Cape (Kotze *et al*. 2010)

Potential future impacts: Shale gas extraction

Environmental concerns associated with shale gas extraction relate mostly to the process of hydraulic fracturing or fracking that is used to release gas from shale formations deep underground and bring it to the surface. The fracking process requires the use chemicals, sand and large quantities of water as inputs. In the Karoo, water is already a scarce resource and there are concerns about the potential for groundwater pollution. Public opposition to hydraulic fracturing, both locally and internationally, led to a moratorium being placed on further shale gas exploration in 2011 although further exploratory prospecting with the aim of furthering understanding and quantification of the reserve has been given the go-ahead since. The following are seen as key areas of conflict that need to be resolved before fracking can move to production:

- Access to the gas resources in a manner acceptable to local communities;
- Availability of land for installations of infrastructure;
- Availability of water in the required quantities for use in fracturing operations and at the fracking sites;
- Increased use and impact on local infrastructure such as roads, or development of new infrastructure;
- Access ways and development of pipelines;
- Lack of facilities to treat waste water;
- Access to capital to sustain ongoing drilling operations;

- Insufficient regulatory control;
- Environmental compliance issues; and
- Lack of existing pipeline infrastructure.

The debate will continue for some time on the possible impacts on land and the environment as well as on the extent and recoverability of the reserves. Exploitation of shale gas reserves will remain an important topic for the province though, since it has the potential to materially alter the energy dependencies and spatial development focus of the province. It will be important to address the lack of appropriate legislation and the lack of baseline data for monitoring should changes take place in the future status of hydraulic fracturing in the country.

5 RESPONSES

Responses to changes in land tend to be multi-sectoral due to the wide variety of uses and needs for land. Environmental governance in relation to land is integrated within many different laws, regulations and policies, as well as institutions and stakeholders, but yet effectiveness remains elusive due to various factors, including capacity constraints and policy failures. At a national level most responses are linked to legislative requirements and provide the policy and strategic direction for land management. At a provincial level, more specific and targeted programmes address specific provincial needs.

While there is a lack of statistics on land degradation, progress has been made in terms of no- tillage and soil erosion conservation agricultural methods. Currently there are 14 methods being implemented, compared to the ploughing system. There is also a shift towards water conservative farming methods (Andrew Roux, personal communication, 8 April 2013). These efforts are fundamental to behavioural changes towards more sustainable land management, and should underpin development of future responses.

Responses in the form of policies, tools and legislation across all scales applicable to this theme are listed in the summary table:

Table 5: Summary of policy, tools and legislation

International Responses	1990	Environmental certification of particular agricultural products
	1994	United Nations Convention to Combat Desertification
	2004	Stockholm Convention on Persistent Organic Pollutants
	2009	Organic production of food products
National Responses	1948	The agricultural Resource Conservation Regulations R1048 of 1948
	1970	The subdivision of Agricultural Land Act70 of 1970
	1983	Conservation of Agricultural Resources Act 43 of 1983
	1997	White Paper on South African Land Policy
	1989	The National Environmental Conservation Act 73 of 1989
	1995	White Paper on Agriculture
	1995	Working for Water Programme
	1998	Agricultural Policy in South Africa: A Discussion Paper
	1998	The National Environmental Management Act 107 of 1998
	1999	Land Care Programme
	2000	The Integrated Sustainable Rural Development Strategy
	2001	National Department of Agriculture: Environmental Implementation

		Plan
	2005	A National Action Programme (NAP) on Combating Land Degradation
	2012/13-2016/17	Strategic Plan for South African Agriculture
Provincial Responses	2002	A Settlement Framework for the Western Cape
	2000	The Policy for Farm Towns
	2005/06-2009/10	The Department of Agriculture's LandCare and Areawide Planning
	2009	Provincial Spatial Development framework

6 CONCLUSION

OUTLOOK: DECLINING

Land is a vital resource for sustainable development in the Western Cape. The loss of land for agriculture, land degradation, habitat fragmentation and the loss of ecological services all impact on the sustainability of the province as well as impact on food security, poverty and livelihoods. Unless measures are put in place to deal with the levels of land transformation and the loss of valuable agricultural land resources there will continue to be a downward trend for many of the land indicators. Currently, there is limited data available to monitor the rates of transformation. A key focus area for State of Environment monitoring and reporting on land is to update land cover data as well as information on the use and loss of agricultural areas. It is however encouraging to note that at the time of writing, the Department of Agriculture was conducting an aerial survey of agricultural resources and activities in the province.

The amount of land under cultivation has increased since in the 2005 Western Cape State of Environment Report, but the exact levels of this are difficult to monitor due to the limited data available. Changes in land potential and land uses are measured through land cover data and the last land cover layer for the Western Cape was completed in 2001, with only some adjustments from a SANBI national data set from 2009.

Efforts to understand ecosystem services offered by various land uses are at an early stage of development and should be strengthened. A growing population, economic development and global market pressures collectively put pressure on land for increased production of food, livestock feed, energy and raw material production. This needs to be weighed against potential environmental costs of land degradation, soil loss and loss of critical biodiversity areas. Decisions made on the use and allocation of land resources should bear in mind these trade-offs and the possible unintended consequences of their decisions.

The findings of the Land chapter can be summarised as an overall declining outlook. Table 6 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action. Table 7 contains the anticipated changes or outlook for the future of land management and land use, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding of the dynamics associated with land.

Table 6: Summary of key aspects identified in the chapter

Aspect	Summary of key points
Pressures	• Agriculture • Urban growth • Possible warmer, drying climate • Access to land • Mining on the West Coast
Impacts	• Reduced ecosystem services • Loss of productive land • Declining fisheries (resulting from climate change related impacts, overuse & poor management)
Challenges	• Lack of updated land cover information • Outlook – changes to land use planning laws
Progress	• Provincial Spatial Development Framework • 23 Formalised Municipal Spatial Development Frameworks • Coastal setback lines in process of being established
Critical areas for action	• Secure appropriate updated information at set intervals • Support conservation agriculture • Develop and implement adaptation and mitigation plans for climate change • Integrated planning approach

Table 7: Summary of the outlook for land based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend

Land cover	• 4th largest province (10.6% of total) in South Africa
	• 78% natural
	• 22% transformed
	  o 18.7% agriculture
	  o 1% urban
	  o 0.7% forestry
	  o 0.7% degraded
		Declining

Land capability	• No high capability soils- vulnerable agriculture requiring high inputs	No change
Land transformation	• Intensification of urbanisation sprawl • 1.6% more agriculture	Declining

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Environmental Affairs and Development Planning

BETTER TOGETHER.

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ABBREVIATIONS

CBAs	Critical Biodiversity Area(s)
CoCT	City of Cape Town Metropolitan Municipality
CKDM	Central Karoo District Municipality
CWDM	Cape Winelands District Municipality
EDM	Eden District Municipality
DEAT / DEA	National Department of Environmental Affairs and Tourism – now known as the Department of Environmental Affairs
FEPA	See NFEPA
ha	Hectares
IUCN	International Union for Conservation of Nature and Natural Resources
NEM:BA	National Environmental Management: Biodiversity Act
NFEPA	National Freshwater Ecosystem Priority Area(s), shortened to FEPAs
NSBA	National Spatial Biodiversity Assessment (2004)
ODM	Overberg District Municipality
PAs	Protected Area(s)
SANBI	South African National Biodiversity Institute
SANRCBD	South Africa's Fourth National Report to the Convention on Biological Diversity
WCCCs	Western Cape Conservation Categories
WCDM	West Coast District Municipality

1 INTRODUCTION

Biodiversity is critically important in the context of South Africa's economic growth and development, as it provides a "*basis for our fishing industry, rangelands that support commercial and subsistence farming, horticultural and agricultural industry based on indigenous species, our tourism industry, aspects of our film industry, and commercial and non-commercial medicinal applications of indigenous resources*" (Rouget *et al.* 2004).

> **Biodiversity**, or biological diversity, is a term used to describe the variability among living organisms (plants and animals), which encompasses "*species and their populations, the genetic variation among these, and all their complex assemblages of communities and ecosystems. It also refers to the interrelatedness of genes, species, and ecosystems and their interactions with the physical environment*"
>
> (ESA 1997)

As an indication of this crucial importance the National Environmental Management: Biodiversity Act (NEM:BA) (Act No. 10 of 2004), which forms part of the National Environmental Management suite of Acts, has been legislated. As a follow-on from NEM:BA, Critical Biodiversity Areas (CBAs) were defined for the country in November 2009 and the formal list released in December 2011.

This chapter describes the condition of the biodiversity and ecosystems of the Western Cape, based on a number of indicators, namely vegetation types, threat status, centres of endemism, alien invasive species, Biodiversity Priority Areas, protected areas and habitat fragmentation. It should be noted the "State of Biodiversity Report" published by CapeNature during 2012 which provides greater levels of detail on the state of provincial biodiversity (Turner 2012). This chapter, however, summarises the pressures on biodiversity, as well as the impacts that changes to the state of biodiversity has on the overall environmental health of the province.

1.1 Biomes of the Western Cape

The Western Cape is home to a rich and varied Biodiversity and the province contains the Fynbos, Nama Karoo, Succulent Karoo and thicket biomes (Figure 1). The Cape Floristic Region (CFR), which includes the Fynbos, and the Succulent Karoo are globally recognised biodiversity hotspots and the CFR alone contains more than 13 000 plant species (Le Roux *et al.* 2012). Biodiversity and the ecosystems services it provides are important to the Western Cape and helps sustain the resource base. When these ecosystem services are eroded or lost to people, it will affect human well-being and such services (e.g. flood retention, water cleansing etc.) will then need to be undertaken at great extra cost.

The **Fynbos biome** covers most of the Western Cape, is endemic to South Africa, and consists of Fynbos, Renosterveld and Strandveld vegetation, which is dominated by evergreen shrubs whose regeneration is dependent on fire (Mucina & Rutherford 2006). Fynbos plants include proteas, ericas and restios, as well as other plants groups like geophytes, daisies, legumes and vygies. There are very few trees or grasses in Fynbos. Animals include small buck like Cape Grysbok and Steenbok, the Bontebok, Leopard, Chacma Baboon, Porcupine, tortoises and nectar- and seed-eating birds. Harvesting of fynbos plants has generated employment within the Western Cape, for example; wildflowers, buchu for medicine and flavouring and restios for thatching.

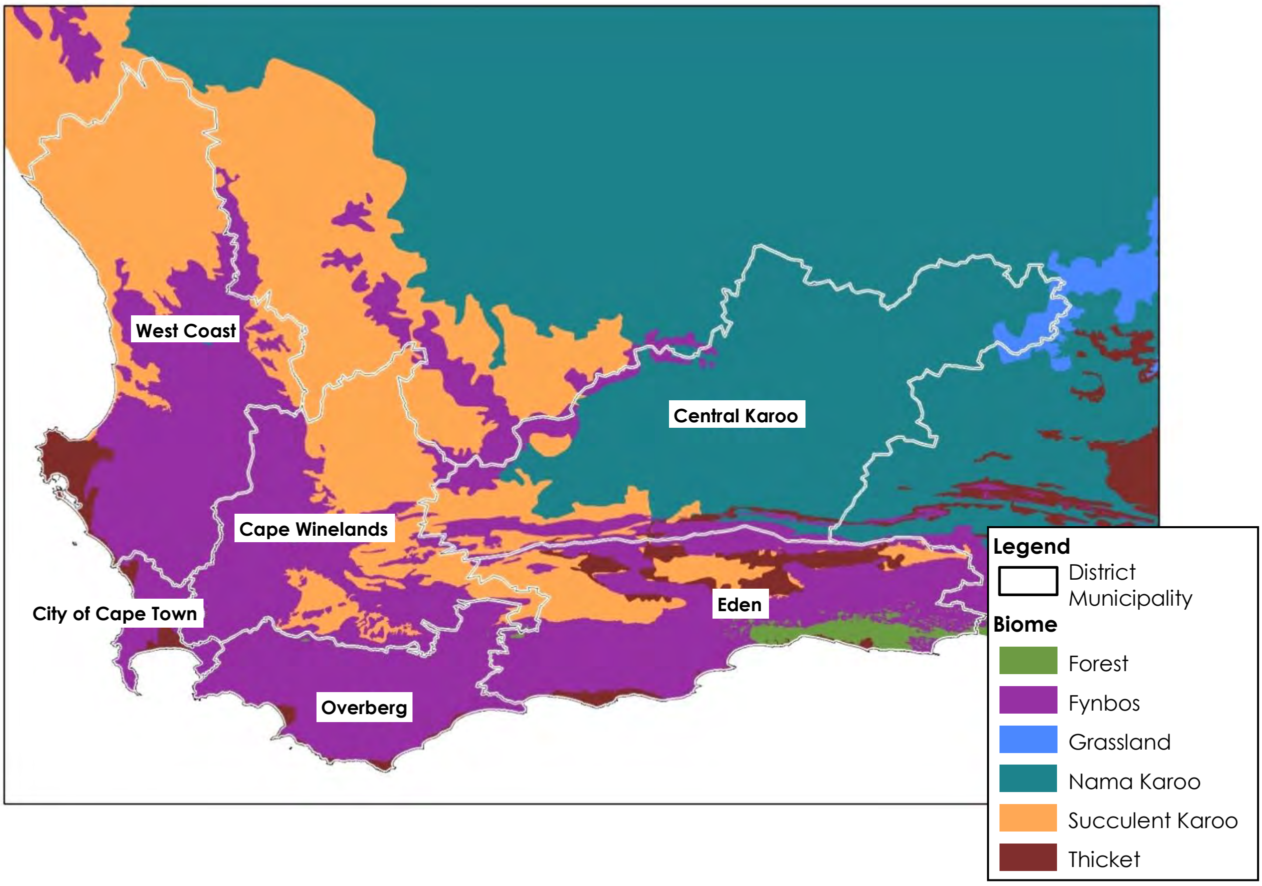

Figure 1: Biomes of the Western Cape (SANBI 2011)

Renosterveld occurs in soils richer than fynbos and as a result has been widely ploughed to plant crops including wheat, grapes and olives. Renosterveld is also an evergreen fire-prone shrubland dominated by asteraceous shrubs, with grasses and high geophytes diversity (Mucina & Rutherford 2006).

The **Succulent Karoo** biome is found in the northern more arid parts of the Western Cape and is highly endemic, with the largest number of succulent plants in the world for a region of its size. The region is extremely dry in summer and the temperature rises above 40^{0}C. Rainfall is extremely varied (20 to 290 mm per year) and falls during the winter. Plants in the Succulent Karoo have adapted to survive these dry hot summers. The Succulent Karoo Ecosystem Programme (SKEP) has been developed to conserve this region.

The **Nama-Karoo biome** is found in the Central Karoo District and extends all the way up to Namibia (Mucina & Rutherford 2006). The Nama-Karoo is a semi-desert area that receives little rain, and then mostly during the summer months. The summers are very hot and winter very cold with frequent frost. Most of the plants are deciduous low shrubs and grasses, and some trees are found along rivers or on along rocky hillside slopes. The landscape is dominated mostly by sheep and goat farms, but in the river valleys people farm olives, citrus and deciduous fruit.

The forest biome is the smallest biome in the Western Cape and South Africa, and it covers small areas dominated by high rainfall and levels of moisture. Forests plants include large long-lived tree species, climbers, epiphytes, mosses and ferns, while the trees themselves form a closed canopy with layers of plants beneath the canopy. The Western Cape contains the Southern Afrotemperate and Southern Coastal Forest types (Mucina & Rutherford 2006). Well-known forests within the Western Cape are the Knysna Forests and Tsitsikamma Forests (in the Eastern Cape as well). Small isolated forests occur on the slopes of Table Mountain.

1.2 Biodiversity hotspots

The Western Cape Province houses two of the three internationally recognised biodiversity hotspots of South Africa, namely the Cape Floristic Region, one of the six global floral kingdoms, and the Succulent Karoo Biome, one of only two arid biodiversity hotspots in the world (CAPE 2011). These regions have exceptionally high endemism and unique assemblages of flora and fauna.

At a smaller and more local scale, Cape Town is considered an urban hotspot within the CFR, as it encompasses four local centres of fynbos plant endemism, 19 national terrestrial vegetation types (of which six are endemic to the city), 190 endemic plant species and numerous species-rich wetland and coastal ecosystems (Holmes *et al.* 2012).

Cape Town's Unique Plant and Animal Biodiversity

The City of Cape Town has an '*unusually high number of endemic species*'.

Approximately 3400 indigenous plant species are found within the city's borders, of which 190 are endemic to Cape Town. Furthermore, 3 veld types and their associated plant species are found only in the Mother City, viz. Peninsula Sandstone Fynbos (140 species), Cape Flats Sand Fynbos (16 species) and Peninsula Granite Fynbos (9 species).

Although Cape Town is home to 27 amphibian species, only two species are endemic, viz. the Table Mountain Ghost Frog and the Cape Peninsula Moss Frog. These are also the only vertebrate endemic species.

In terms of invertebrate endemics, the full number present is yet unknown. However, some 138 species comprising insects, molluscs, crustaceans, arachnids, velvet worms and other arthropods, are known endemics to the Cape Peninsula.

These unique species are threatened by agriculture, urbanization, invasive alien plants and fire and the responsibility for their conservation and management rests with the City of Cape Town Metropolitan Municipality.

Table Mountain Ghost Frog exclusively found on Table Mountain

(CoCT 2011)

2 PRESSURES

2.1 Land transformation and degradation

The most significant and on-going cause of biodiversity loss and deteriorating ecosystem health in the Western Cape and throughout South Africa is the conversion of the natural environment to artificial, manmade landscapes. Such modification occurs through activities such as agriculture, forestry plantations, mining, infrastructure development and urban expansion (DEAT 2006; Turner 2012). Agriculture is particularly intense in the Western Cape, covering 13 million hectares (ha), and producing approximately 45% of South Africa's agricultural exports (WCG 2012).

Land transformation effectively alters natural environments, resulting in the elimination, degradation and fragmentation of the remaining viable habitats. In the Western Cape, habitat loss is mostly in the lowland areas with many of the terrestrial ecosystems now deemed critically endangered.

2.2 Climate change

Human-induced climate change is predicted to be the greatest long-term threat to biodiversity. The complexities and multiple components of climate change affect all levels of biodiversity, from organisms through to biomes and landscape processes (Lovejoy 2010; Bellard *et al.* 2012).

Climate change is likely to cause a shift in species distributions in response to habitat changes and shifts in food resources (Lovejoy 2010). Some animal and plant species are already undergoing related change in terms of timing of life stages and growth (phenology). This often leads to a breakdown in species interactions with consequences for ecosystem functioning (for example, plants flowering too early for their seasonal pollinators) (Lovejoy 2010; Bellard *et al.* 2012). More importantly, the effects on certain species populations could have an indirect impact, or knock-on effects, for numerous other species that depend on them, resulting in large-scale biodiversity losses (Bellard *et al.* 2012). Human induced disturbances, such as habitat fragmentation, pollution, overexploitation and biological invasions, will exacerbate the effects of climate change on biodiversity and may increase the likelihood of extinctions if adequate natural habitat is not preserved. Estimations of species loss point to a 30% loss in diversity (DEADP 2007).

For the Western Cape, and the broader winter rainfall region of South Africa, the frequency of drought is predicted to increase (Hoffman *et al.* 2009), with changes in rainfall patterns manifesting as reduced total rainfall for the region (CapeNature 2009). While the effects of climate change on Fynbos are still being studied, the anticipated impacts are likely to be significantly negative for both the Fynbos and Succulent Karoo biomes. This impact is expected to be particularly negative for the latter, as it is more sensitive to climate fluctuations with a greater number of drought sensitive species. The frequency of fires is also likely to increase with the prevalence of hotter and drier conditions, thereby altering fire regimes with negative implications for the survival of the fire-prone and fire-dependent vegetation (CapeNature 2009).

2.3 Illegal harvesting

Direct uncontrolled exploitation of natural living resources is a major threat to biodiversity across South Africa. The Western Cape is no exception given the rarity and sensitivity of the flora and fauna of the region. With numerous threatened plant and animal species, the indiscriminate and unlimited harvesting of indigenous animals and plants may lead to the local extinction of rare and protected species, and is thus a severe threat to the unique biodiversity.

For example, the commercial abalone species, *Haliotis midae,* which is found only in shallow, temperate marine environments off the Eastern and Western Cape, is considered South Africa's most threatened exploited marine species due to extensive illegal harvesting (Lombard *et al.* 2004), resulting in the collapse of the abalone fishery in 2008 (DEAT 2009). Other examples include uncontrolled flower removal and the collection of tortoises and other small game for the pet trade.

Illegal harvesting may also lead to other indirect impacts such as habitat disturbance and trampling, by-catch (collection of unwanted / non-target species) and changes to the gene pool and community structure as a result of species removal (Lombard *et al.* 2004).

2.4 Over-abstraction of water

As a water-stressed country, the water resources in South Africa are under increasing pressure through over-abstraction and modification of natural watercourses.

The consequences for biodiversity are largely negative as altered flow regimes have significant implications for migration, breeding and survival of fauna and flora during seasonal dry periods, and the availability of essential aquatic habitats and food resources. Many of the river systems in the Western Cape have been dramatically and some irreversibly altered. Consequently, these river systems are categorised as threatened ecosystems.

Associated wetland ecosystems, which are key biodiversity areas, are very sensitive to lowered water tables, land transformation and artificial draining hence their vulnerability to the over-utilisation of aquifers and diversion of natural water supply (De Villiers *et al.* 2005).

2.5 Altered fire regimes

Fire is an important process in fynbos and Renosterveld shrublands of the Fynbos Biome, the characteristic vegetation of the Western Cape. These ecosystem types are fire-adapted and fire-dependent for seed regeneration and thus the maintenance of populations of long-lived, obligate reseeding shrubs (mainly in the family Proteaceae) (Van Wilgen *et al.* 2011).

Altered fire regimes, through increases in fire frequency (often to promote grasses for grazing potential or to control invasive plant species) or shifts in fire season, are detrimental for fynbos biodiversity (De Villiers *et al.* 2005). Fires at immature vegetation ages result in the elimination of slow-maturing seed-regenerating plant species such as *Protea repens* (Kraaij 2010).

The number of ignition opportunities and the frequency of fires are expected to increase with the growth in human populations in all areas of the Western Cape (Van Wilgen *et al.* 2010). In contrast, fire suppression, or the complete absence thereof generally in close proximity to urban areas, may result in the local extinction of many fynbos species. Altered fire regimes can therefore have devastating consequences for the biodiversity of the Western Cape.

3 STATE

To measure the state of biodiversity in the Western Cape a number of indicators are used. These indicators look at ecosystems or vegetation types, species information as well as levels of ecosystem protection (DEAT 2009). A State of Biodiversity Report has been published by CapeNature during 2012 and provides greater levels of detail on state of provincial biodiversity (Turner 2012).

Tracked indicators of the *status* of Biodiversity and Ecosystem Health:

- Percentage of land and coast conserved
- Degree of habitat loss and fragmentation per vegetation type
- Extent of threatened status of ecosystems and species
- Extent of alien infestation

3.1 Vegetation types

"Ecosystems can operate at any scale from very small (e.g. a small pond) to an extensive landscape (an entire mountain water catchment area). As biodiversity is so complex and many-faceted, scientists have developed surrogates for representing it in a more simplified fashion. In South Africa, vegetation types are most commonly used as such a 'stand-in' for biodiversity (i.e. biodiversity surrogate)" (Maree and Vromans 2010, p.3).

Vegetation types provide a higher level of detail to categorise biodiversity in different ecosystems by looking at key factors, both biotic and abiotic (soil, climate, water and so on). The wide range of vegetation types present in the Western Cape is presented in Figure 2.). Further detail and full vegetation descriptions are available on SANBI's Biodiversity GIS Website: bgis.sanbi.org.

Many of the vegetation types in the Western Cape are under pressure from land transformation. In order to understand which of the vegetation types are most under pressure, prioritise important areas and to reduce the rate of ecosystem and species extinction, the NEM:BA has listed threatened or protected ecosystems in one of the following categories (Government Gazette 9 December 2010, No. 1002):

- **Critically Endangered (CR) ecosystems**, being ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation;
- **Endangered (EN) ecosystems**, being ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems;
- **Vulnerable (VU) ecosystems**, being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result

of human intervention, although they are not critically endangered ecosystems or endangered ecosystems; and

- **Protected ecosystems**, being ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed as critically endangered, endangered or vulnerable.

"*Nearly half of Renosterveld ecosystems are either Critically Endangered or Endangered. They harbour very high numbers of rare and localised species which are often associated with very specific edaphic (soil) or alluvial environments. Most Renosterveld habitats should be treated as threatened*" (De Villiers *et al.* 2005, pg 52).

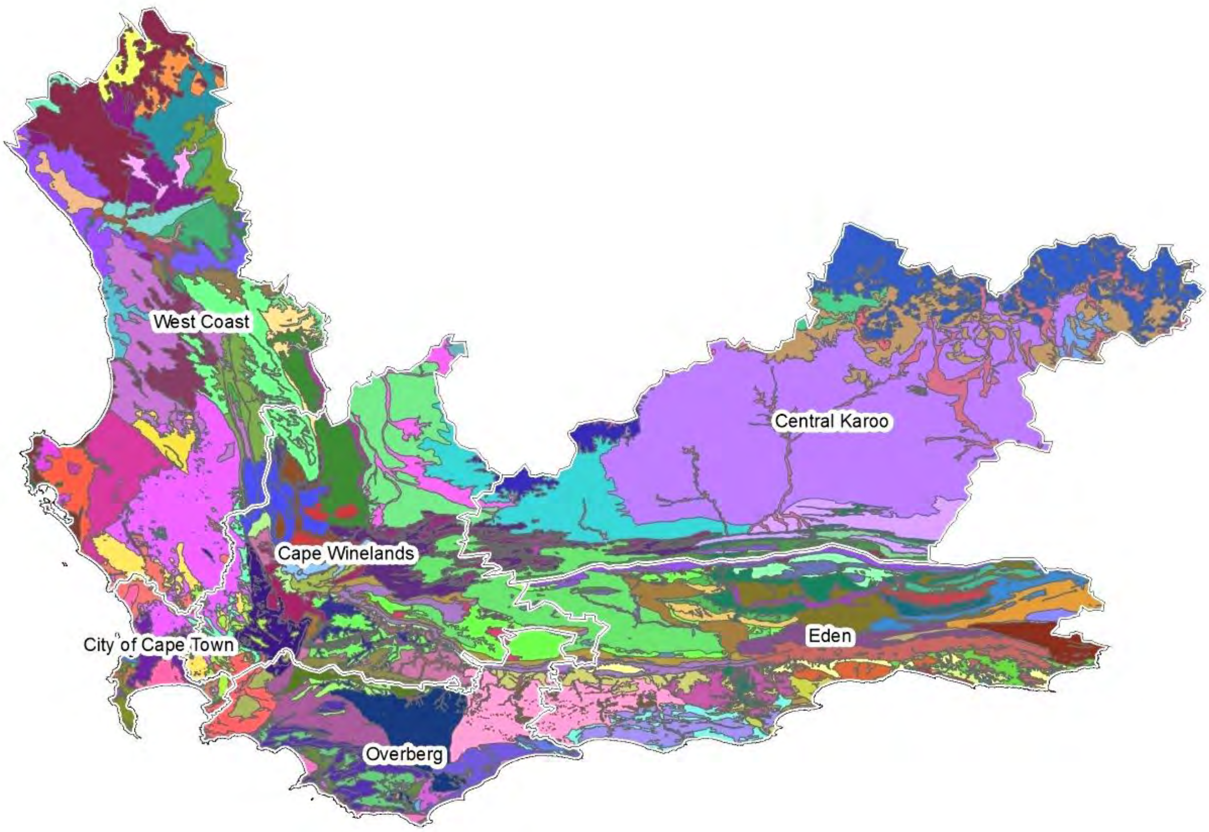

Figure 2: Vegetation types of the Western Cape (Mucina & Rutherford 2006)

3.2 Threat status

The Western Cape is been described as the most transformed province in South Africa, with the highest number of critically endangered terrestrial ecosystems occurring here (Rouget *et al.* 2004). The Biodiversity Act allows for the classification of ecosystems and species according to a threatened status scale that categorises risk and ecosystem thresholds.

3.2.1 Ecosystems

According to the most recent assessments (Le Roux *et al.* 2012), there are 58 threatened terrestrial ecosystems in the Western Cape, of which only two are not endemic or near endemic to the province. Of these, 21 are critically endangered, 14 are endangered, and the remaining 23 are classified as vulnerable. These comprise almost exclusively fynbos vegetation types. Most concerning is that ten critically endangered, six endangered and nine vulnerable ecosystems have no official conservation protection. These particular ecosystems that lack protection should be targeted to be included in protected areas with strong legislated security as recommended by Le Roux *et al.* (2012).

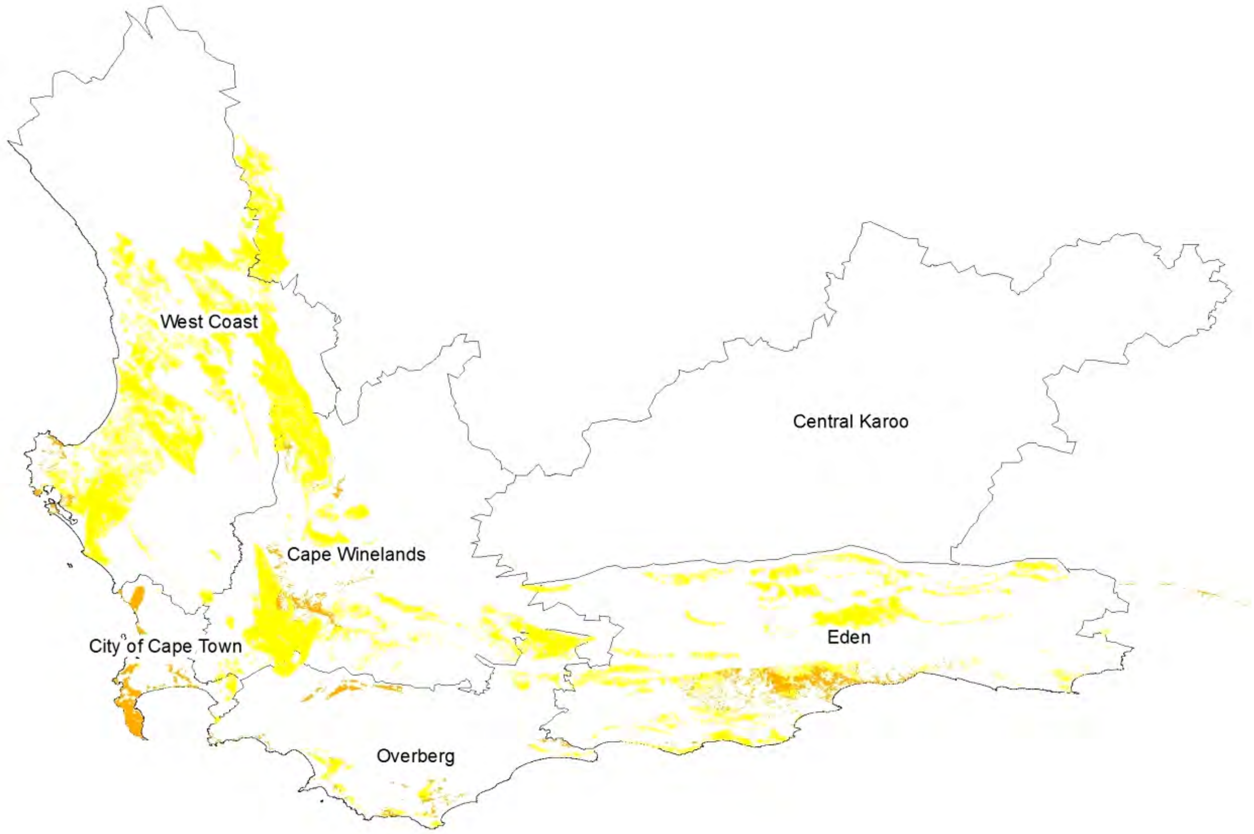

Figure 3: Remaining extent of listed threatened ecosystems in the Western Cape (SANBI 2011)

At the district level, the Cape Winelands District Municipality (CWDM) area has the highest number of threatened terrestrial ecosystem types at 24, 13 of which are Critically Endangered (Figure 4), followed closely by the City of Cape Town Metropolitan Municipality (CoCT) area of jurisdiction at 11 ecosystems. The threatened status can be ascribed to rapid urban expansion and agriculture (particularly cultivation) with the associated habitat destruction in the midst of the unique Fynbos biome.

More than a third (34.6%) of the CoCT area comprises threatened ecosystems; followed by the Overberg District Municipality (ODM) (33.1%). For the districts with lower area coverage of threatened ecosystems, i.e. the West Coast District Municipality (WCDM)(19.9%) and Eden District Municipality (EDM) areas (13.9%), Vulnerable systems are becoming more prevalent. There are no threatened ecosystems indicated in the Central Karoo District Municipality (CKDM) region.

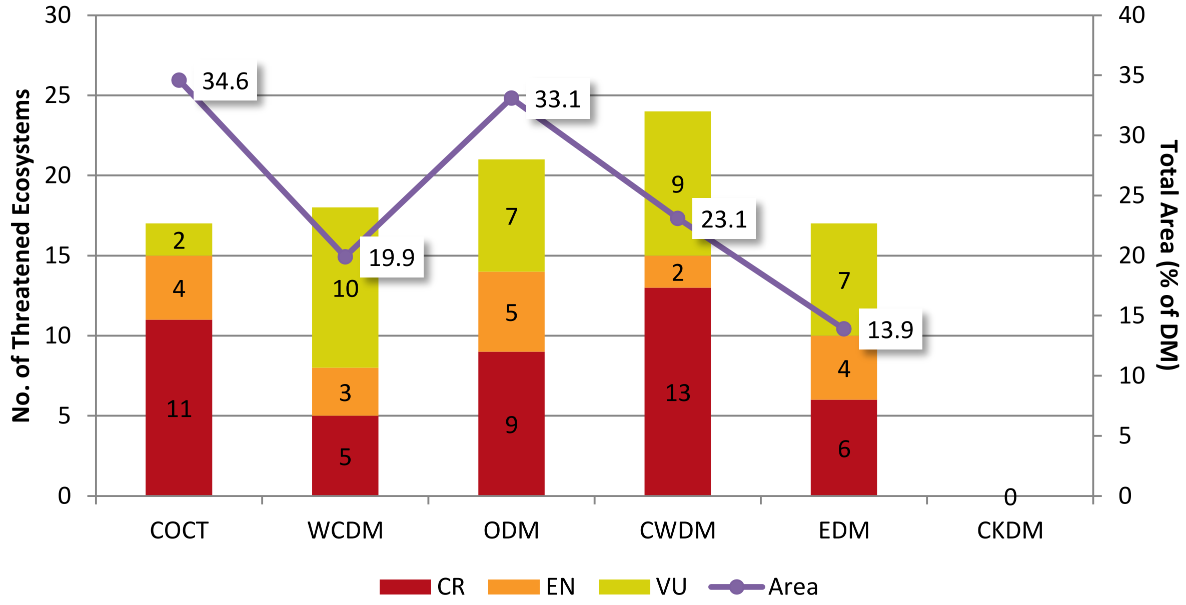

Figure 4: Number of threatened terrestrial ecosystems and total area as a percentage of each district municipality of the Western Cape Province (SANBI 2011)

3.2.2 Species

There are 13 489 recorded plant species in the Western Cape Province, which constitutes 56% of South Africa's flora species, and a large number of these are endemic (6 776). Some 1 709 plant species are classified as threatened, with 296 classified as Critically Endangered, 575 are Endangered, and 801 are Vulnerable (Figure 5). These species account for up to 68% of the threatened plant species for the country; 1 695 of these are endemic to the Western Cape (Le Roux *et al.* 2012). Moreover, there are 2 984 plant species of conservation concern because they are Near Threatened, Data Deficient, Rare Endemics or Declining in numbers (Le Roux *et al.* 2012). Twenty-one plants species are reported as being Extinct. In the marine environment *Zostera capensis* is the only threatened (Vulnerable) plant species (IUCN 2012).

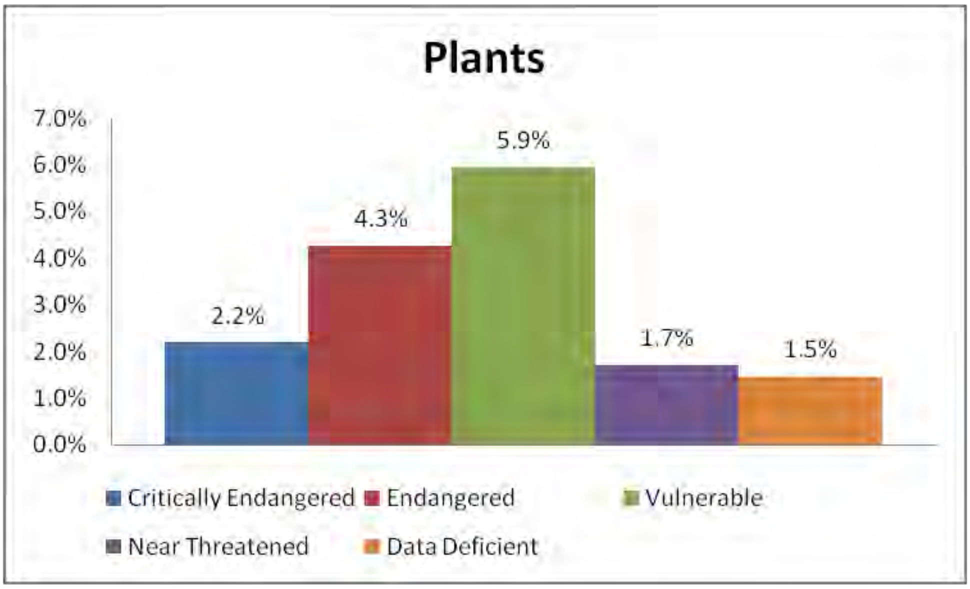

Figure 5: Plant species of conservation concern as a percentage of plant species in the Western Cape (Le Roux *et al.* 2012; SANBI 2012)

A significant number of threatened plant species are harvested and traded in informal markets in the CoCT. These plants have numerous applications, such as for traditional medicinal uses, as a food source, as fibre and for use in plant nurseries (Petersen *et al.* 2012). Of the 181 species assessed for Red data list status, 30 threatened species are available at informal markets, of which three species are critically endangered, 14 are endangered, and 13 are vulnerable. A further 13 species are considered near threatened, while six species are known to have declining population numbers (Petersen *et al.* 2012).

The Western Cape is home to unique animal species and many of the terrestrial fauna are dependent on the fynbos for their survival. In addition, the freshwater fish are particularly diverse and the Western Cape Province has the highest number of threatened and endemic freshwater fish species in South Africa. This is also the most threatened group of vertebrates in the province as 16 of the 23 recorded species[1] are considered threatened (70%), with four considered Critically Endangered (39%) (Jordaan *et al.* 2012). In terms of the terrestrial vertebrate groups, 15% of amphibians, 5% of reptiles, 5% of birds and 10% of mammals recorded in the province have been classified as threatened (Turner 2012) (Figure 6).

Of the animals which are harvested and sold out of Cape Town, two are Critically Endangered, namely *Psammobates geometricus* (Geometric tortoise) and all *Colophon* Stag beetle species (Petersen *et al.* 2012). One species of the animals sold, *Cyprinus carpio* (Common carp), although alien to South Africa and contributing negatively to water quality for indigenous species, is considered Vulnerable elsewhere.

In terms of the marine environment, our knowledge of marine species remains fairly limited and represents only a fraction of what is estimated to exist. Cartilaginous fishes are the most threatened group of marine organisms, with four of the 35 species known to occur in the oceanic waters off the Western Cape being critically endangered (Table 1) (IUCN 2012). These include two species of catshark, *Holohalaelurus favus* and *H. punctatus*, and two species of the hammerhead shark, *Sphyrna lewini* and *S. mokarran*. A single species of mollusc (*Tomichia tristis*), hagfish (*Eptatretus octatrema* – Eightgill Hagfish), bony fish (*Thunnus maccoyii* – Southern Bluefin Tuna), and bird (*Diomedea abbenena* – Tristan Albatross) are all critically endangered. Data for threatened marine birds has been included under the ‘birds’ category in Figure 6 though.

The full IUCN threatened species list for the Western Cape is provided as an Appendix.

[1] This number includes six species that are still to be classified, and are suspected to have ranges restricted to the Western Cape.

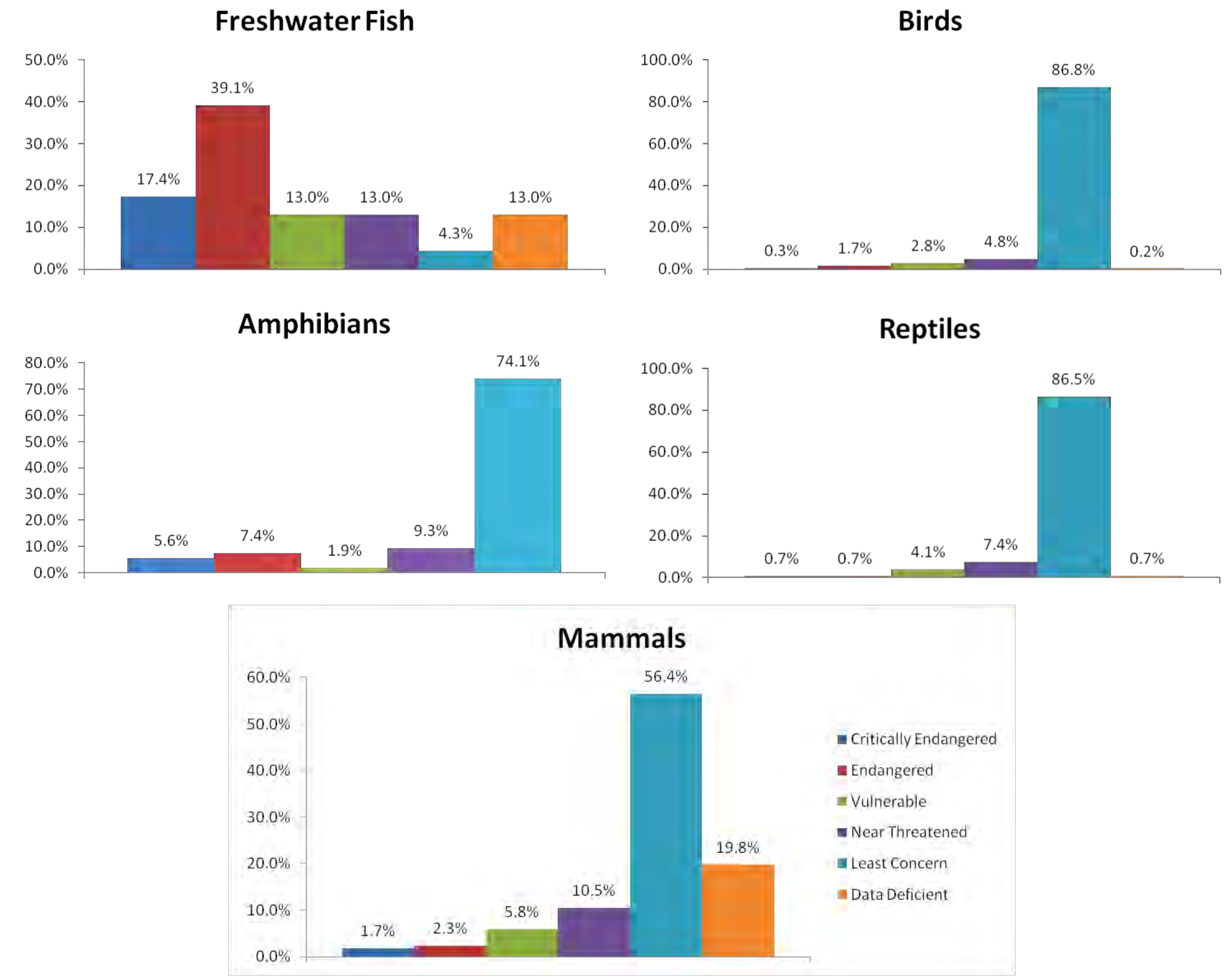

Figure 6: Inland fauna species of conservation concern as a percentage of fauna species in the Western Cape (Turner 2012)

Table 1: Summary of threatened marine animal groups for the Western Cape (IUCN 2012)

Group	CR	EN	VU	Total
Corals			9	9
Molluscs	1			1
Hagfish	1			1
Cartilaginous fishes	4	7	24	35
Bony fishes	1	2	6	9
Reptiles			1	1
Birds	1	8	9	18
Mammals		3	2	5
Total	**8**	**20**	**51**	**79**

**CR = critically endangered   EN = endangered   VU = vulnerable

3.3 Centres of Endemism

Species endemism is high in the Western Cape. Endemism refers to species that are confined to a certain geographical area and do not occur naturally anywhere else in the world. The rich biodiversity of the Succulent Karoo and Fynbos biomes is due to the wealth of complex habitat types that have arisen from extreme topographical and climatic variation in the rugged terrain of South Africa's south-western region (Driver *et al.* 2003; Turner 2012).

3.3.1 Succulent Karoo Biome

The Succulent Karoo Biome extends through the central and the north-western regions of the Western Cape Province and into southern Namibia, and covers approximately 11.6 million ha (116 000 km^2) (Driver *et al.* 2003). Despite the aridity of the region, the level of plant diversity and endemism is extraordinary at 6 356 different plant species, 40% of which are endemic and 936 (17%) of which are Red Data Listed. The region contains the richest diversity of succulent flora in the world, and the flora is especially adapted for extreme habitat conditions and particular soil types, leading to very small distribution ranges also known as local endemism (Driver *et al.* 2003). At the same time the Succulent Karoo Biome is also a centre for high faunal diversity including reptiles, amphibians, some mammals and invertebrates closely associated with the floral diversity.

The Succulent Karoo is under increasing pressure from human impacts and activities, particularly livestock grazing which dominates 90% of the land use in the area. However, due to the unfavourable rugged terrain and harsh climate, only 5% has been irreversibly transformed. Many opportunities thus exist for the establishment of priority conservation areas aimed at protecting the biodiversity of the Succulent Karoo.

3.3.2 Fynbos Biome

The CFR, located in the south-west portion of the Western Cape Province and covering almost 9 million ha (90 000 km^2), is despite its small size one of the richest areas in the world for plants. It is characterised by the Fynbos biome (comprising both Fynbos and Renosterveld vegetation) which occurs exclusively in this region. As with the Succulent Karoo Biome, the CFR exhibits important ecological processes, biodiversity and endemism, with more than 13 000 plants, of which some 70% are endemic and 1 435 listed as threatened (CAPE 2011, Le Roux *et al.* 2012, UNESCO no date). Fynbos shrubland accounts for more than 70% of the plant species identified in the CFR, and covers over 80% of the land area (CAPE 2011). Renosterveld replaces Fynbos in the lowland coastal areas. Both vegetation types are fire-prone yet fire-dependent for their reproduction.

Human population density is higher in the CFR than in the Succulent Karoo. As such, the Fynbos biome is under increasing pressure and being continuously degraded by agriculture, urban development and invasive alien plants. The CFR is thus considered "*one of the world's 34 most threatened biodiversity hotspots*" (CAPE 2011). Furthermore, the estimated total economic value of the Cape Floristic Region's biodiversity, including vital ecosystem services such as water purification and erosion control, is over R10 billion per year, which is the equivalent of over 10% of the Western Cape's Gross Geographic Product (CAPE 2011).

Eight serial Cape Floristic Region Protected Areas have been established, covering a total area of 553 000 ha and including a buffer zone of 1 315 000 ha, designed to facilitate functional connectivity and mitigate the effects of global climate change and other anthropogenic impacts (UNESCO 2012).

3.3.3 Species endemism

The Western Cape Province is renowned for the high level of endemism associated with the unique Fynbos biome. Half of the recorded plant species in the Western Cape Province (6 776 species) are endemic to the area (Le Roux *et al.* 2012) (Figure 7), while an impressive 96% of those classified as threatened are also endemic to the province (1 695 species) (SANBI 2012).

In parallel with the high levels of diversity, freshwater fish of the Western Cape have the highest level of endemism of all the freshwater animal groups (Jordaan *et al.* 2012). Each of the four major river systems (the Breede, Berg, Olifants/Doring and Gouritz river systems) in the Western Cape is recorded as having a unique fish community, where 65% of fish fauna in the community are endemic to the Western Cape. The Olifants-Doring river system is considered an endemic fish hotspot, home to ten indigenous species, of which eight are endemic and Threatened (Jordaan *et al.* 2012). Amphibians follow closely, with 52% endemism (Turner & De Villiers 2012).

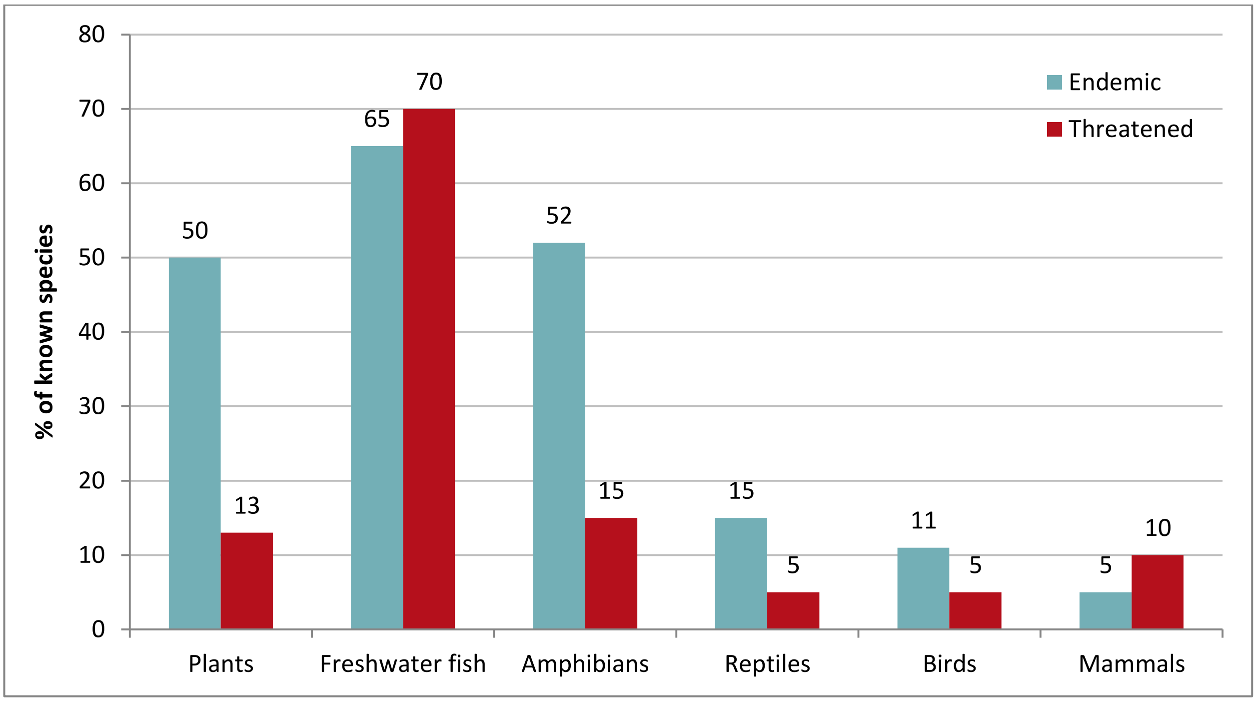

Figure 7: Summary of threatened species status for inland plants and animals in the Western Cape [ADU 2011 (birds), Turner 2012]

3.4 Alien invasive species

Invasions by alien plant and animal species represent a key threat to ecosystems of the Western Cape. An invasive alien species is defined as "*an alien (non-native) species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity*" (IUCN 2000). Effectively, they have the potential to alter ecosystems and landscapes, at the expense of the indigenous biodiversity (DEA 2009).

Without their natural enemies to control them, alien invasives out-compete indigenous plant species for resources such as space, nutrients and light. During burns, dense stands of woody aliens increase the intensity and temperature of fires which, in turn, can destroy indigenous seed banks and change the physical structure and composition of soil. Combined with climatic conditions, the very nature of fynbos makes it particularly prone to the spread of alien species after physical disturbance and unseasonal and too-frequent fires (De Villiers *et al.* 2005).

A further point is that many alien invasive plant species are pioneer species and thus are able to utilise degraded or modified areas more effectively than the indigenous species, which for the Western Cape Province are often very niche-specific and thus sensitive to change. Invasive plant species generally also utilise far greater quantities of water, thus threatening the already sparse freshwater resources within the province.

3.4.1 Flora

There are 291 alien plant species recorded in the Western Cape (AGIS 2007). The most important groups of species that have invaded the fynbos biome include the pines (*Pinus* species), wattles (*Acacia* and *Paraserianthes* species), hakeas (*Hakea* species), and gums (*Eucalyptus*, notably *Eucalyptus camaldulensis*) (Van Wilgen 2009). In the Succulent Karoo habitats and ecosystems, the main species are *Nerium oleander* (mostly in watercourses abutting the Fynbos Biome), Mesquite (*Prosopis* species), prickly pear (*Opuntia* species) and saltbush (*Atriplex* species) (De Villiers *et al.* 2005).

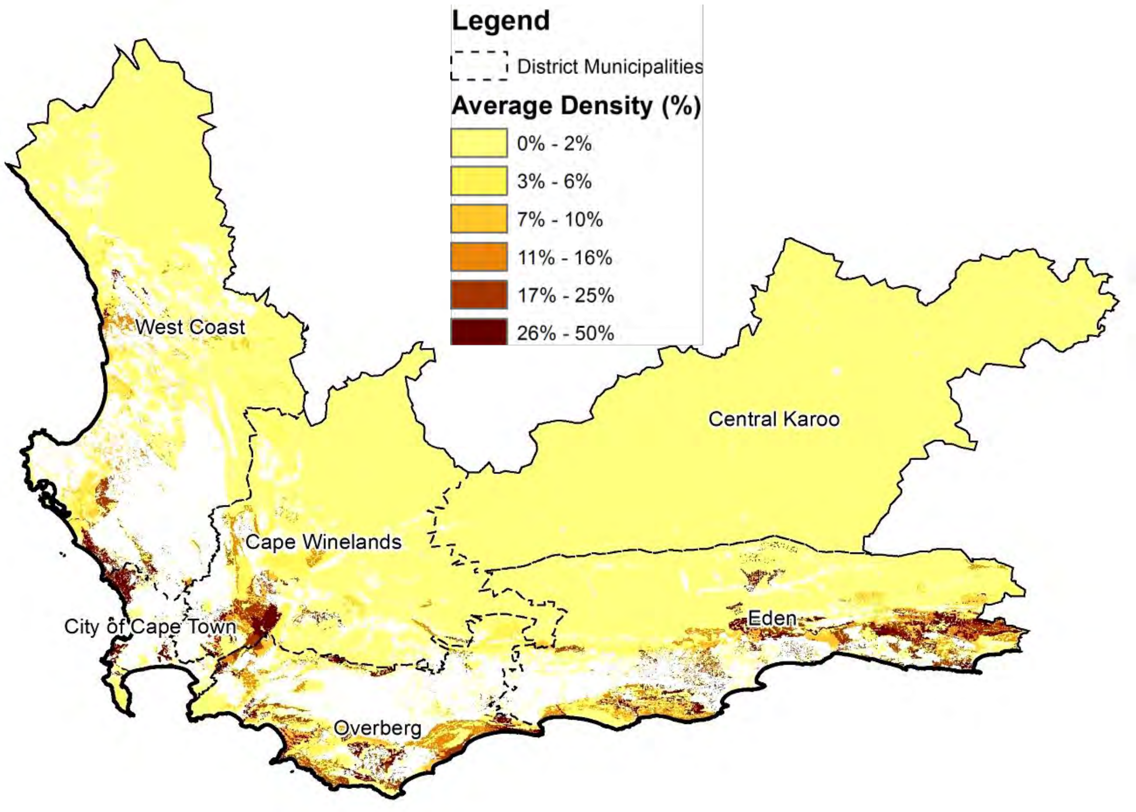

Figure 8: Average density (abundance) Invasive alien plant infestation in the Western Cape (SANBI Working for Water Programme, Kotzé *et al.* 2010)

Figure 8 shows the average density of infestations as a percentage calculated by dividing the accumulated density for all invasive species by the total number of all sample points within a quaternary (fourth order) catchment (Kotzé *et al.* 2010). If one compares the map on invasive alien plant infestation to the map of land transformation (refer to the Land chapter) it shows a close correlation between the expansion of human activities and the occurrence of invasive alien plants. This also indicates areas most under pressure for habitat fragmentation and loss of biodiversity.

3.4.2 Fauna

Alien invasive fish species are considered to be the primary threat to the survival of the indigenous fish of Western Cape Province (Jordaan *et al.* 2012). Alien fish affect indigenous populations primarily by preying on the small fish species and juveniles of a wider range of fish, thus limiting the number of individuals reaching sexual maturity for reproduction and leading to local extinction of the species. The alien species also compete with native species for resources and can be responsible for habitat alteration, introduction of disease, and disruption of ecological processes (Jordaan *et al.* 2012).

There are very few indigenous species remaining in all the four river systems in the Western Cape Province as the main stream fish fauna is dominated by alien invasive species. There are 15 alien invasive species from six families, originating mostly from North America and Africa (Jordaan *et al.* 2012).

3.5 Biodiversity Priority Areas

The Critical Biodiversity Areas categorisation divides the landscape into several categories:

- Protected Areas;
- Critical Biodiversity Areas – Terrestrial;
- Critical Biodiversity Areas – Freshwater;
- Ecological Support Areas;
- Other Natural Areas; and
- No Natural Remaining Areas.

The first four categories represent the biodiversity priority areas. According to provincial policies and the NEM:BA they should be maintained in a natural to near natural state. The other categories are not considered as priority areas and are not monitored as closely for biodiversity losses. A network of CBAs represents the most efficient selection and classification of land portions requiring safeguarding in order to meet national biodiversity objectives (termed biodiversity thresholds) and is closely monitored within the Western Cape.

Maps of Critical Biodiversity Areas identify areas that should be conserved as opposed to areas where development can take place without compromising biodiversity. These CBA Maps are based on the science of systematic biodiversity planning which, among other things, aims to meet the national targets for both biodiversity pattern and process areas in the least amount of land possible.

Loss of habitat through land use change remains the biggest threat to biodiversity within the Western Cape (Driver *et al.* 2012, Turner 2012). If the maps that have been presented in this chapter are assessed for biodiversity priorities and land cover (See Land Chapter) within the Western Cape, there is a major overlap between extensive farming in the Karoo, where the least transformation has taken place, and areas of identified biodiversity sensitivity (Figure 9). This suggests a land use and associated land transformation as a threat to biodiversity.

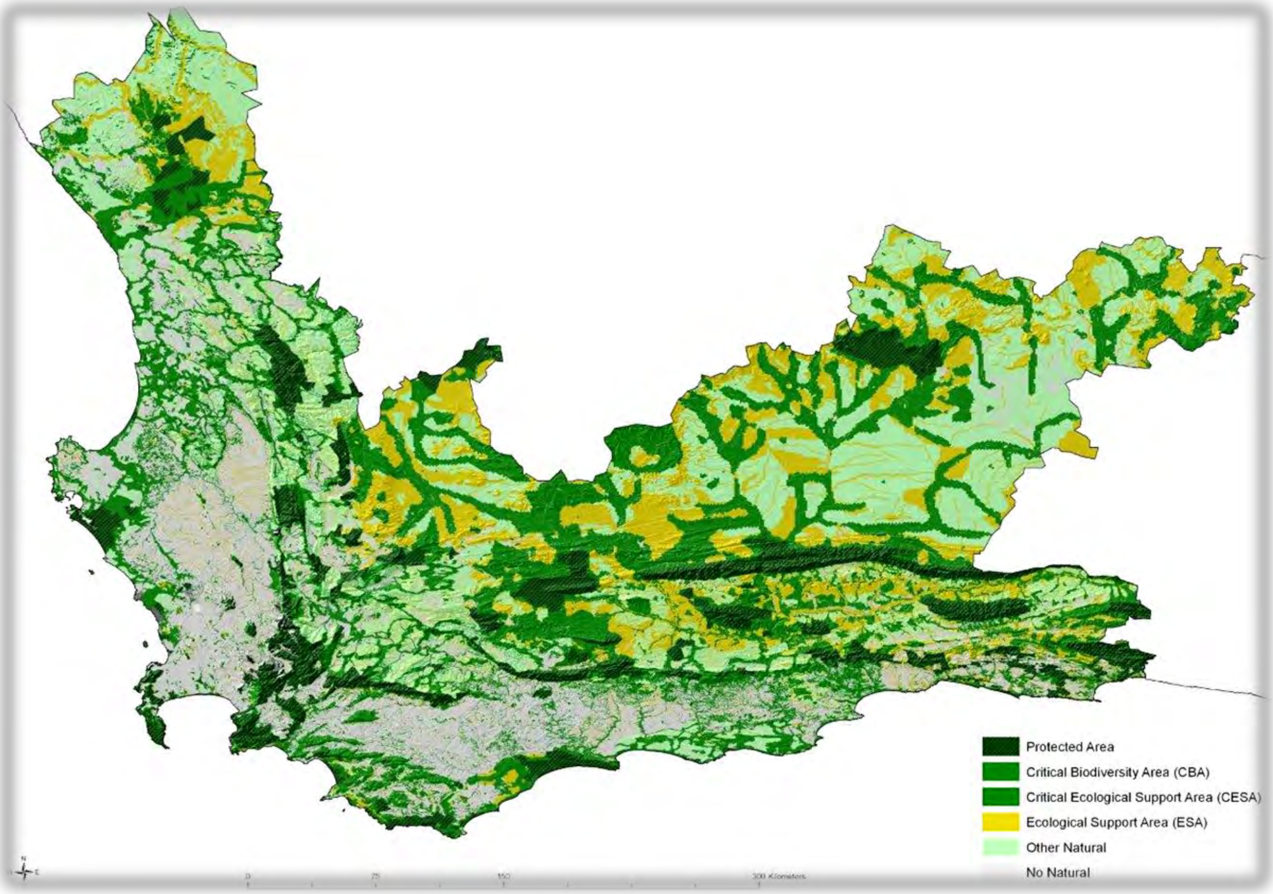

Figure 9: Important biodiversity areas in the Western Cape (SANBI 2011)

3.6 Protected areas

The Western Cape Province has 16 types of protected areas, which have been grouped into three Western Cape Conservation Categories (WCCCs), from protected areas that offer the highest level of afforded protection and legislative security (WCCC1), through to protected areas with little or no legislative security and thus little protection (WCCC3) (Maree & Ralston 2012).

The Biodiversity Stewardship Programme initiated by CapeNature in 2003 has made significant contributions to each category through Contract Nature Reserves and Protected Environments (WCCC1), Biodiversity Agreements (WCCC2) and Voluntary Conservation Areas (WCCC3) (Maree & Ralston 2012).

Western Cape Conservation Category 1

Protected Areas with *strong* legislative security, covering 1 203 132 ha (8.7%) of the Western Cape Province and 28 313 ha of CBA. These include National Parks, World Heritage Sites, Wilderness Areas, Provincial Nature Reserves, State Forest Nature Reserves, Marine Protected Areas, Island Nature Reserves, Contract Nature Reserves, and Protected Environments*.

Western Cape Conservation Category 2 Protected Areas with *some* legislative security, covering 744 181 ha (5.7%) of the Western Cape Province) and 242 040 ha of CBA. These include Local Authority Nature Reserves, Mountain Catchment Areas, Private Nature Reserves and Biodiversity Agreements*.

Western Cape Conservation Category 3 Protected areas with *little or no* legislative security, covering 1 623 479 ha (12.5%) of the Western Cape Province) and 472 007 ha of CBA. These include Voluntary Conservation Areas, Biosphere Reserves and Conservancies*.

*indicates new protected areas as of 2012 through the CapeNature Biodiversity Stewardship Programme (Maree & Ralston 2012)

3.6.1 Terrestrial protected areas

In terms of terrestrial protected areas (PAs), the Cape Winelands has the greatest proportion of protected land of all the districts, with more than a quarter under formal conservation (25.3%), followed closely by the CoCT (20%) (Figure 10) (SANBI 2012). In comparison, less than 10% of each the West Coast and Central Karoo District Municipalities are conserved. As there are no threatened ecosystems in the Central Karoo very few protected areas exist in this region. Priority conservation areas (WCCC1) are concentrated in the Overberg (38), Eden (40) and Cape Winelands areas (32).

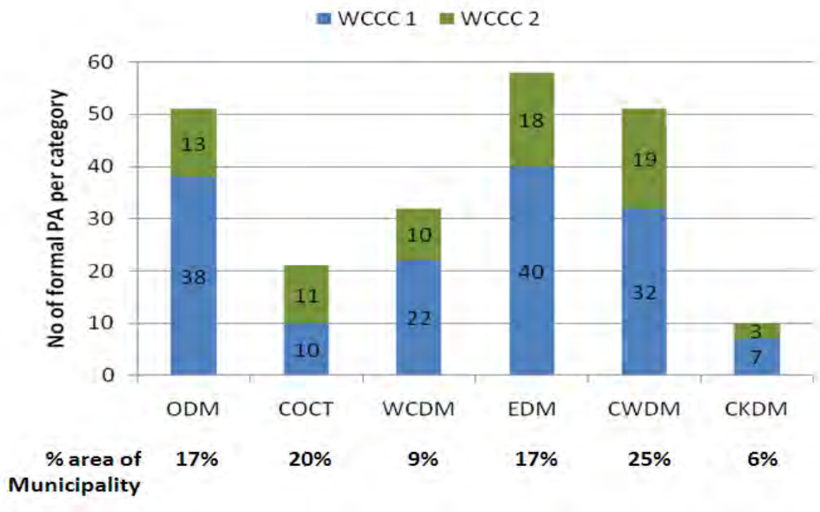

Figure 10: Number of formal protected areas per Western Cape Conservation Category and percentage coverage for each district[2] (SANBI 2012)

3.6.2 Marine protected Areas

Currently, 23% of the South African coastline is afforded protection under numerous Marine Protected Areas (MPAs), which includes those of the Western Cape Province (Griffiths *et al.* 2012). These are classed as WCCC1 areas, established for the conservation and management of the exceptional marine biodiversity and exploited species that occur along the province's coastline. At present, MPAs of the Western Cape Province conserve a total of 72 092 ha of coastal and marine habitats (Maree & Ralston 2012). These are often adjacent, or a part of, significant terrestrial protected areas (e.g. Table Mountain National Park, West Coast National Park, Tsitsikamma National Park MPA). While there are currently no MPA's along the West Coast District Municipality north of Saldanha Bay, known as the Namaqua Marine Bioregion, the proclamation of a Namaqualand MPA is proposed for the area to increase marine and coastal conservation (Griffiths *et al.* 2012).

Further details on Marine Protected Areas for the Western Cape are contained within the Oceans and Coasts chapter.

3.6.3 Protected area expansion targets

To ensure the long-term viability of core biodiversity areas, targets have been set per ecosystem type for protection within some formal measures. These protection measures include formal protected areas or types of biodiversity agreements and stewardship options (Table 2). The table shows on the ground expansion between 2002 and 2012, and the level of CBA coverage. Categories indicated by (*) are stewardship categories. Total row includes area (ha) of other protected areas not showing real expansion.

[2] WCCC1 includes Marine Protected Areas (but not included in percentage land cover of PAs)

Table 2: Extent of Western Cape Conservation Categories and Protected Area types (Maree & Ralston 2012)

Category	Sub-category	2002 ha	2007 ha	2012 ha	CBA ha	% of category that includes CBA
WCCC1	SA National Park	156 923	290 631	303 424	9 590	3.16
	Provincial Nature Reserve	152 794	189 474	234 987	5 616	2.39
	Marine Protected Area	41 784	68 338	72 092	NA	NA
	Contract Nature Reserves*	NA	17 602	52 824	12 348	23.38
Total WCCC1		**891 935**	**1 105 817**	**1203 132**	**28 283**	**2.35**
WCCC2	Biodiversity Agreement*	NA	960	14 959	7 083	47.35
Total WCCC2		**739 320**	**751 916**	**744 181**	**242 041**	**32.67**
WCCC3	Biosphere Reserves	320 186	498 330	820 349	193 787	23.62
	Conservancies	1 186 216	641 086	897 181	300 084	33.45
	Voluntary Conservation Area	NA	19 097	22 348	11 185	50.05
Total WCCC3		**1 596 402**	**1 598 200**	**1 623 479**	**472 008**	**29.07**

The most critically endangered vegetation types in the country are in the fynbos biome, which occurs in the Western Cape Province. Table 3 indicates that the biodiversity conservation targets for many of these areas are yet to be realised. It is evident that the percentage of remaining natural habitat is already less than the biodiversity target, which is set to represent 75% of the plant species associated with the vegetation type (Lombard *et al.* 2004). This is a major concern for biodiversity conservation and should be the focus for future conservation initiatives.

Table 3: Critically endangered vegetation types in the Western Cape, based on the percentage remaining area (extent of habitat fragmentation) and biodiversity target (NBSA 2004)

Vegetation Type	Biome	Remaining Area (%)	Biodiversity Target (%)	Protected (%)
Piketberg Quartz Succulent Shrubland	Fynbos	0	26	0.0
Lourensford Alluvium Fynbos	Fynbos	7	30	4.2
Swartland Shale Renosterveld	Fynbos	9	26	0.5
Swartland Silcrete Renosterveld	Fynbos	10	26	0.6
Cape Vernal Pools	Wetlands	12	24	0.0
Central Ruens Shale Renosterveld	Fynbos	13	27	0.4
Western Ruens Shale Renosterveld	Fynbos	14	27	0.0
Elgin Shale Fynbos	Fynbos	18	30	5.9
Cape Flats Sand Fynbos	Fynbos	19	30	0.1
Eastern Ruens Shale Renosterveld	Fynbos	19	27	0.4
Swartland Granite Bulb Veld	Fynbos	20	26	0.6
Ruens Silcrete Renosterveld	Fynbos	22	27	0.1
Peninsula Shale Renosterveld	Fynbos	23	26	18.7
Swartland Alluvium Fynbos	Fynbos	25	30	1.7
Cape Lowland Alluvial Vegetation	Fynbos	31	31	0.7

3.6.4 Freshwater ecosystems

The conservation of the freshwater ecosystems of the Western Cape Province has come under increased scrutiny over the past few decades as the pressure on these systems continues to intensify.

Most freshwater ecosystems in the Western Cape have been transformed from a natural state. Some of the poor condition of rivers results from urban development (filling of flood plains, excessive extraction and poor effluent quality), and extensive and intensive farming practices (excessive siltation due to unstable topsoils, riverbank ploughing and erosion). This situation suggests that river conservation should be a major area of policy focus.

The only rivers in the province that are of good quality are those in the Kogelberg and the Southern Cape. While the Kogelberg is protected, much of the Southern Cape faces considerable urban development pressure.

The National Freshwater Ecosystem Priority Areas (NFEPA) project products highlight important freshwater priorities for South Africa, while also providing ways to manage the protection of these areas in the Western Cape strategically. Through the NFEPA process, areas were identified and mapped and a desktop inventory of the status of these aquatic ecosystems was developed. The four major findings were (Nel 2011):

- Rivers and wetlands are highly threatened;
- Tributaries are generally in a better condition than the main channel;
- FEPAs only contribute 20 % of total river length in the Western Cape;
- If only 17 % of FEPAs were protected, all Western Cape endangered (including critically endangered) fish species could be protected.

Further details on the state of water resources and wetlands are contained within the Inland Water Chapter.

3.7 Habitat fragmentation and degradation

Habitat fragmentation is the breaking up of a continuous habitat, ecosystem, or land-use type into smaller fragments, generally by human activities and interference, which leads to habitat degradation. This in turn has major implications for ecosystem functioning and thus fragmentation is a good indicator of biodiversity loss (Rouget *et al.* 2004). The National Biodiversity Spatial Assessment (NSBA) of 2004 assessed the level of habitat fragmentation per vegetation type in South Africa (Rouget *et al.* 2004). Habitat fragmentation was quantified in terms of extent of habitat fragmentation (extent values), resistance to species movement (resistance value), and average fragment size (fragment size). The extent of habitat transformation ranged from 0 (natural) to 100 (transformed).

The study revealed that, of the 439 vegetation types assessed, 17 are highly fragmented, and almost all of these highly fragmented types occur in the Renosterveld and Fynbos of the Western Cape Province (Table 4). The high level of discontinuity between habitats and the dwindling availability of preferred habitat reduces the survival of rare and unique species associated with the vegetation of the Western Cape Province.

Table 4: Fragmentation level for the most highly fragmented vegetation types in the Western Cape Province (Rouget *et al.* 2004)

Vegetation Type	Overall Index (consists of a relative score, and should not be read as a percentage)
Swartland Silcrete Renosterveld	87
Cape Vernal Pools	86
Lourensford Alluvium Fynbos	85
Swartland Shale Renosterveld	82
Central Ruens Shale Renosterveld	78
Cape Flats Sand Fynbos	76
Saldanha Granite Strandveld	75
Western Ruens Shale Renosterveld	74
Ruens Silcrete Renosterveld	73
Eastern Ruens Shale Renosterveld	73
Swartland Granite Bulb Veld	71
Cape Lowland Alluvial Vegetation	71
Swartland Alluvium Fynbos	69
Elgin Shale Fynbos	67
Garden Route Granite Fynbos	65

In the Western Cape Province, 22% of the terrestrial landscape is completely transformed from a natural state (SANBI 2012). Clearing of land for agriculture and livestock overgrazing continue to be the major sources of habitat degradation. Urban expansion is particularly intense in the coastal district municipalities. The Land chapter shows the natural and transformed areas within the province as a measure of habitat degradation and loss. Unfortunately, no new land cover data has been generated since the 2005 Western Cape State of Environment Report (DEADP 2005). The last complete land cover data for the Western Cape was completed in 2001 (CSIR 2001), and has been moderately updated by a summarised national layer in 2009 (SANBI 2009). These data sets are out of date and new land cover and transformation data is needed to be able to accurately assess habitat loss.

4 IMPACTS

Pressures on the natural environment and its natural resources are manifested as impacts on biodiversity.

4.1 Water resources

Water is a critical resource, required for the survival of organisms and entire ecosystems, but is in high demand for human consumption and use for anthropogenic activities. Water resources in the Western Cape are limited due to the strong seasonal Mediterranean climate of the region, and mismatch between water availability and water demand, and the situation is likely to be compounded by the predicted effects of global climate change. Water intensive activities, particularly agriculture, livestock farming and mining, are therefore impacted by any degradation in the water supply system. Overabstraction of water for these purposes can reduce biodiversity, which in turn reduces the provision and effective execution of some water-related ecosystem services (for example, the water purification function provided by wetlands). In addition, the prevalence of invasive alien species which extracts large volumes of water from the landscape further exacerbates low water availability for natural fauna and flora, or for humans and human activities.

4.2 Loss of habitat

Increased development and clearing of land for agriculture and mining operations results in significant loss of habitat. The vegetation types of the CFR and Succulent Karoo are extremely habitat-specific and occupy unique niches that enable their survival. Decimation of such habitat, which is governed by a delicate balance between topography, soil type and climatic regime, would lead to the demise of these globally significant biomes with repercussions for their dependent fauna. Ultimately, the degrading effects would spiral down to all related ecosystem services.

4.3 Habitat degradation

While the complete loss of habitat is disastrous, even just degradation of remaining natural habitats poses a significant threat to biodiversity. Habitat fragmentation restricts the movement of biota between areas to more favourable environments, which further reduces their prevalence in the landscape and impedes genetic exchange. This in turn reduces the long-term viability of rare and unique plants and animals.

4.4 Ecosystem services

The sustained provision of ecosystem services is dependent on biodiversity. Plants and animals provide important ecosystem services which are of enormous benefit to society, for example water purification and pollination of economically important crops. If the threats to biodiversity are not reduced, many of the ecosystems services that people are dependent on may reach a level where human intervention is required to maintain or replace them, leading to severe cost implications.

4.5 Disease

Growing scientific evidence indicates that loss of biological diversity increases the risk of disease transmission in plants, animals and potentially humans (Keesing *et al.* 2010, Johnson *et al.* 2013). As biodiversity decreases, encounters among infected individuals and between infected and susceptible hosts increase, leading to the rapid spread of diseases. Greater diversity provides a greater proportion of incompatible hosts thereby interrupting the cycle of infection (Keesing *et al.* 2010).

Habitat loss and degradation may exacerbate disease transmission. For example, the devastating outbreak of the highly pathogenic avian influenza virus across ostrich farms in the Western Cape Province in 2012, and subsequent culling of thousands of birds, was possibly introduced by wild waterfowl species which are attracted to ostrich grazing lands and feeding areas in response to habitat degradation (Sinclair *et al.* 2006, BirdLife International 2007, CoCT 2012). Although the infection and loss of entire wild birds populations to avian influenza is considered rare, such a disease could be most damaging to species that are already threatened, and/or found in only a few localities (BirdLife International 2007), such as many of the endemic species of the Western Cape. In another example, the highly endemic fish populations of the province are at risk of disease caused by a pathogen (Epizootic Ulcerative Syndrome) recently discovered in several dams, which is known to infect various fish species (Jordaan *et al.* 2012).

It is critically important that major threats to biodiversity, such as habitat fragmentation, are addressed to prevent the concentration of fauna and flora in localised areas and the increased dependency of species on urban environments which further increases the spread of infection and potential for human transmission.

5 RESPONSES

5.1 General

Responses to biodiversity challenges within South Africa has been somewhat mixed. South Africa, and particularly the Western Cape, has a reputation for valuing its biodiversity resources and responding effectively to some of the challenges. Yet, many areas for improvement still exist.

Some progress has been made with establishment of a suite of bioregional programmes that have a strong focus on the ecosystem approach and on mainstreaming conservation. Examples include the development of tools for mainstreaming biodiversity in land-use planning and environmental assessment, business and biodiversity initiatives with key production sectors, establishment of stewardship programmes to secure protected area expansion on private land, and most recently the implementation of fiscal incentives to support conservation on private land (DEAT 2009).

However, there are also indications that the status of threatened species is worsening and biodiversity and ecosystem health continues to decline as key drivers of change (land-use change, climate change and alien invasive species) show no sign of decreasing (DEAT 2009). Human capacity is listed as a constraint, and shortfalls in financial resources present a significant challenge (DEAT 2009).

The provincial level Biodiversity Conservation Plan builds on national biodiversity plans, including the National Spatial Biodiversity Assessment of 2004, National Biodiversity Assessment 2012, as well as numerous regional and fine scale biodiversity plans in the Western Cape Province, and develops a specific systematic biodiversity plan for the province. It is intended to be used by all who are involved in land-use and development planning. The plan provides a basis for the Western Cape Province to review its biodiversity conservation policy and to focus its attention on high value areas for future protection initiatives. The plan and its land-use guidelines are intended to supplement other spatial planning tools such as municipal Integrated Development Plans and Spatial Development Frameworks.

One of the ways in which the biodiversity planning can be applied in practice is through biodiversity offset arrangements. The Province has produced a Guideline on Biodiversity Offsets, which ties into a National policy framework. This prepares a local framework for the introduction of offset agreements as a mechanism through which to secure priority or valued biodiversity areas, and in rehabilitating degraded areas or as conditions of environmental authorisations.

5.2 Policy, tools and legislation

Responses in the form of policies, tools and legislation across all scales applicable to this theme are listed in the summary table below:

Table 5: Summary of policy, tools and legislation

International Responses	1975	Convention on Wetlands of International Importance (RAMSAR)
	1975	Convention on International Trade in Endangered Species of Fauna and Flora (CITES)
	1983	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)
	1999	World Heritage Conservation Act 49 of 1999
National Responses	1998	National Environmental Management Act 107 of 1998 (NEMA)
	2003	National Environmental Management Protected Areas Act 57 of 2003 · Listed Critical Biodiversity Areas · Lists of protected fauna and flora
	2005	National Environmental Management Biodiversity Act 10 of 2005
Provincial / Regional	1998	Western Cape Nature Conservation Board Act 15 of 1998
	1998	Kogelberg UNESCO Biosphere

Responses	2007	Guideline on Biodiversity Offsets (edition 2)
	2009	Provincial Spatial Development Framework (2009)
	2009	CAPE Invasive Alien Species Strategy for the Greater Cape Floristic Region
		Bioregional programmes such as: · Cape Action for the People and the Environment (CAPE) · Subtropical Thicket Ecosystem Plan (STEP) · Succulent Karoo Ecosystem Programme (SKEP) · Biodiversity Corridor initiatives (Gouritz, Greater Cederberg)
		CapeNature and its: · State of Biodiversity Programme · Spatial Information Management Programme · Protected Area Expansion and Implementation Strategy (new)
		The Fynbos Forum and its ecosystem-specific guidelines
		Environmental education and awareness programmes
Local Authority Responses	2003	City of Cape Town Biodiversity Strategy
		Table Mountain Fund
		Cape Argus Ukuvuka Operation Fire-stop initiative
		Cape Flats Nature – Biodiversity for the people partnership project
		Establishment of Voluntary Conservation Areas
		Environmental education and awareness programmes

6 CONCLUSION

OUTLOOK: DECLINING

From the current assessment of the state of biodiversity of the Western Cape Province, it is evident that biodiversity continues to be under increasing pressure from human activities. While more and more plant and animal species are being described exclusive to the region, which contributes to the iconic high biodiversity and endemism, the number of species listed as threatened remains high, particularly for critically endangered and endangered plants and freshwater fishes.

By virtue of the presence of the Cape Floristic Region and Succulent Karoo Biome, two global hotspots renowned for their rich biodiversity, high species density and endemism, all of the district municipalities of the Western Cape Province encompass critically endangered and/or endangered ecosystems. However, significant progress has been made with respect to increased number of protected areas, identification of critical biodiversity areas, conservation initiatives, monitoring and reporting. Conservation targets have been set, and although many are not yet realised, there is a strong impetus toward ever-increasing biodiversity conservation for the province.

The findings of the Biodiversity and Ecosystem Health chapter can be summarised as an overall declining outlook. The reasons for this declining outlook, as presented in this chapter, focus around the continuing loss of biodiversity and general decline of the quality of ecosystem and the goods and services they provide. That there are 6 endangered and 9 vulnerable ecosystems that have no official conservation protection, and certain biodiversity targets that are by now impossible to reach, is of immense concern. As systems and processes are so closely connected, if the danger of spiralling decline of biodiversity and ecosystem health is not managed, we all face an uncertain future.

Table 6 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action. Table 7 contains the anticipated changes or outlook for the future of biodiversity and ecosystem health, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding of the dynamics associated with the biodiversity and ecosystem health.

Table 6: Summary of key aspects identified in the chapter

Aspect	Summary of key points
Pressures	• Agriculture • Urban growth • Invasive alien species • Possible warmer, drying climates
Impacts	• Reduced ecosystem services • Threatened natural wealth
Challenges	• Many critically endangered vegetation types have less remaining spatial extents than what is required for conservation • Mandate paralysis
Progress	• Protected areas being expanded • Extensive conservation planning • Recommendations for action • Protection for critical biodiversity areas and adoption of biodiversity planning into local SDFs
Critical areas for action	• Biodiversity Planning implementation- Municipal support for implementation & incorporation into spatial planning • Ongoing expansion of conservation network through PPP • Ecological Goods and Services - enhance & support functionality of ecosystem through programmes that reduce the vulnerability of the poor • EPWP type programmes e.g. Working for Water

Table 7: Summary of the outlook for biodiversity and ecosystem health based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend
Alien invasive species	• 291 invasive plant species • Primary threat to indigenous fish	Declining
Biodiversity Priority Areas	• Progress on expansion of conserved areas but only 2.3% of expansion qualifies as formal protection	High concern
Protected areas	• Since 2002: o 311 197ha formally protected (Only 2.4% of which are Critical Biodiversity Areas) o 4 861ha biodiversity agreements • 27 077ha conserved with no legal protection	Improving

Indicator	Quantification	Trend
Habitat fragmentation	• The province contains 15 of the 17 highly fragmented vegetation types in the country	Insufficient data
Vegetation types	• Existing mapping is from the South African National Biodiversity Institute (SANBI)	No change
Threat status	• Threatened species: o 70% of freshwater fish (16 of 23 indigenous species under threat) o 13% of plants (13 489 species total – 1 709 Threatened + 296 Critically Endangered + 575 Endangered + 801 Vulnerable; 68% of National Threatened species total; 2 984 additional species of concern; 21 species Extinct; 1 695 endemic to Western Cape) o 10% of mammals o 5% of reptiles o 5% of birds o Marine fish and invertebrates – information not available, cartilaginous fishes are assumed most threatened with 4 of 35 species Critically Endangered • Threatened terrestrial ecosystems: o 21 critically endangered o 14 endangered o 23 vulnerable	Insufficient historical data
Centres of endemism	• 96% of threatened species are endemic	High concern

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8 APPENDICES

Table 8: Harvested Western Cape plant species, their red list status and source locality (*) Indicates Cape Indigenous species.

Family	Scientific Name	Common Names	Harvest Target	Common Use	Method	Red List Status	Source Locality
PROTEACEAE	*Leucadendron floridum* R. Br.	Flats conebush / Tolbos	Flowers / foliage	Flowers / foliage	Hand	CR EN	Table Mountain National Park
PROTEACEAE	*Leucadendron levisanus* (L.) P.J. Bergius	Cape flats conebush	Flowers / foliage	Flowers / foliage	Hand	CR EN	Table Mountain National Park
PROTEACEAE	*Serruria florida* (Thunb.) Salisb. Ex Knight	Blushing bride	Flowers / foliage	Flowers / foliage	Hand	CR EN	Table Mountain National Park
IRIDACEAE	*Gladiolus alatus* L.	Turkey chick	Flowers/ bulb	Flowers / foliage	Hand	EN	Atlantis Conservation Area
PROTEACEAE	*Leucadendron argenteum* (L.) R. Br.	Silver tree	Flowers / foliage	Flowers / foliage	Hand	EN	Table Mountain National Park
PROTEACEAE	*Leucadendron daphnoides* (Thunb.) Meisn.	Giant pompom	Flowers / foliage	Flowers / foliage	Hand	EN	Table Mountain National Park
PROTEACEAE	*Leucadendron discolor* E. Phillips and Hutch	Flame goldtips	Flowers / foliage	Flowers / foliage	Hand	EN	Table Mountain National Park
PROTEACEAE	*Leucadendron gydoense* I. Williams	Gydo conebush	Flowers / foliage	Flowers / foliage	Hand	EN*	Table Mountain National Park
PROTEACEAE	*Leucadendron laxum* I. Williams	Bredasdorp conebush	Flowers / foliage	Flowers / foliage	Hand	EN*	Table Mountain National Park
PROTEACEAE	*Leucospermum conocarpodendron* (L.) H. Buek subsp. Conocarpodendron	Grey tree pincushion	Flowers / foliage	Flowers / foliage	Hand	EN	Table Mountain National Park
PROTEACEAE	*Leucospermum grandiflorum* (Salisb.) R. Br.	Rainbow pincushion	Flowers / foliage	Flowers / foliage	Hand	EN	Table Mountain National Park
PROTEACEAE	*Leucospermum heterophyllum* (Thunb.) Rourke	Snakebush	Flowers / foliage	Flowers / foliage	Hand	EN	Table Mountain National Park
LAURACEAE	*Ocotea bullata* (Burch.) Baill.	Black stinkwood	Bark	Medicine	Axe / saw	EN	Macassar / Wolfgat Nature Reserves
PROTEACEAE	*Paranomus reflexus* (E.Phillips and Hutch.) Fourc.	Green scepter	Flowers / foliage	Flowers / foliage	Hand	EN	Table Mountain National Park
GERANIACEAE	*Pelargonium ellaphieae* E.M. Marais		Whole plant	Nursery	Hand	EN	Cape Town - General
PROTEACEAE	*Protea lacticolor* Salisb.	Hottentott sugarbush	Flowers / foliage	Flowers / foliage	Hand	EN	Table Mountain National Park
PROTEACEAE	*Protea pudens* Rourke	Creeping protea	Flowers / foliage	Flowers / foliage	Hand	EN*	Table Mountain National Park

Family	Scientific Name	Common Names	Harvest Target	Common Use	Method	Red List Status	Source Locality
ASPHODELACEAE	*Aloe commixta* A. Berger		Whole plant	Nursery	Hand	VU	Cape Town - General
AMARYLLIDACEAE	*Cyrtanthus carneus* Lindl.	Wild crocus	Bulb	Medicine	Hand	VU	Table Mountain National Park
PROTEACEAE	*Diastella thymelaeoides* (PJ Bergius) Rourke subsp. Meridiana Rourke	Hangklip, Silkypuff	Flowers / foliage	Flowers / foliage	Hand	VU	Table Mountain National Park
ORCHIDACEAE	*Disa longicornu* L.f.		Whole plant	Nursery / Fibre	Hand	VU	Table Mountain National Park
RANUNCULACEAE	Knowltonia bracteata Harv ex. J Zahlbr.	Katjiedrie Blaar	Rhizome	Medicine	Hand	VU	Table Mountain National Park
PROTEACEAE	*Leucadendron corymbosum* P.J. Bergius	Swartveld conebush	Flowers / foliage	Flowers / foliage	Hand	VU	Table Mountain National Park
PROTEACEAE	*Leucadendron galpinii* E. Phillips and Hutch	Silver cone conebush	Flowers / foliage	Flowers / foliage	Hand	VU	Table Mountain National Park
PROTEACEAE	*Leucadendron linifolium* (Jacq.) R. Br.	Line leaf conebush	Flowers / foliage	Flowers / foliage	Hand	VU	Table Mountain National Park
PROTEACEAE	*Leucadendron platyspermum* R. Br	Flat seed	Flowers / foliage	Flowers / foliage	Hand	VU	Table Mountain National Park
PROTEACEAE	*Leucospermum hypophyllocarpodendron* (L.) Druce subsp. Hypophyllo-carpodendron		Flowers / foliage	Flowers / foliage	Hand	VU	Table Mountain National Park
PROTEACEAE	*Mimetes hirtus* (L.) Salisb. Ex Knight	Pineapple bush	Flowers / foliage	Flowers / foliage	Hand	VU	Table Mountain National Park
GERANIACEAE	*Pelargonium leptum* L. Bolus		Whole plant	Medicine	Hand	VU	Cape Town - General
PROTEACEAE	*Protea subvestita* N. E. Br.		Flowers / foliage	Flowers / foliage	Hand	VU*	Table Mountain National Park

Table 9: Harvested Western Cape animal species, their red list status and source locality (*) Indicates species alien to South Africa.

Family	Scientific Name	Common Names	Common Use	Method	Red List Status	Source Locality
Insecta	Colophon beetles - all species		Pet trade / collectors	Hand	EN	Table Mountain National Park
Reptilia	*Psammobates geometricus*	Geometric tortoise	Medicine	Hand	EN	Table Mountain National Park
Osteichthyes	*Cyprinus carpio*	Common carp	Food source	Hand	VU*	All waterways

Table 10: Threatened marine animal species of the Western Cape animal species and their red list status.

Corals		Threat Status	Cartilagenous fishes (cont…)		Threat Status
Heliopora	*coerulea*	VU	*Manta*	*alfredi*	VU
Acropora	*anthocercis*	VU	*Manta*	*birostris*	VU
Acropora	*appressa*	NT	*Mobula*	*japanica*	NT
Acropora	*austera*	NT	*Mobula*	*thurstoni*	NT
Acropora	*digitifera*	NT	*Aetobatus*	*narinari*	NT
Acropora	*divaricata*	NT	*Electrolux*	*addisoni*	CR
Acropora	*florida*	NT	*Heteronarce*	*garmani*	VU
Acropora	*formosa*	NT	*Pristis*	*pectinata*	CR
Acropora	*glauca*	NT	*Pristis*	*zijsron*	CR
Acropora	*horrida*	VU	*Rostroraja*	*alba*	EN
Acropora	*humilis*	NT	*Rhinobatos*	*cemiculus*	EN
Acropora	*hyacinthus*	NT	*Rhinobatos*	*rhinobatos*	EN
Acropora	*millepora*	NT	*Rhinoptera*	*javanica*	VU
Acropora	*monticulosa*	NT	*Rhynchobatus*	*djiddensis*	VU
Acropora	*nana*	NT	*Centrophorus*	*granulosus*	VU
Acropora	*nasuta*	NT	*Deania*	*quadrispinosa*	NT
Acropora	*retusa*	VU	*Dalatias*	*licha*	NT
Acropora	*secale*	NT	*Oxynotus*	*centrina*	VU
Acropora	*tenuis*	NT	*Squalus*	*acanthias*	VU
Acropora	*verweyi*	VU			
Acropora	*willisae*	VU	**Bony Fishes**		
Isopora	*palifera*	NT	*Lophius*	*vomerinus*	NT
Turbinaria	*mesenterina*	VU	*Chaetodon*	*trifascialis*	NT
Favia	*matthaii*	NT	*Epinephelus*	*lanceolatus*	VU
Favia	*stelligera*	NT	*Epinephelus*	*malabaricus*	NT
Favites	*abdita*	NT	*Plectropomus*	*laevis*	VU
Favites	*flexuosa*	NT	*Kajikia*	*albida*	VU
Favites	*halicora*	NT	*Kajikia*	*audax*	NT
Goniastrea	*columella*	NT	*Makaira*	*nigricans*	VU
Goniastrea	*peresi*	NT	*Scomberomorus*	*commerson*	NT
Montastrea	*annuligera*	NT	*Thunnus*	*alalunga*	NT
Oulophyllia	*crispa*	NT	*Thunnus*	*albacares*	NT
Platygyra	*crosslandi*	NT	*Thunnus*	*maccoyii*	CR
Hydnophora	*exesa*	NT	*Thunnus*	*obesus*	VU
Hydnophora	*microconos*	NT	*Thunnus*	*thynnus*	EN
Pocillopora	*eydouxi*	NT	*Hippocampus*	*capensis*	EN
Alveopora	*allingi*	VU	*Hippocampus*	*histrix*	VU
Alveopora	*spongiosa*	NT			
Anomastraea	*irregularis*	VU	**Reptiles**		
Tubipora	*musica*	NT	*Lepidochelys*	*olivacea*	VU
Molluscs			**Birds**		
Tomichia	*tristis*	CR	*Charadrius*	*pallidus*	NT

			Haematopus	*moquini*	NT
Hagfish			*Sterna*	*balaenarum*	NT
Eptatretus	*octatrema*	CR	*Sterna*	*virgata*	NT
			Numenius	*arquata*	NT
Cartilagenous fishes			*Phalacrocorax*	*capensis*	NT
Carcharhinus	*albimarginatus*	NT	*Phalacrocorax*	*coronatus*	NT
Carcharhinus	*brevipinna*	NT	*Phalacrocorax*	*neglectus*	EN
Carcharhinus	*leucas*	NT	*Morus*	*capensis*	VU
Carcharhinus	*limbatus*	NT	*Phoeniconaias*	*minor*	NT
Carcharhinus	*longimanus*	VU	*Diomedea*	*dabbenena*	CR
Carcharhinus	*melanopterus*	NT	*Diomedea*	*epomophora*	VU
Carcharhinus	*obscurus*	VU	*Diomedea*	*exulans*	VU
Carcharhinus	*plumbeus*	VU	*Diomedea*	*sanfordi*	EN
Carcharhinus	*sorrah*	NT	*Phoebetria*	*fusca*	EN
Galeocerdo	*cuvier*	NT	*Phoebetria*	*palpebrata*	NT
Prionace	*glauca*	NT	*Thalassarche*	*carteri*	EN
Haploblepharus	*edwardsii*	NT	*Thalassarche*	*cauta*	NT
Haploblepharus	*fuscus*	VU	*Thalassarche*	*chlororhynchos*	EN
Haploblepharus	*kistnasamyi*	CR	*Thalassarche*	*chrysostoma*	VU
Holohalaelurus	*favus*	EN	*Thalassarche*	*melanophrys*	EN
Holohalaelurus	*punctatus*	EN	*Thalassarche*	*salvini*	VU
Sphyrna	*lewini*	EN	*Thalassarche*	*steadi*	NT
Sphyrna	*mokarran*	EN	*Procellaria*	*aequinoctialis*	VU
Galeorhinus	*galeus*	VU	*Procellaria*	*cinerea*	NT
Mustelus	*mustelus*	VU	*Procellaria*	*conspicillata*	VU
Triakis	*megalopterus*	NT	*Pterodroma*	*incerta*	EN
Alopias	*pelagicus*	VU	*Eudyptes*	*chrysocome*	VU
Alopias	*superciliosus*	VU	*Eudyptes*	*chrysolophus*	VU
Alopias	*vulpinus*	VU	*Spheniscus*	*demersus*	EN
Carcharodon	*carcharias*	VU			
Isurus	*oxyrinchus*	VU	**Mammals**		
Lamna	*nasus*	VU	*Balaenoptera*	*borealis*	EN
Carcharias	*taurus*	VU	*Balaenoptera*	*musculus*	EN
Odontaspis	*ferox*	VU	*Balaenoptera*	*physalus*	EN
Himantura	*uarnak*	VU	*Sousa*	*chinensis*	NT
Taeniurops	*meyeni*	VU	*Hippopotamus*	*amphibius*	VU
			Physeter	*macrocephalus*	VU

Table 11: Summary of listed ecosystems for the Western Cape Province, including those shared with other provinces (SANBI 2011)

ECOSYSTEM	BIOME	CRITERION	SHARED WITH
Critically Endangered			
Atlantis Sand Fynbos (FFd 4)	Fynbos	D1	
Cape Flats Sand Fynbos (FFd 5)	Fynbos	A1 & D1	
Cape Lowland Alluvial Vegetation (AZa 2)	Azonal	A1	
Central Rûens Shale Renosterveld (FRs 12)	Fynbos	A1	
Eastern Rûens Shale Renosterveld (FRs 13)	Fynbos	A1	
Elgin Shale Fynbos (FFh 6)	Fynbos	A1	
Elim Ferricrete Fynbos (FFf 1)	Fynbos	A1	
Knysna Sand Fynbos (FFd 10)	Fynbos	A1	
Kogelberg Sandstone Fynbos (FFs 11)	Fynbos	D1	
Langkloof Shale Renosterveld (FRs 17)	Fynbos	A1	Eastern Cape
Lourensford Alluvium Fynbos (FFa 4)	Fynbos	A1	
Muscadel Riviere (AZi 8)	Azonal	A1	
Overberg Sandstone Fynbos (FFs 12)	Fynbos	D1	
Peninsula Granite Fynbos (FFg 3)	Fynbos	A1	
Peninsula Shale Renosterveld (FRs 10)	Fynbos	A1	
Rûens Silcrete Renosterveld (FRc 2)	Fynbos	A1	
Swartland Alluvium Fynbos (FFa 3)	Fynbos	A1	
Swartland Granite Renosterveld (FRg 2)	Fynbos	A1 & D1	
Swartland Shale Renosterveld (FRs 9)	Fynbos	A1 & D1	
Swartland Silcrete Renosterveld (FRc 1)	Fynbos	A1	
Western Rûens Shale Renosterveld (FRs 11)	Fynbos	A1	
Endangered			
Agulhas Sand Fynbos (FFd 7)	Fynbos	A1	
Breede Alluvium Fynbos (FFa 2)	Fynbos	A1	
Cape Flats Dune Strandveld (FS 6)	Fynbos	D1	
Cape Vernal Pools (AZf 2)	Azonal	A1	Northern Cape
Garden Route Granite Fynbos (FFg 5)	Fynbos	A1	
Greyton Shale Fynbos (FFh 7)	Fynbos	A1	
Groot Brak Dune Strandveld (FS 9)	Fynbos	A1	
Hangklip Sand Fynbos (FFd 6)	Fynbos	A1	
Kouebokkeveld Alluvium Fynbos (FFa 1)	Fynbos	A1	
Mossel Bay Shale Renosterveld (FRs 14)	Fynbos	A1	
Peninsula Sandstone Fynbos (FFs 9)	Fynbos	D1	
Potberg Ferricrete Fynbos (FFf 2)	Fynbos	A1	
Saldanha Granite Strandveld (FS 2)	Fynbos	A1	
Western Cape Milkwood Forest (FOz VI3)	Forest	C	
Vulnerable			
Agulhas Limestone Fynbos (FFl 1)	Fynbos	D1	

Albertinia Sand Fynbos (FFd 9)	Fynbos	A1	
Bokkeveld Sandstone Fynbos (FFs 1)	Fynbos	D1	Northern Cape
Boland Granite Fynbos (FFg 2)	Fynbos	D1	
Breede Alluvium Renosterveld (FRa 1)	Fynbos	A1	
Breede Sand Fynbos (FFd 8)	Fynbos	A1	
Cape Winelands Shale Fynbos (FFh 5)	Fynbos	A1	
Cederberg Sandstone Fynbos (FFs 4)	Fynbos	D1	
Ceres Shale Renosterveld (FRs 4)	Fynbos	A1	
Eastern Coastal Shale Band Vegetation (FFb 6)	Fynbos	A1	Eastern Cape
Eastern Little Karoo (SKv 11)	Succulent Karoo	A1	
Garden Route Shale Fynbos (FFb 9)	Fynbos	A1	Eastern Cape
Hawequas Sandstone Fynbos (FFs 10)	Fynbos	D1	
Hopefield Sand Fynbos (FFd 3)	Fynbos	A1 & D1	
Kango Limestone Renosterveld (FRl 1)	Fynbos	A1	
Kouebokkeveld Shale Fynbos (FFh 1)	Fynbos	A1	
Leipoldtville Sand Fynbos (FFd 2)	Fynbos	A1 & D1	
Montagu Shale Renosterveld (FRs 7)	Fynbos	A1	
Piketberg Quartz Succulent Shrubland (SKk 8)	Succulent Karoo	A1	
Piketberg Sandstone Fynbos (FFs 6)	Fynbos	D1	
Saldanha Flats Strandveld (FS 3)	Fynbos	A1	
Swartland Alluvium Renosterveld (FRa 2)	Fynbos	A1	
Swellendam Silcrete Fynbos (FFc 1)	Fynbos	A1	

Western Cape Government
Environmental Affairs and Development Planning

BETTER TOGETHER.

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Inland Water Chapter

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ABBREVIATIONS

CMA	Catchment Management Agency
DAFF	Department of Agriculture, Forestry and Fisheries
DEADP	Department of Environmental Affairs and Development Planning
DWA	Department of Water Affairs
FEPAs	Freshwater Ecosystem Priority Areas
FI	Fish Index
GI	Geomorphologic index
IHI	Index of Habitat Integrity
NAEHMP	National Aquatic Ecosystem Health Monitoring Programme
NEMP	National Eutrophication Monitoring Programme
NWA	National Water Act
PES	Present Ecological State
RHP	River Health Programme
RQO's	Resource Quality Objectives
RVI	Riparian Vegetation Index
SASS5	South African Scoring System version 5
StatsSA	Statistics South Africa
UGEP	Utilizable Groundwater Exploitable Potential
WAAS	Water Availability Assessment Study
WCWSS	Western Cape Water Supply System
WMA	Water Management Areas

GLOSSARY

Biodiversity	The diversity of animals, plants and other organisms found within and between ecosystems, habitats, and the ecological complexes
Ecological Water Reserve	The water that is necessary to protect the water ecosystems. The ecological reserve specifies both the quantity and quality of water that must remain unused in a water resource. The ecological reserve is determined for all major water resources in the different water management areas to ensure sustainable use
EcoStatus	The totality of the features and characteristics of a river and its riparian area that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services
Ecosystem	A dynamic system of plant, animal (including humans) and micro-organism communities and their non-living physical environment interacting as a functional unit. The basic structural unit of the biosphere, ecosystems are characterised by interdependent interaction between the component species and their physical surroundings. Each ecosystem occupies a space in which macro-scale conditions and interactions are relatively homogenous
Environment	In terms of the National Environmental Management Act (NEMA) (No 107 of 1998)(as amended), "Environment" means the surroundings within which humans exist and that are made up of: the land, water and atmosphere of the earth; Micro-organisms, plants and animal life; any part or combination of (i) of (ii) and the interrelationships among and between them; and the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing
Environmental Impact	A change to the environment, whether adverse or beneficial, wholly or partially, resulting from an organisations activities, products or services.
Integrated Environmental Management	A philosophy that prescribes a code of practice for ensuring that environmental considerations are fully integrated into all stages of the development and decision-making process. The IEM philosophy (and principles) is interpreted as applying to the planning, assessment, implementation and management of any proposal (project, plan, programme or policy) or activity - at local, national and international level - that has a potentially significant effect on the environment. Implementation of this philosophy relies on the selection and application of appropriate tools for a particular proposal or activity. These may include environmental assessment tools (such as strategic environmental assessment and risk assessment), environmental management tools (such as monitoring, auditing and reporting) and decision-making tools (such as multi-criteria decision support systems or advisory councils)

Integrated Water Resource Management	Is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM is simultaneously a philosophy, a process, and an implementation strategy to achieve equitable access to, and sustainable use of, water resources by all stakeholders at catchment, regional, national, and international levels, while maintaining the characteristics and integrity of water resources at the catchment scale within agreed limits
Pollution	Is the direct or indirect alteration of the physical, chemical or biological properties of a water resource, so as to make it (inter alia)- less fit for any beneficial purpose for which it may reasonably be expected to be used; or harmful or potentially harmful to the welfare or human beings, to any aquatic or non-aquatic organisms, or to the resource quality
Present Ecological State	The status quo estimate of environmental resources ecology. For a water resources, system driver (Geomorph and Hydrology) and response (Biological) components are measured in terms of the ecoclassification whereby an index derived approach is used to measures representative changes from a perceived natural reference state to its current reference state
Water Quality	The term water quality describes the physical, chemical, biological and aesthetic properties of water which determine its fitness for a variety of uses and for protecting the health and integrity of aquatic ecosystems. Many of these properties are controlled or influenced by constituents which are either dissolved or suspended in water
Water Resource	includes a watercourse, surface water, estuary or aquifer
Water Use	An activity which has an impact on a water resource and affects the: amount of water in the resource; the quality of water in the resource; or the environment depended on the status quo of the water resource being used
Watercourse	A river or spring; a natural channel or depression in which water flows regularly or intermittently; a wetland, lake or dam into which, or from which, water flows; and any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse as defined in the National Water Act, 1998 (Act No. 36 of 1998) and a reference to a watercourse includes, where relevant, its bed and banks
Wetland	Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil

1 INTRODUCTION

South Africa is a water scarce country and the resource is unevenly distributed across the country's landscape. The majority of the exploitable water is found in sparsely populated mountain catchment areas and within the boundary of our neighbour Lesotho. Nevertheless, as custodian of the country's water resources the South African government has the responsibility to provide water for the entire population. It also has the obligation to supply this resource in an ecologically sustainable manner (DWA 2009). As a result, South Africa is faced with many complexities related to its water resources, therefore making sound and comprehensive management a crucial requirement.

Demands in terms of quality and quantity of water differ across sectors, water users and ecological requirements. Importantly, for the Western Cape, a strong seasonality and micro-regional differentiation determines the balance between availability of water and the demands from water users. As a result, the pressures and impacts associated with water use are diverse in composition and intensity, and affect the resilience of the province's water resource situation and subsequent resource management. Water resource management schemes, such as the Western Cape Water Supply System, therefore become critical to the sustainable management of both water reserves and the demands on the resource.

This chapter aims to describe the unique water perspective of the Western Cape Province, as well as highlight the trends of change over time and emerging threats related to this precious resource. Indicators used to describe the current state of water resources include water availability, fitness for use and freshwater ecosystem health. Discussions extend to the pressures on water resources as well as to the impacts of changes to the state of water resources and the responses from government and other entities to these impacts.

2 PRESSURES

Primary consumptive water use activities include the agricultural sector, human settlements, industry and forestry. Other non-consumptive but equally important uses include water treatment systems, recreation and aquaculture. These everyday demands for water are likely to increase over time since climate change projections indicate that temperatures will rise and rainfall might decrease. A corresponding increase in the frequency of droughts will further reduce the availability of water (DEADP 2012a).

Importantly, despite growing demands for water supply to the expanding urban areas, agricultural activities and industrial users, sufficient water must be left in natural watercourses to maintain their ecological integrity – the 'ecological reserve'. Furthermore, the pollution of water resources leads to the degradation of ecosystems and the loss of ecosystem services, health implications, increasing treatment costs and limits water use based on quality requirements. These impacts are discussed under Section 4.

The resultant pressure on water resources will therefore require more investment in water recovery, transfer schemes to balance water availability between catchments, the intensification of irrigation schemes, as well as water conservation and demand management. Increased utilisation of currently under-utilised groundwater reserves will also become inevitable.

The primary activities associated with water use in the Western Cape are discussed in the sub-sections below.

Ecological Reserve

The National Water Act (36 of 1998) Chapter 3 Part 3 prescribes the calculation of a minimum water reserve or ecological reserve as a mandatory requirement and benchmark for water use management. In its most basic form, the reserve is defined as the amount of water required to protect the aquatic ecosystem dependant on a particular water resource (river, stream, etc.) as well as to supply basic human needs of water users.

Historically the Ecological Reserve was not considered in water resource management and planning. Since 1998, it has been a legal requirement that the Reserve be determined for WMAs and considered in all planning and management of water resources. In many cases setting an ecological reserve as minimum requirement over and above the existing water uses effectively took up any "spare" water use capacity, or in some cases even pushed the catchment into a deficit situation. Such borderline or deficient balances indicate unsustainable abstraction practise, which increases a dire need for management intervention and in possibly even water use re-allocation. The Breede-Overberg region is a prime example, as it was always thought that there was surplus water available in the system, and that additional large-scale irrigation expansion or increased water transfers to the Berg WMA to supplement Cape Town's water supply were possible. The latest draft of the Breede-Overberg Catchment Management Agency's Catchment Management Strategy, however, found that based on current information, a precautionary approach needs to be adopted in terms of the allocation of water from the Breede. Until such time as the availability of water has been confirmed through an updated Water Availability Assessment Study (WAAS), no further water allocations can be made. This recommendation has been taken into consideration by DWA (National Water Resource Planning), in terms of their programme for further studies on water availability assessment.

Data source: NWA and DEADP 2012a

2.1 Agriculture

Agriculture, and in particular irrigated cultivation, is the country's largest water user, utilising approximately 62% of the available water resources nationally (StatsSA 2010). The state of the South African economy is strongly influenced by the state of the agricultural sector and the country continues to have a very important role in regional food production. This results in the availability of water resources for irrigation purposes being extremely important.

The Western Cape mirrors this national norm, with agriculture as the most extensive land use. Approximately 2.5 million ha are currently under cultivation, of which about 270 000ha are under irrigation.

Agricultural potential can only be fully realised where climatic conditions are favourable and water is available for irrigation. Where surface water is scarce, pressure is placed on groundwater reserves to satisfy irrigation requirements. These groundwater reserves must be pro-actively managed to ensure that recharge exceeds abstraction in order to realise a sustainable level of utilisation of the resource.

Furthermore, agricultural activities rely heavily on pesticides and fertilisers. These contribute to pollution of freshwater resources and soils through surface water runoff and seepage containing high levels of phosphates and nitrates.

2.2 Human settlements

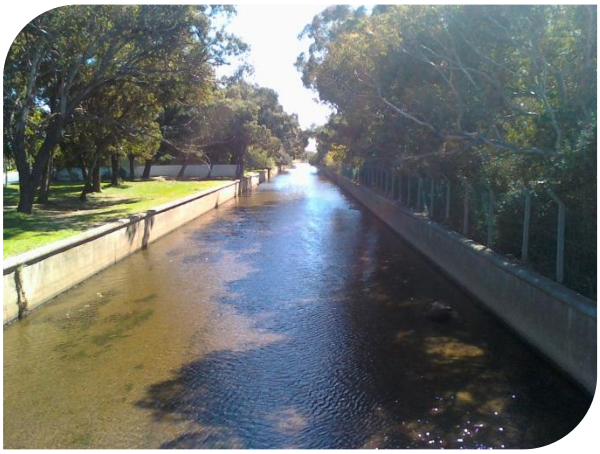
Water is one of the most basic requirements to sustain life. Human needs for water resources relate to domestic use (e.g. drinking water, washing, cooking, recreation, spiritual and aesthetic value), agriculture and industry. As such, access to water is a basic human need. However, almost all human activities that require water results in the degradation of this resource and associated ecosystems. This is a consequence of the modification of natural surface water resources by channel and flow alterations, of nutrient loading and of pollution.

2.2.1 Informal settlements

Informal settlements and backyard dwellers often have poor access to infrastructure and services for electricity, water, solid waste and sanitation services. This lack of access to services results in pollution of the surrounding environment, including nearby water courses and stormwater systems, with solid waste, grey and black water. Polluted water is routed into the stormwater drainage system in the absence of adequate drainage and sanitation services, thereby creating a serious health risk. Natural dilution and ecological "scrubbing" processes are not always sufficient to dilute the pollutant load and the polluted water then poses a risk to crop irrigation and a health risk to those making direct use of the river water (e.g. for washing of clothes and other domestic chores). In addition, it becomes difficult to service infrastructure where informal dwellings have been constructed above access points to sewer lines (DEADP 2012a).

2.2.2 Urban and semi-urban settlements

The majority of the population in the Western Cape is found around the urban nodes. This has resulted in landscape transformation that directly impacts on stream ecosystems. The most noticeable impact is related to the increase of impervious surfaces within urban catchments. It alters the hydrology and geomorphology of streams, resulting in increases of runoff and pollution that reaches wetlands and rivers, and ultimately the ocean, and limits recharge of groundwater sources (DEADP 2005). Municipal and industrial discharges further add to the levels of nutrients, metals, pesticides and other contaminants entering riparian systems. This nutrient loading results in algal blooms, and alters water conditions beyond their natural state, thereby compromising the water dependant ecological systems.



2.3 Invasive alien plants

Invasive alien plants are well known to use significant volumes of water, compared to indigenous species. As a result, invasive alien plants also reduce the quantity of water available for ecosystems and land-users. Invasive alien plants, both terrestrial and aquatic, also impact on biodiversity by causing vegetation transformation and a reduction in ecosystem services. This impacts on the economy as a result of management costs and through losses to agriculture associated with reduced water resource availability and quality (De Lange *et al.* 2012; Kotze, *et al.* 2010).

Invasive alien plants are thought to cover approximately 1.813 million condensed ha nationally, with the highest concentrations found in the south-western, southern and eastern coastal belts and the adjacent interior (Van Wilgen 2012). Therefore the impacts of management and control of invasive alien plants on catchment water resources are significant, and include native species loss, increased biomass and fire intensity, increased erosion, decreased river flows and detrimental effects on water quality (Chamier 2012). The Breede and Gouritz Water Management Area (WMA) are identified as the worst affected areas in the Western Cape. Priority areas include the upper reaches of the Riviersonderend and Upper Breede in the Breede WMA and the Goukou and Duiwenhoks catchments in the Gouritz WMA (Le Maitre *et al.* 2000).

For further information about the quantities of water utilised by alien invasive plants across the province, refer to Section 3.1.4.

2.4 Forestry

Forestry covers approximately 88,000 ha of the province and accounts for a modest part of the provincial economic base. Typically, small commercial plantations are located in the mountainous catchment regions with high precipitation (>800mm)(DEADP 2012a).

According to the Berg, Breede, Gouritz and Olifants-Doorn Internal Strategic Perspectives (2005) an estimated volume of 28 million m^3/annum of water use is estimated to be consumed for forestry activities. This is largely attributed to the use of non-indigenous species for plantations. Species such as pines, gums and wattle require greater quantities of water than indigenous afromontane type forests, and therefore result in stream flow reductions greater than that which would be experienced from indigenous local species.

2.5 Aquaculture

Aquaculture is an emerging industry in the province, and production figures indicate a significant growth between 2006 – 2010, recording an increase of 234.65 tons or 11.6% (DAFF 2011). According to the Draft Western Cape Aquaculture Market Analysis and Development Programme/Strategy (2012), the aquaculture sector in the Western Cape is realistically projected to grow a hundredfold within the following ten to fifteen years. On the one hand, this projection is good for trade and industry as job creation and sector growth is stimulated, but on the other hand, various impacts related to aquaculture have already proven to be problematic in affected catchments. For example, the impacts of aquaculture species on indigenous biota are either on a primary competitor level (competing for foods) and/or a predator level (preying on indigenous species). Furthermore, species such as bass and carp impacts on water resource clarity when promoting increased levels of turbidity and thereby degrading the natural habitat of wetlands and rivers (RHP 2006).

Trout is the most cultured freshwater species in South Africa, followed by the culturing of Ornamental species. The freshwater species cultured in 2010 included trout (*Oncorhynchus mykiss and Salmo trutta*), tilapia (*Oreochromis mossambicus*), catfish (*Clarias gariepinus*), carp (*Cyprinus carpio* and *Ctenopharyngodon idella*), mullet (*Liza richardsonii*), largemouth bass (*Micropterus salmoides*), Marron crayfish (*Cherax tenuimanus*), Atlantic salmon (*Salmo salar*) and a number of ornamental species (DAFF 2011).

3 STATE

Tracked indicators of *status* of Inland Water:

- Quantity of water available
- Quality of the available water resources
- Health of freshwater ecosystems

To facilitate water resources management, South Africa is divided into 19 Water Management Areas (WMAs), as shown in Figure 1. In turn, these WMA's are managed by 9 catchment management agencies (CMAs) with the goal of progressively decentralising national management and realising the National Water Act's integrated water resource management ethos.

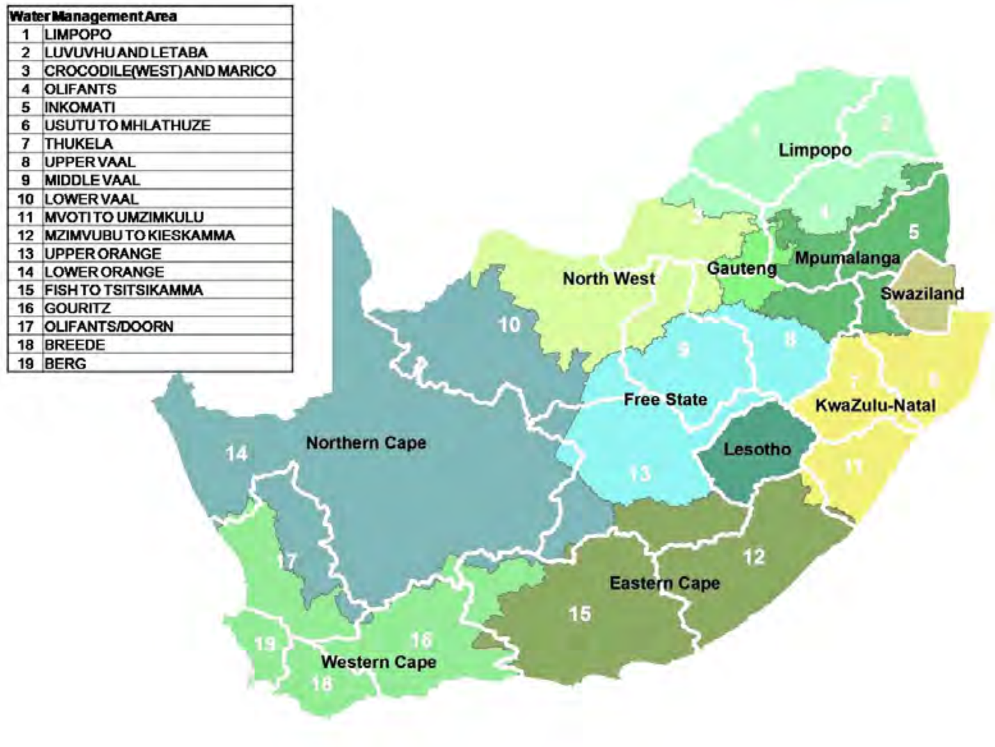


Figure 1: WMA and provinces of South Africa (DWAF 2009)

The Western Cape hosts primarily four WMAs, namely the Berg, Breede, Olifants/Doorn and Gouritz. The four WMAs differ significantly in terms of surface and groundwater resource availability, associated dependant landscape ecology, sensitivity for exploitation and its priority for conservation. WMAs that 'overlap' with the Western Cape provincial boundary are the Lower Orange WMA and the Fish to Tsitsikamma WMA. The major WMAs in the Western Cape, with associated major rivers, are listed in Table 1:

Table 1: The Water Management Areas and major rivers of the Western Cape

Water Management Area		Catchment Management Agency	Major rivers
16	Gouritz	Western Cape South Coast Rivers	Gouritz, Olifants, Kamanassie, Gamka, Buffels, Touws, Goukou and Duiwenhoks
17	Olifants / Doorn	Western Cape West Coast Rivers	Olifants, Doring, Krom, Sand and Sout
18	Breede	Western Cape South Coast Rivers	Breede, Sonderend, Sout, Bot and Palmiet
19	Berg	Western Cape West Coast Rivers	Berg, Dwars, Eerste, Diep and Steenbras

3.1 Water availability

The quantity of water available for direct human use or to support aquatic ecosystems depends on the availability of the resource and sustainability in its use. Availability is also closely linked to climatic variability in South Africa. Rainfall is unevenly spread across the country's catchments, with most of the northern and western regions of the country receiving less rainfall. These areas are therefore semi-arid, including the north-western and inland areas of the Western Cape. A further aspect that adds complexity to managing South Africa's water resources is the seasonality of rainfall patterns and subsequent runoff, particularly in the Western Cape where high winter rainfall is contrasted with much less precipitation during summer.

3.1.1 Surface water resources

Surface water, originating mainly from rivers and dams, is our primary source of water. In order to effectively manage and allocate this water for use, it is important to be able to quantify how much is available. The Western Cape Water Supply System (WCWSS) serves to manage surface water resources in order to supply the City of Cape Town, surrounding urban centres and agricultural areas' water demands. The system consists of infrastructure components owned and operated by the City of Cape Town, Trans Caledon Tunnel Authority and the Department of Water Affairs.

Table 2 compares the quantities of surface water available in each WMA in terms of the natural mean annual runoff, storage in dams, and provisions for the ecological reserve.

Table 2: Available surface water per water management area (million m³)[1] (StatsSA 2010 & NWRS I 2004)

	Water Management Areas								
	Gouritz		Olifants/Doorn		Breede		Berg		Total for SA
	2000	2012	2000	2012	2000	2012	2000	2012	
Mean annual runoff	1679		1108		2472		1429		49040
Storage in major dams	272.2	301	127.5	132	1039.3	1060	419	295	32412
Ecological Reserve	325		156		384		217		9545

From the table it is evident that surface water is not evenly distributed across the province. The Breede WMA receives almost double the mean annual runoff that of the Olifants/Doorn WMA, i.e. 2427 million m³ and 1108 million m³ respectively. In addition, the Breede WMA stores far more water in its dams than any of the other WMAs. This distribution of water resources have direct implications for land use and planning, together with considerations of climate and utilisable soil type. With regards to water availability, the Breede WMA has the largest capacity for broad scale agricultural practices, whilst the Olifants/Doorn WMA and Gouritz WMA have the least (they are characterised by the Namaqualand and Klein-Karoo semi arid climates).

The human population settlement density grouping within the province also intensifies the water availability situation as settlement growth over time is no longer directly related to

[1] Dam storage data was sourced from the NWRS I and updated by current Department of Water Affairs Regional data supplied for this project. Cape Town Systems are estimated to be responsible for 890.22 million m³ and the total for the Western Cape is at 1855.42 million m³. Also evident is the additional augmentation provided by the construction of the Berg River Dam.

the spatial distribution of available water. Most of the province's population is found within the urban nodes, generally distributed around significant trade and port centres, and in particular the Cape Town metropolitan area. The Cape Town water systems are estimated to provide for only 890.22 million m³ of water resources, with inter-basin transfers from the Breede WMA providing additional water to the area. Therefore careful consideration is needed where water use is concerned.

It is also important to note that the limits to the development of surface water sources have been reached in most places, and the opportunities for the economically feasible placement of new dams are few (DWA 2010b). The costs of transfers to locations where water is needed are also rising with increasing distances and rising costs of pumping and associated infrastructure. Despite this, a new dam may need to be constructed in order to meet water demands in the Western Cape region by 2019.

3.1.2 Groundwater resources

It is estimated that the total available and renewable groundwater resource in South Africa, the 'Utilizable Groundwater Exploitable Potential' (UGEP), is 10 343 m^3/annum or 7500 m^3/annum under drought conditions (DWA 2010c). Of this resource, the Western Cape has access to 1049.3 m^3/annum, although the amount of UGEP varies greatly across WMAs, as some areas have far higher groundwater reserves than others (see Table 3).

Table 3: Utilizable groundwater exploitable potential (UGEP) per WMA in the Western Cape (DWA 2010c)

Water Management Area		UGEP (m^3/annum)
16	Gouritz	279.9
17	Olifants/Doorn	157.5
18	Breede	362.9
19	Berg	249
	Total	**1049.3**

3.1.3 High water yield areas

High water yield areas are those areas where the mean annual runoff is at least three times more than the average per annum for the whole primary catchment (Nel *et al.* 2011). When these areas are in a poor condition, they can have a disproportionately large effect on ecosystem services and associated water uses for downstream growth and development. Ideally these areas should be maintained in a healthy condition and activities that are likely to reduce stream flows or lower water quality.

High water yield areas are shown spatially as surface water yield areas in Figure 2 and groundwater recharge areas in Figure 3. There is a close relationship between surface yields and groundwater recharge, as groundwater aquifers are replenished through surface water infiltration and seep.

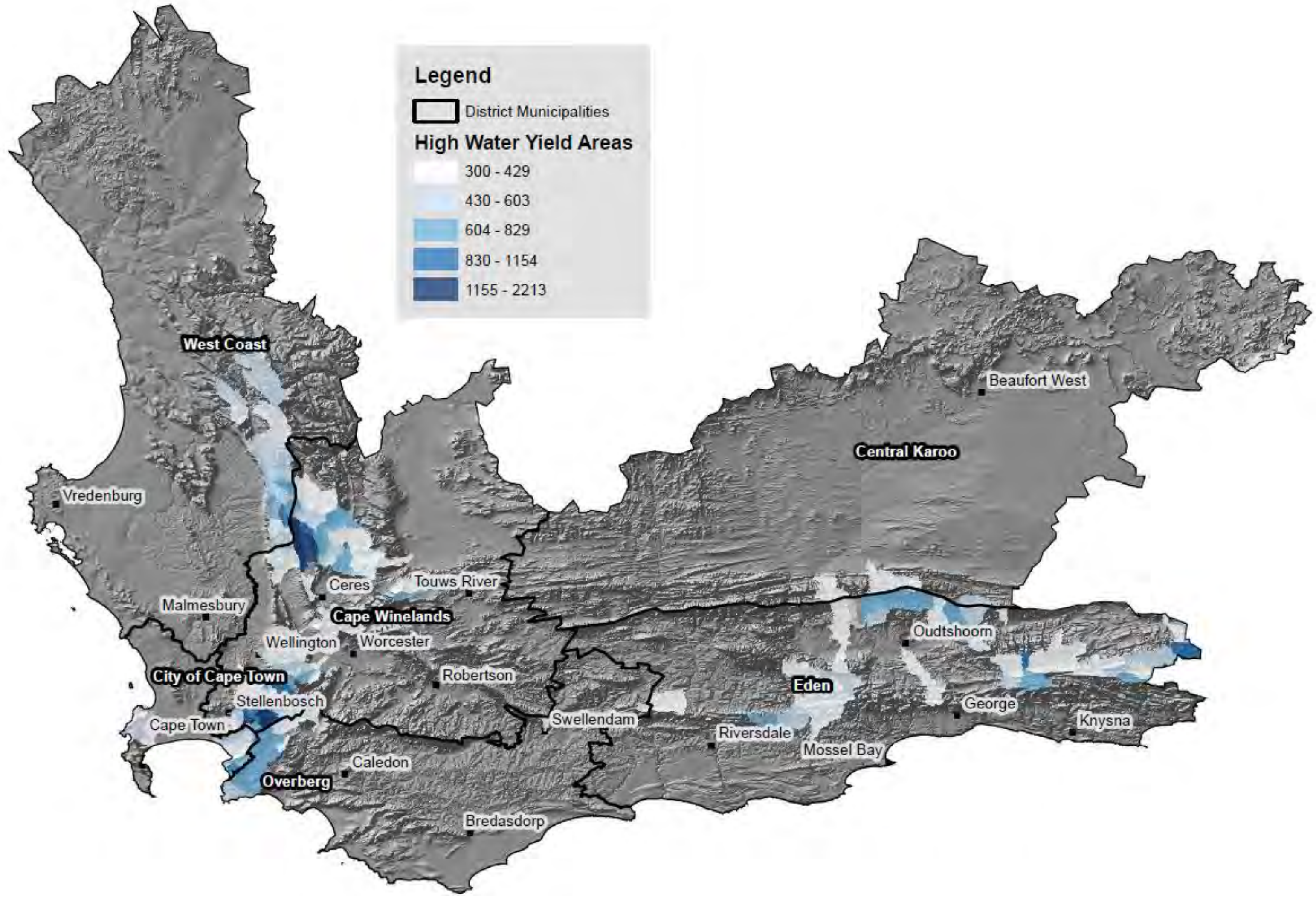


Figure 2: High surface water yield areas, shown in m³/annum (Nel *et al.* 2011)

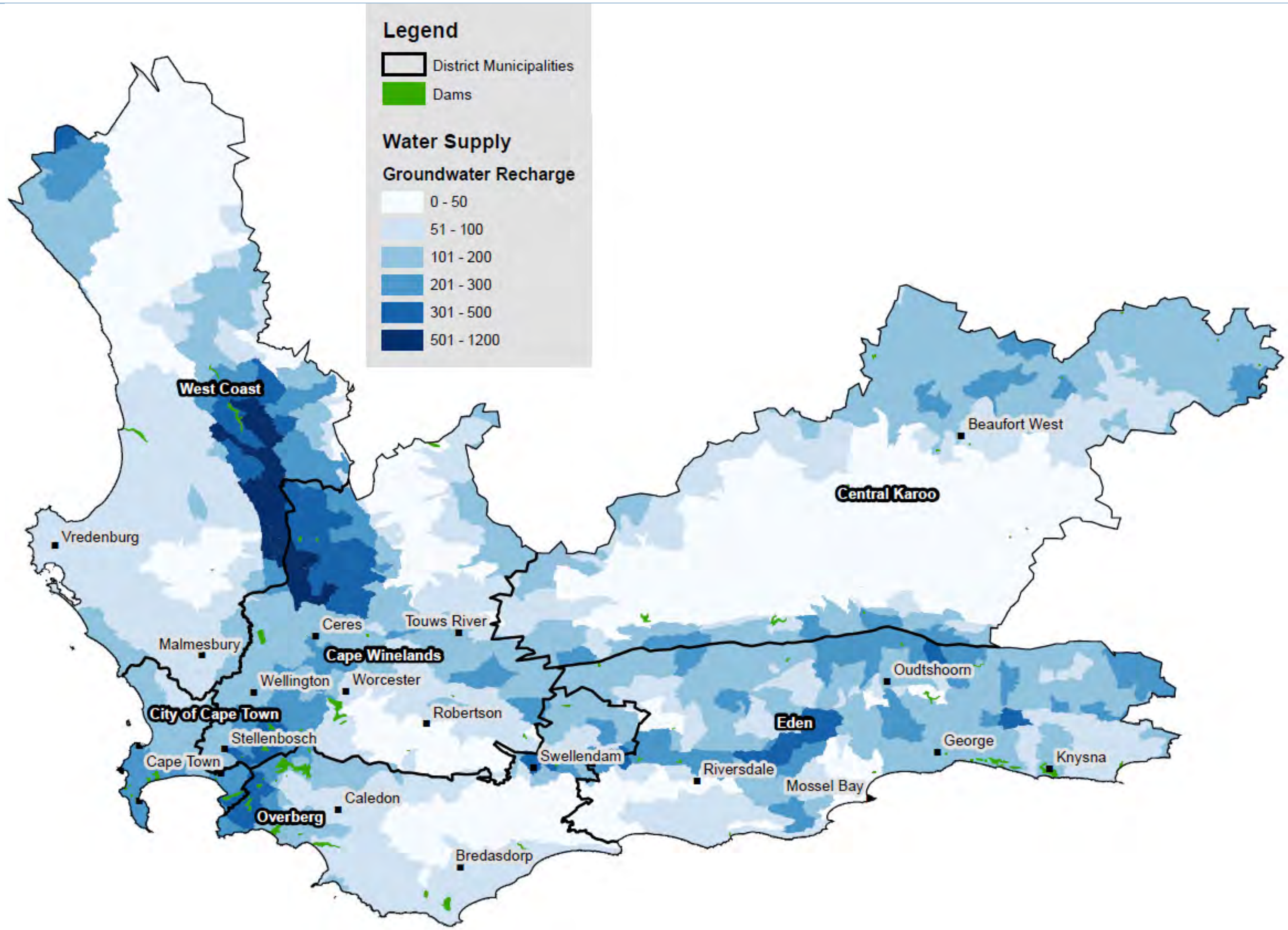
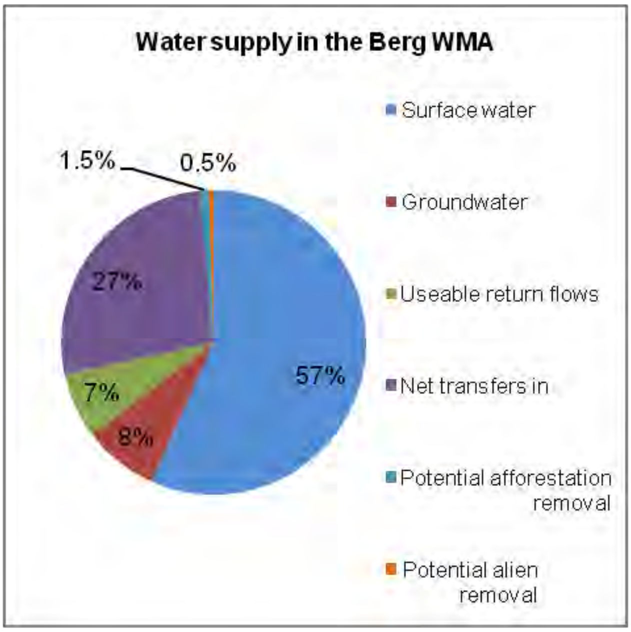


Figure 3: High groundwater recharge areas, shown in m^3/annum (Nel *et al.* 2011)

3.1.4 Water supply and consumption

According to the Department of Water Affairs (DWAF 2004; DWA 2010b), after allowing for environmental flow requirements, half of the South African WMAs are in water deficit. This means that the water requirements in that area exceed availability. This holds true for the Western Cape WMAs, as can be seen from Figure 4 to Figure 7, and especially in the Olifants/Doorn WMA. As a result, the WMA's are severely stressed and vulnerable to any major changes in rainfall, e.g. from drought or climate change.

Figure 4 to Figure 7 presents the availability of water in the Western Cape as well as its consumption per WMA. The figures highlight water sources, thereby indicating where our main sources of water resources lie, and compares them to user categories to highlight which are the main consumers of water in each WMA. From this analysis it is clear that surface water is the primary resource used in the Western Cape, while the primary use of this resource is irrigated agriculture.



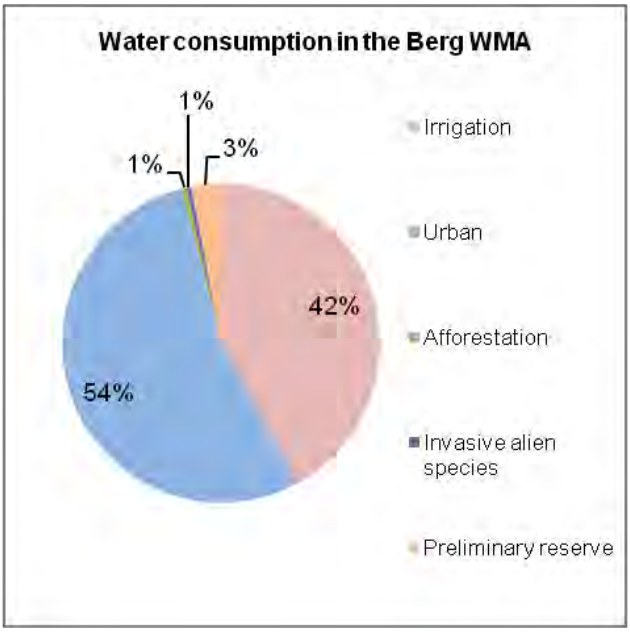


Figure 4: Availability and consumption of water in the Berg WMA (DEADP 2012a)

The Berg WMA receives 676 million m^3 per annum. 57 % originates from surface water supplies, and 27% from inter-basin transfers out of the Breede WMA. Other smaller sources include groundwater (8%), useable return flows (7%), a potential of 1.5% from the removal of afforestation and 0.5% from the removal of alien species.

There is a high population concentration (more than 80% of the population of the Western Cape) within the Berg WMA (including the Cape Town Metro), and as such the main water user here is urban activities (54%). This is closely followed by irrigation which uses 42% of the water supply. Smaller users include the preliminary ecological reserve (3%), afforestation (1%) and invasive alien species (1%).

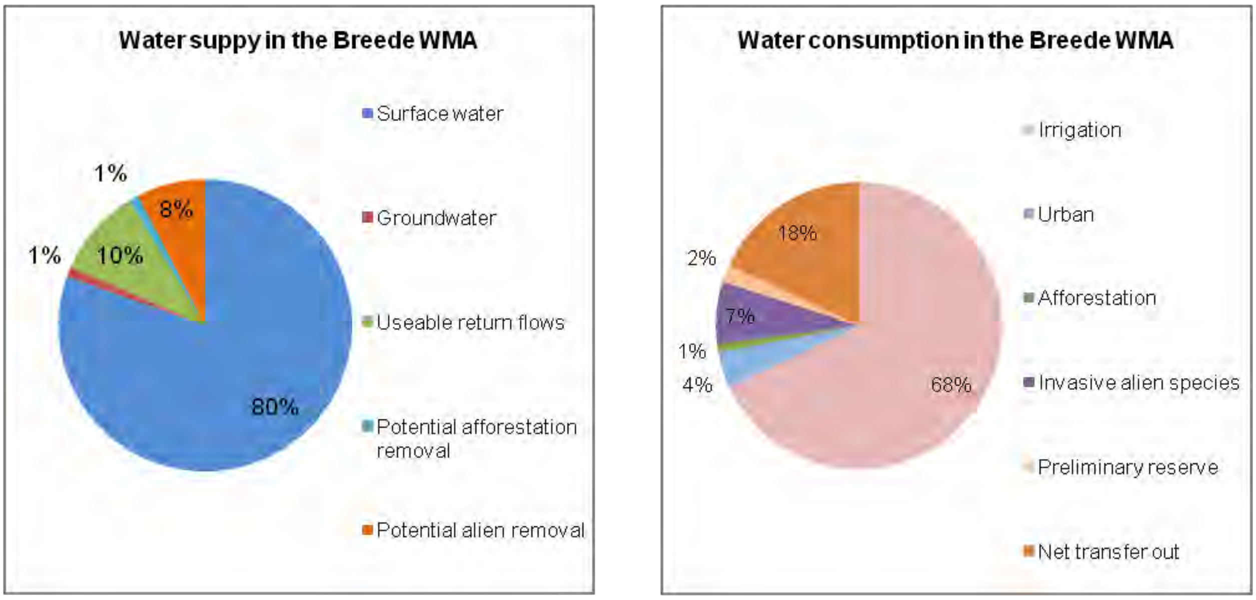


Figure 5: Availability and consumption of water in the Breede WMA (DEADP 2012a)

At 865 million m^3 per annum, the Breede WMA receives the most surface water of all the WMAs in the province. In fact, 43% of the province's water supply can be found in this WMA. Groundwater (1%) and useable return flows (10%) make up the remainder of the water supply, with respectively 8% and 1% of water supply attributed to the removal of alien vegetation and afforestation.

Irrigation is the main water use (68%), with a net transfer of 18% out of this region to the Berg WMA. Minor users include: urban activities (4%), afforestation (1%), invasive alien species (7%) and a preliminary ecological reserve of 2%.

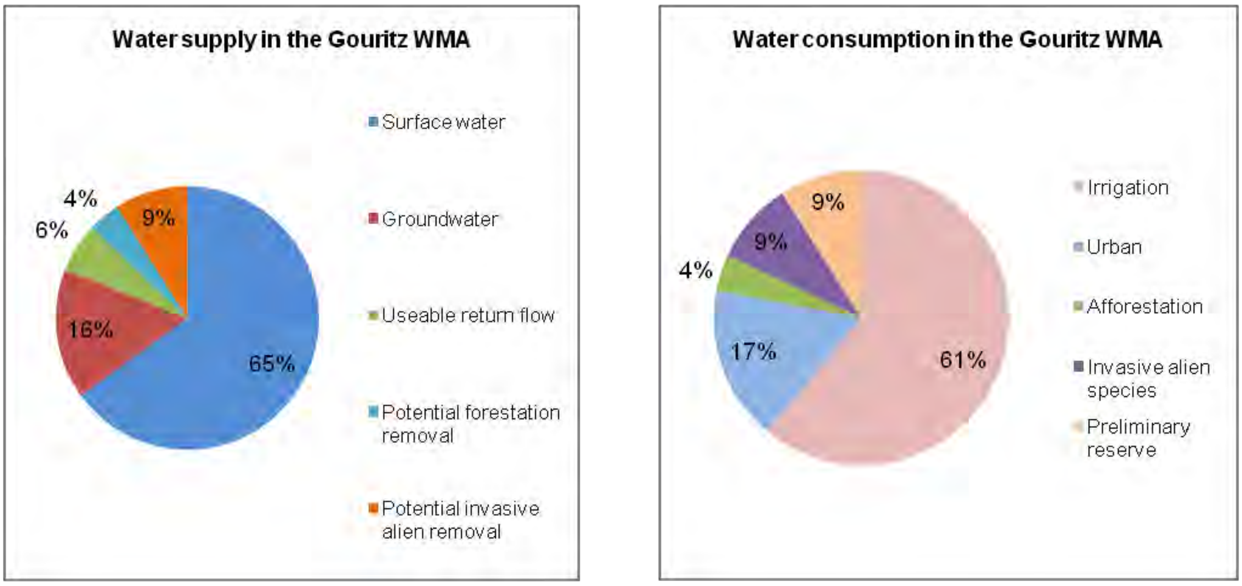
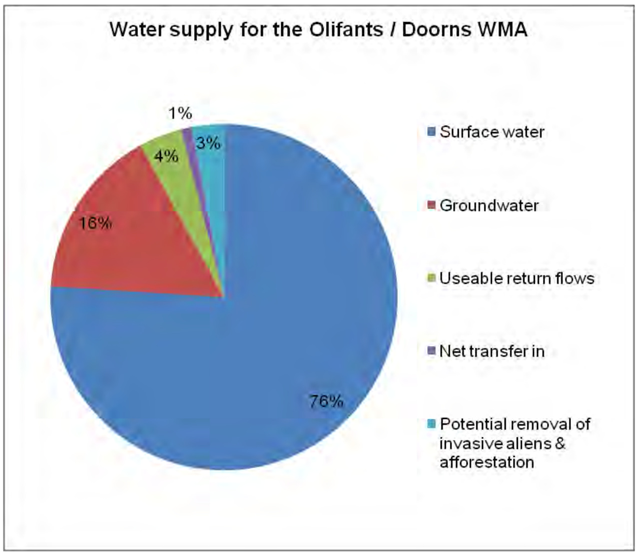


Figure 6: Availability and consumption of water in the Gouritz WMA (DEADP 2012a)

Surface water supplies 65% of the resources in the Gouritz WMA, and groundwater 16%. In total, 275 million m^3 per annum flows through the WMA. This supply is utilised predominantly for irrigation (61%) and urban activities (17%). A noteworthy 9% of water use could be returned to the water system with the removal of invasive alien species in the region, of which 4% is reported as water use linked to afforestation.



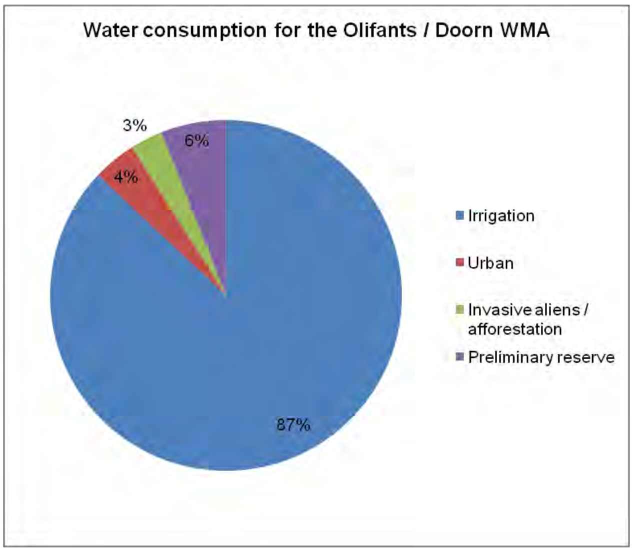


Figure 7: Availability and consumption of water in the Olifants / Doorn WMA (DEADP 2012a)

In the Olifants / Doorn WMA, the main water source is surface water (76%), with groundwater as the secondary source (16%), with combined supply totalling 338 million m^3 per annum. As agricultural practices are prominent in this region, the main water use is irrigation (87%). The population is smaller in this area than other WMAs and as such urban use is low (4%). However, 3% loss of water to afforestation and invasive aliens could be rectified or re-allocated to the water system.

Table 4 summarises these findings in terms of overall water use compared to the availability of water. From this, the balance of water resources for the province can be determined (i.e. supply minus consumption), and the results are presented for 2000 and 2005 reference years.

Table 4: A comparison of the overall water resource supply and consumption between 2000 and 2005, per Water Management Area[2] (DEADP 2005; DEADP 2012a)

WMAs	2000 (million m^3 per annum)			2005 (million m^3 per annum)		
	Water supply	Water use	Balance	Water supply	Water use	Balance
Berg	676	704	-28	709	745	-36
Breede	865	828	37	1090	1071	19
Gouritz	275	339	-64	351	415	-64
Olifants / Doorn	338	373	-35	372	406	-34
Provincial total			-90			-115

[2] The information presented in the table includes inter-basin transfers and the provision for the estimated Water Reserves per WMA.

From the table it can be determined that despite the increase in water supply between 2000 and 2005, there are insufficient water resources available to meet the current demands for the Province. All WMAs, except the Breede, are recorded with a negative water balance as a result of overutilization.

3.2 Fitness for use

Water quality refers to the physical, chemical and biological characteristics of water with regard to how suitable the water is for its intended use (DWA 2011b). According to the NWA, water quality relates to all the aspects of a water resource, including in-stream flow (quantity, pattern, timing, water level and assurance), natural water quality (physical, chemical and biological characteristics), in-stream and riparian habitat (character and condition) and aquatic biota (characteristics, condition and distribution).

Water resources that are rich in nutrients are referred to as eutrophic. This becomes a problem in water bodies where the presence of excessive nutrients promotes the growth of more algal plants than what can be accommodated by the rest of the ecological system. This results in water quality deterioration, often to a level which cannot sustain aquatic life. Eutrophication in South Africa is caused mainly by inadequately treated sewerage effluents that are discharged into river systems. Other sources of high nutrient loads resulting in eutrophication include industrial effluents, agriculture, households, and urban and road surface runoff (Oberholster & Ashton 2008; Harding 2011).

It is important to note that not all water quality problems are from anthropogenic causes, and in some areas of South Africa water quality is naturally unsuitable for human use. There are some naturally saline river systems resulting from specific geological conditions, for example the various 'Sout' or 'Brak' rivers in the Western Cape. These systems are generally also associated with groundwater that has a salinity above the recommended concentrations for human use. In these cases the salinity levels are natural and the aquatic ecosystems adapted to the conditions.

3.2.1 Surface water quality

Surface water quality is primarily measured in two ways namely laboratory analysis of water samples (e.g. National Eutrophication Monitoring Programme, National Microbial Monitoring Programme and National Chemical Monitoring Programme) and standardised rapid in-field ecological assessments, as part of the River Health Programme (RHP) of the DWA (e.g. River Health SASS5/Macro Invertebrate Response Assessment Index). Both methodologies are important, and are utilised in concurrently to facilitate understanding of water quality and the dynamics influencing the quality.

Table 5 shows the categories used to classify the river health quality of surface water, primarily rivers. Ratings are reported through the RHP. Water quality indicators are used to reflect the suitability of water for aquatic ecosystem functioning, based on the total phosphate, nitrogen, ammonia and dissolved oxygen measured in water samples from RHP bio-monitoring sites. This means that the RHP information should only be seen as relative to the water quality required to support river associated biota (i.e. ecosystems) and not in terms of human health and uses.

The actual river health quality category ratings for each of the WMAs in the Western Cape are provided in Figure 8.

Table 5: River health categories utilised in the assessment of surface water quality (DWAF 1999)

Category	Ecological perspective	Management perspective
Natural (N)	No or negligible impact	Relatively little human impact
Good (G)	Biodiversity and integrity largely intact	Some human-related disturbance but ecosystems essentially in good state
Fair (F)	Sensitive species may be lost, with tolerant or opportunistic species dominating	Multiple disturbances associated with the need for socio-economic development
Poor (P)	Mostly only tolerant species present; alien species invasion; disrupted population dynamics; species are often diseased	High human densities or extensive resource exploitation

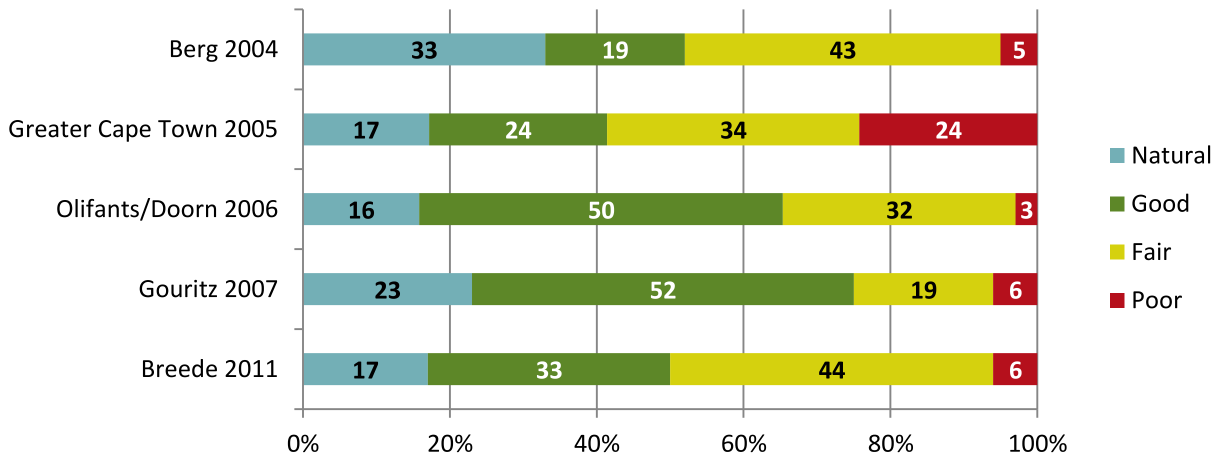


Figure 8: Consolidated River Health Water Quality sampling results (RHP 2004, 2005, 2006, 2007 & 2011)

The findings of this assessment provide for reflection on the state of river water quality for the province. As such, Figure 8 indicates that 21% of rivers are in a natural condition, 36% are in a good condition, 34% are in a fair condition, and 9% are in a poor condition. The high percentage of rivers within a good and fair condition can be attributed to the fact that river pollution and degradation is mostly contained within the provincial 'working rivers', and is not found to any great extent across the provincial riparian areas. Most rivers found across the province are therefore found to be in an ecologically good state and as a result can support diverse ecosystems with their integrity largely intact.

It should be noted that these results are not a complete reflection of water quality across the province as condition can vary quite dramatically within catchments. It should be considered in conjunction with the ecological status of rivers as displayed in Figure 10. A case in point is the introduction of an 'unacceptable' category in the State of Rivers Report for the Greater Cape Town Rivers to highlight the poor state of certain sections of highly transformed rivers.

The National Eutrophication Monitoring Programme by the DWA also collects data on the trophic status of a number of large dams in South Africa. Of grave concern is that all the dams have been classified with a serious (>0.13 mean annual TP mg/l) or significant ($0.047<x\geq0.13$ mean annual TP mg/l) risk of algal productivity. It includes the Theewaterskloof Dam which is a major water source for the City of Cape Town. Typically the risk is associated with high nutrient loads from contaminated surface runoff or water discharges.

3.2.2 Groundwater quality

Despite groundwater pollution and over-abstraction being serious problems in certain parts of South Africa, the Western Cape has only localised threats of over-abstraction, predominantly in farming areas. There are also numerous areas where the quality of water is not good enough for the water to be usable due natural salinisation processes. Further causes of deteriorating groundwater quality can be attributed to diverse sources in sectors such as industrial activities, effluent from municipal wastewater treatment works, stormwater runoff from urban and especially informal settlements (where adequate sanitation facilities are often lacking), return flows from irrigated areas, effluent discharge from industries and various other sources (DWA 2010c).

3.3 Freshwater ecosystem health

Freshwater ecosystem health or aquatic ecosystem health refers to the condition or 'resource quality' of surface water resources. This includes its fauna and flora within the in-stream, wetland and riparian habitats (Karr 1999). Aquatic ecosystem health status is measured by its ecosystem state through a process termed EcoClassification, or bio-monitoring in practice. Over the last 15 years, the development and refinement of the National Ecosystem Health Monitoring Programme standardised bio-monitoring indices (WET-Health, Estuary-Health and River-Health) has led to an ever more accurate understanding of the dynamics and value of the economic, social and ecological needs of water resources.

3.3.1 River health indicators of ecological change

The RHP aims to assess the health of rivers based on the response of biota (instream and riparian) to human influences that change habitat integrity (e.g. hydrology, geomorphology and chemical variables) (Kleynhans *et al.* 2005). These assessments are scored in terms of Present Ecological State (PES) classes (A-F) which provides an ecological and management perspective of river health (Natural to Poor), although an 'unacceptable' category was added to report on water quality in the Greater Cape Town rivers (RHP 2005).

The results of the RHP provide a very good indication of our human use impacts as well as the value of our management actions to secure our water resources for future generations (i.e. the Water Reserve).

The EcoStatus bar graph for the Western Cape (Figure 10) combines all River Health indices (SASS5, RVI, IHI, FI and GI) and is compiled from RHP assessments undertaken for the four major WMA's of the Western Cape. The findings of this assessment provides a reflection of the state of surface water resource health for the province where only 6% of rivers are in a natural condition, 30% are in a good condition, 48% are in a fair condition and where 14% are in a poor condition. The results are also shown in terms of spatial distribution as Figure 9.

The findings are typical, as land-uses in the upper catchment areas are generally forestry and conservation based which result in mountain catchment protection areas classed as natural or good. Where rivers are used for agriculture and land development, a cumulative impact progressively increases the deterioration status of surface water resources as one gets closer to the coast. In addition, the influence of significant urban development of the greater Cape Town area can be seen to reflect in the Berg River assessment results that display a significantly poorer water resource quality.

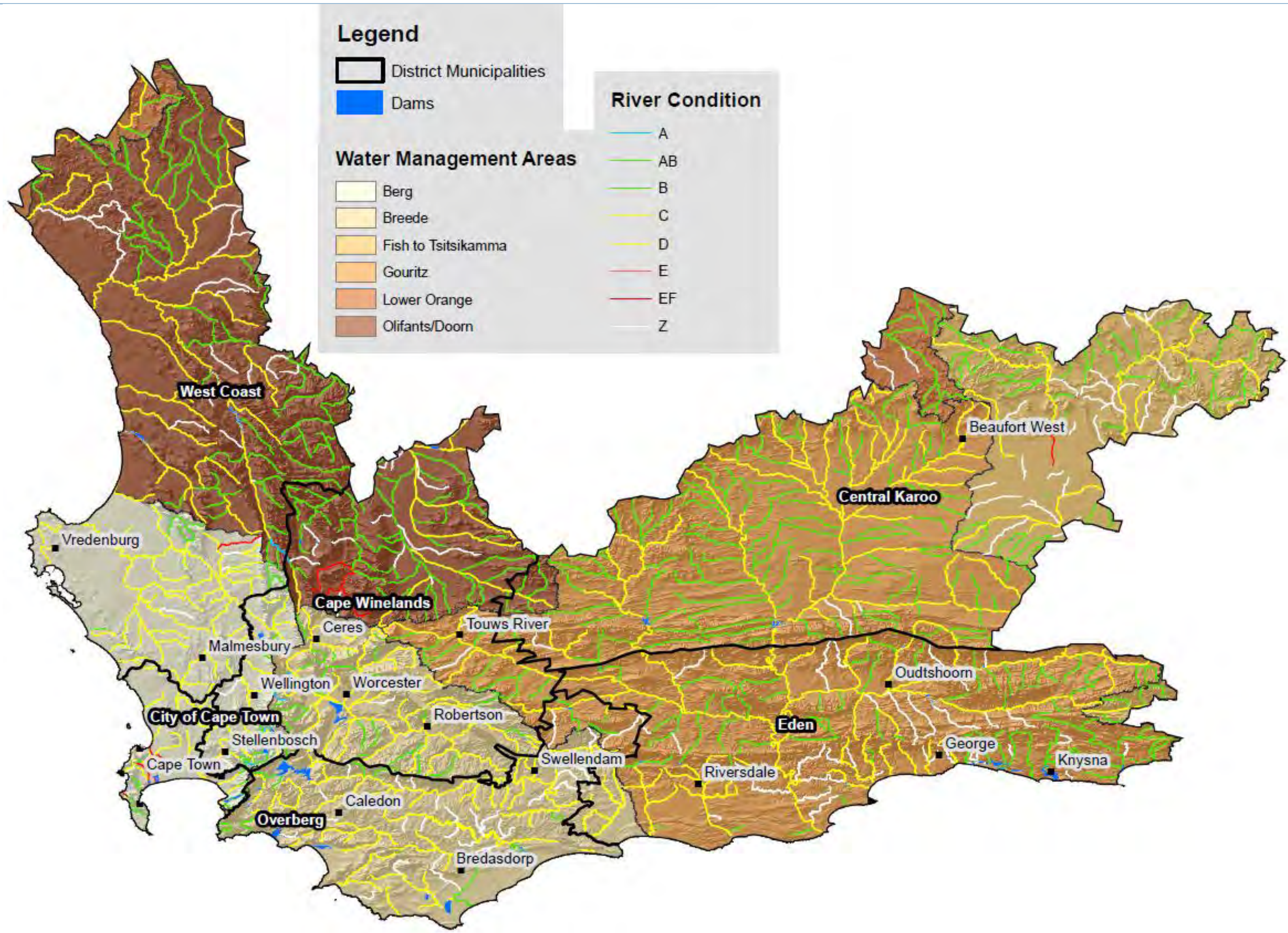


Figure 9: River Condition Map for the Western Cape (Nel *et al.* 2011)

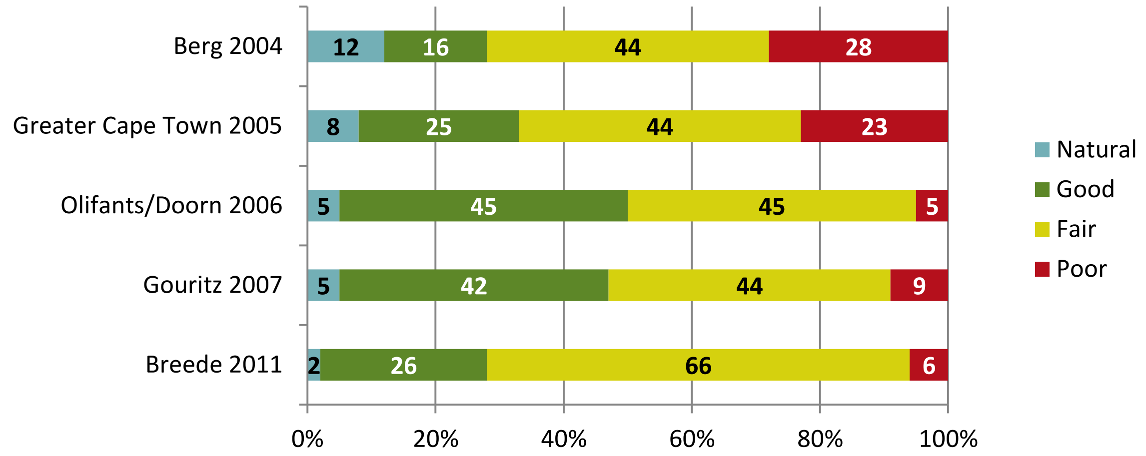


Figure 10: Consolidated River Health EcoStatus Assessment Results reflecting PES of the Western Province[3] (RHP 2004, 2005, 2006, 2007 & 2011)

Table 6 provides more detail on river health monitoring per WMA. Survey results are listed displaying the percentage of rivers found in a desired state of management as well as associated major disturbance pressures. The general trend across the province relates to direct and indirect impacts on water resources, such as from abstraction, flow modification and pollution originating from urban and agricultural pressures.

Table 6: Summarised river health monitoring survey results (RHP 2004, 2005, 2006, 2007 & 2011)

Water Management Area	Total monitoring sites surveyed	Percentage in desired management state	Major disturbance pressures
Berg (2004)	25	52 %	Stormwater water quality impairment, Inter-basin Transfers, Extensive Channel and flow modification, Agriculture use return flow turbidity and nutrient loading, Alien Fish and Vegetation infestations as well as forestry.
Greater Cape Town (2005)	38	50 %	Urban development, Stormwater water quality impairment, Inter-basin Transfers, Alien Fish and Vegetation infestations, Extensive Chanel and Flow Modification, Loss of Riparian Zone, Mismanaged Informal Settlement Uses, Agriculture Use return flow turbidity and nutrient loading.
Olifants/Doorn (2006)	40	79 %	Abstraction for agriculture, Agriculture within floodlines, Agriculture Use return flow turbidity and nutrient loading, Loss of Riparian Zone, Alien Fish and Vegetation infestations, Overgrazing by livestock.

[3] Table 5 shows the categories used to classify the river health quality of surface water, primarily rivers, and the river health quality category ratings for each of the WMAs in the Western Cape are provided in Figure 8.

Water Management Area	Total monitoring sites surveyed	Percentage in desired management state	Major disturbance pressures
Gouritz (2007)	69	39 %	Extensive abstraction use, Agriculture within floodlines, Channel and flow modification, Nutrient Enrichment from agriculture return flows.
Breede (2011)	82	68 %	Inter-basin Transfers, Loss of Riparian Zone, Channel and flow modification, Alien Fish and Vegetation infestations, Alien tree induced flooding, Agriculture use return flow turbidity and nutrient loading.

3.3.2 Wetlands

Wetlands are extremely valuable natural resources, with high environmental, economic, aesthetic, spiritual, cultural and recreational value. Wetlands provide habitat to many animals and plants as well as essential services to humans in the form of water storage, supply and treatment services. As an example, wetlands have the ability to remove nutrients associated with agricultural runoff, thus helping to regulate the nutrient levels in water bodies and preventing groundwater contamination. In contrast, the degradation of wetlands will result in increased eutrophication of water bodies (De Villiers & Thiart 2007).

Wetland resources are often under-appreciated, resulting in inadequate management thereof, unsustainable exploitation and poor wetland integrity (RAMSAR 2011; UNESCO 2011). The main pressures on wetland ecosystems are diverse and include most land development activities like cultivation, urban development, mining, dam construction and poor grazing management, combined with broader catchment impacts like disruption of freshwater flows, pollutants and sediment from surrounding land uses (Driver *et al.* 2012).

The distribution of wetlands within the Western Cape is shown in Figure 11, along with the current estimated condition.

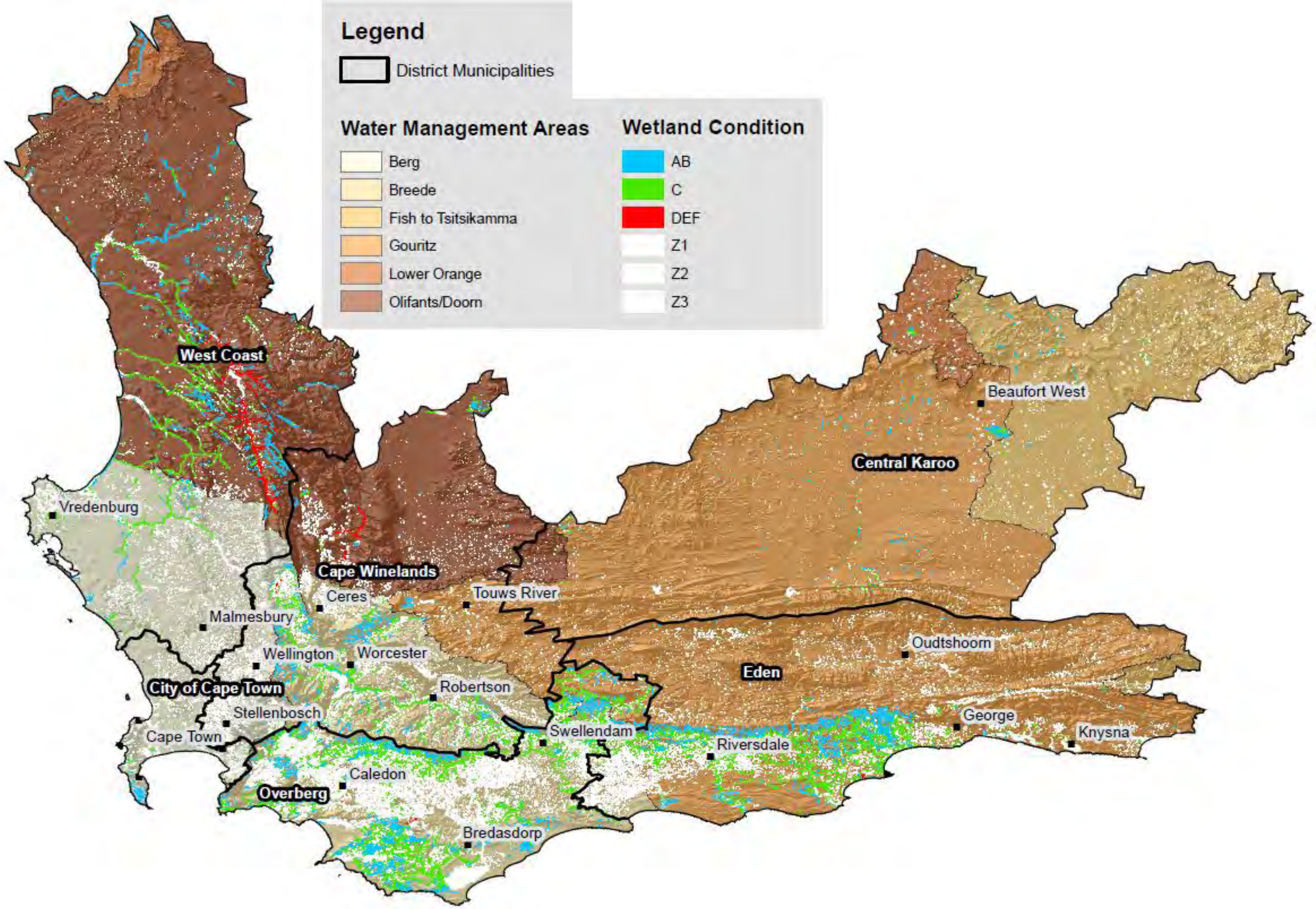


Figure 11: Wetland Condition Map for the Western Cape (Nel *et al* 2011)

The wetland condition classes shown in Figure 11 are as follows:

A B	Natural
C	Largely intact, some human related disturbance but generally in a good state; Ecosystem functions essentially unchanged
DEF	Multiple disturbances associated with the need for socio-economic development and dense development; extensive resource exploitation
Z classes	Condition unknown; wetland assigned a condition based on the lowest percentage of natural land cover

Most wetlands in the Western Cape are classified as AB or C, with only a few within the Olifants / Doorn classified as threatened. However, there are a large number of unclassified wetlands. The land cover data for the province is outdated and this therefore raises concerns about the true condition of the wetlands.

4 IMPACTS

Urban development and associated activities result in the alteration of the morphology of rives. Most commonly the river's ability to attenuate floods and decompose pollutants is reduced by canalisation, while levees intensify flood flows, disrupt the natural ability of the floodplain to absorb flood water and increases siltation in the river. Canalisation is most evident in densely populated urban areas surrounding the Black, Elsieskraal and Keysers rivers in the City of Cape Town. The Big and Little Lotus rivers, which are largely artificial, are canalised along most of their reaches (RHP 2005). Furthermore, dam walls and weirs prevent the natural movement of fish and other aquatic species, while regulated flows eliminate seasonal flow variations and have adverse impacts on the resilience of river systems (RHP 2005).

Many of the urban rivers serve as conduits for discharging treated effluent to sea and whilst these rivers cannot be returned to their natural state; their condition should at least be maintained at levels that will not introduce adverse environmental health and social impacts. Stormwater runoff from informal settlements and back-yard dwellings further adds to the water quality impacts in downstream reaches. The resultant nutrient loading of freshwater systems leads to multiple effects, including algal blooms, loss of biodiversity and ecosystem services, health hazards most commonly experienced as diseases and illness, and limitations on fitness for use (e.g. drinking water quality, irrigation, industry, etc).

Sustained eutrophication may lead to the presence of noxious forms of algae (cyanobacteria) (Oberholster & Ashton 2008). The presence of algal toxins poses direct threats to human and animal health via consumption or exposure. Consumption of contaminated water takes place in the form of utilisation of water for cooking and drinking as well as through consumption of fish that have been exposed to the algae. Exposure may occur through direct contact with the water or using the water for laundry, personal hygiene or cultural practices. The toxins cause reactions ranging from respiratory difficulties, gastrointestinal symptoms, allergic reactions, ear pain and eye irritation to liver and nerve damage (Oberholster *et al.* 2008; Harding 2011).

Aquaculture often has negative consequences on freshwater ecosystems, including the loss or alteration of natural habitats, the introduction of exotic species, threats to species biodiversity, changes in water quality, the introduction and spread of disease to local fish species (DAFF 2011). Unfortunately, some of the most invasive alien fish are also economically valuable (for aquaculture and recreational angling) and are therefore sometimes actively encouraged. As such, invasive alien fish have had a huge impact on the biodiversity and ecological functioning of rivers in the Western Cape and are the principal reason for the threatened status of all endemic species. However, with careful management it is possible to support aquaculture farming without compromising the conservation of indigenous fish species.

Most climate change forecasting for the Western Cape identifies a progressive drying of the province towards the south-west. This will reduce surface runoff and slow down the recharge rate of groundwater aquifers. Ultimately, this implies a reduced water yield from both surface and groundwater sources. The water shortage is also likely to be exacerbated by the expected increase in temperature and resultant increased evaporation rates (DEADP 2012a). Changes to coastal rainfall patterns could also lead to increased salt water intrusion into estuaries and coastal aquifers or raised groundwater tables near the coast. This will have numerous knock-on effects for socio-economic development, integrity of the wetlands, rivers and estuaries (Midgley *et al.* 2005).

5 RESPONSES

The Western Cape is serviced by aging water infrastructure, which leads to significant system losses, yet has a high demand for basic services. An obligation nevertheless rests on water management authorities to secure a sustainable water supply as the basis for a developing country's economy and society, and at the same time an ecological need for the sustainable implementation of the ecological reserve. This conundrum is being addressed by government through implementation of a water resources reconciliation strategy mandate which seeks to ensure a sustainable supply and equal access to water for all current and future citizens of the country (DWA 2011a). This should be matched by a plan for the maintenance of aging infrastructure, and development of new networks.

5.1 Sustainable Water Management Plan

The Western Cape Sustainable Water Management Plan (hereafter "Water Plan") was developed collaboratively by the Western Cape Government and DWA to guide sustainable water management towards meeting the growth and development needs of the region. Short (1-5 years), medium (6-15 years) and long term (+16 years) actions to guide the implementation of projects / activities were developed, as a means towards achieving integrated and sustainable management of water in the Western Cape. The Water Plan focuses on water quality and water quantity in terms of Water Conservation / Water Demand Management, while maintaining the ecological integrity of the Provinces' water resources.

The vision of the Water Plan is, "*Sustainable water management for growth and development in the Western Cape, without compromising ecological integrity*".

The Water Plan has the following 4 Strategic Goals:

- **Goal 1:** Ensure effective co-operative governance and institutional planning for sustainable water management.
- **Goal 2:** Ensure the sustainability of water resources for growth and development.
- **Goal 3:** Ensure the integrity and sustainability of socio-ecological systems.
- **Goal 4:** Ensure effective and appropriate information management, reporting and awareness-raising of sustainable water management.

5.2 Berg River Improvement Plan

As part of implementing the Water Plan, a Berg River Improvement Plan was endorsed by the Western Cape Government during January 2013 (DEADP 2012b). Under this plan, short and long-term actions are currently being implemented and integrated across the various Departments of the Western Cape Government towards a common outcome, *viz*. a Water Stewardship Programme for the Berg River that facilitates the recognition of the Berg River for its value for ecosystem services, and its natural resource state as it relates to water quality and quantity returns, while promoting sustainable growth and development in a green economy. In particular, the objectives of the Berg River Improvement Plan are to:

i. Reduce the *negative impact from Municipal urban areas*, particularly informal settlements and wastewater treatment works;
ii. Reduce the *negative impact of agriculture* on the Berg River's water quality to acceptable levels;
iii. Ensure *sustainable resource use efficiency and ecological integrity*.

From the 3 objectives, 6 major tasks have been identified for implementation:

- **Task 1:** Establish a Berg River Water Quality Monitoring Programme
- **Task 2:** Upgrade Wastewater Treatment Works and Train Process Controllers
- **Task 3:** Upgrade Informal Settlements
- **Task 4:** Advocate Best Practice in Agricultural, Industrial and Domestic Land-use
- **Task 5:** Riparian Zone Rehabilitation and Management (Buffer Zone)
- **Task 6:** Pricing Water Management in the Berg River Catchment

This Berg River Improvement Plan is also intended to complement the Business Plan that is currently being drafted by CASIDRA, on behalf of the Department of Water Affairs, as well as link with the Berg River Water Quality Task Team, as managed by DWA. The initial focus and aim is to plant indigenous vegetation in the riparian zone along identified sections of the Berg River towards naturally improving water quality and ecological integrity in the catchment.

5.3 Reconciliation strategies

The National Water Resource Strategy (2004) states that, "*in general, sufficient water can be made available at all significant urban and industrial growth points in the country for water not to be a limiting factor to economic development. However, given the long lead times for developing new supply schemes, co-operative planning will be required between water users and water management institutions to ensure that water can be made available when it is needed*". With this in mind the following reconciliation interventions have been explored, or are in the process of being assessed for feasibility per location and situation:

- Demand management
- Water resource management
- Managing groundwater resources
- Re-use of water
- Control of invasive alien vegetation
- Re-allocation of water
- Development of surface water resources
- Inter-catchment transfers

In response to the NWRS, the DWA has embarked on establishing Water Reconciliation Strategies for all towns throughout the country, looking at water requirements (based on use, estimated need and projected need), at water availability (ability to meet those demands), and at the overall resource situation in terms of infrastructure and affordability - to find ways of reducing demand and increasing availability. The approach to water resource reconciliation is set out in a strategy that recommends actions to ensure sufficient water. These strategies could vary from complex, in the case of major metropolitan areas and systems and catchments, to simple strategies for smaller towns. The key objectives of the reconciliation study are to develop future water requirement scenarios, investigate all possible water sources and methods for reconciling, provide recommendations for interventions and actions and offer a system for continuous updating in the future.

Currently, the areas in the Western Cape with highest water demand are managed and serviced under the auspices of the WCWSS. The scheme provides water to the communities of and around Cape Town, to towns on the West Coast and in the Swartland region, as well as to irrigation areas in the Cape Winelands and Overberg Districts. Major infrastructure in the system includes the Theewaterskloof and Voëlvlei dams (owned and operated by the Department of Water Affairs (DWA)), the Berg River Dam (owned by the Trans Caledon Tunnel Authority and operated by the DWA) and the Wemmershoek, Upper Steenbras and Lower Steenbras dams (owned and operated by the City of Cape Town). The water storage in the system is evaluated towards the end of

the wet season (no later than 1st November), to assess whether or not supplies must be restricted for the following year, to ensure that sufficient water remains for the more essential uses, were a drought to occur. The dams are operated as an integrated system to minimise spillage and maximise storage during drought months (DWAF 2007).

The DWA planning work for the Western Cape Water Supply System has highlighted development of the Voëlvlei dam as a surface water intervention which could be undertaken by 2019, which is the time when the WCWSS will require additional storage capacity. In addition to this, water re-use and desalination of seawater will need to be explored further. The following surface water interventions were identified for further feasibility and environmental studies for post- 2019 implementation depending on need (refer to Figure 11):

- Michell's Pass Diversion
- Raising of Steenbras Upper Dam

Groundwater interventions for the WCWSS which focuses on Cape Town and surrounds include the development of the Table Mountain Group Aquifer as well as the Newlands and Cape Flats Aquifers. The Table Mountain Group Aquifer is a substantial aquifer located under the Cape Fold Mountains and has been identified as a potentially significant source of water for future supply to the WCWSS. The City of Cape Town is busy with an on-going Feasibility Study and Pilot Project to test the viability of the exploitation of the aquifer. The earliest implementation date for larger scale abstraction is currently estimated as 2021. The City of Cape Town is committed to the prioritisation of water re-use[4] and desalination as their first priority though.

Figure 12 shows a comparison between available water sources and anticipated water demand in order to determine when interventions would be required to ensure water requirements can be met. It is clear that the anticipated growth in water requirements requires a combination of several different interventions. The policy of DWA is that water conservation demand management must be fully implemented before additional water is sought.

During 2009 and 2010 severe droughts in the Southern and Eastern Cape helped to concentrate the minds of planners anxious to find a way of providing water to towns. The answer is generally seen to be recycling facilities and investment in desalination for coastal areas. This is particularly evident in the popular Garden Route tourist region where visitor numbers during the hottest part of the year put additional pressure on water supplies. Inland areas are more reliant on accessing groundwater resources.

[4] Treatment of waste water for the purpose of re-use.

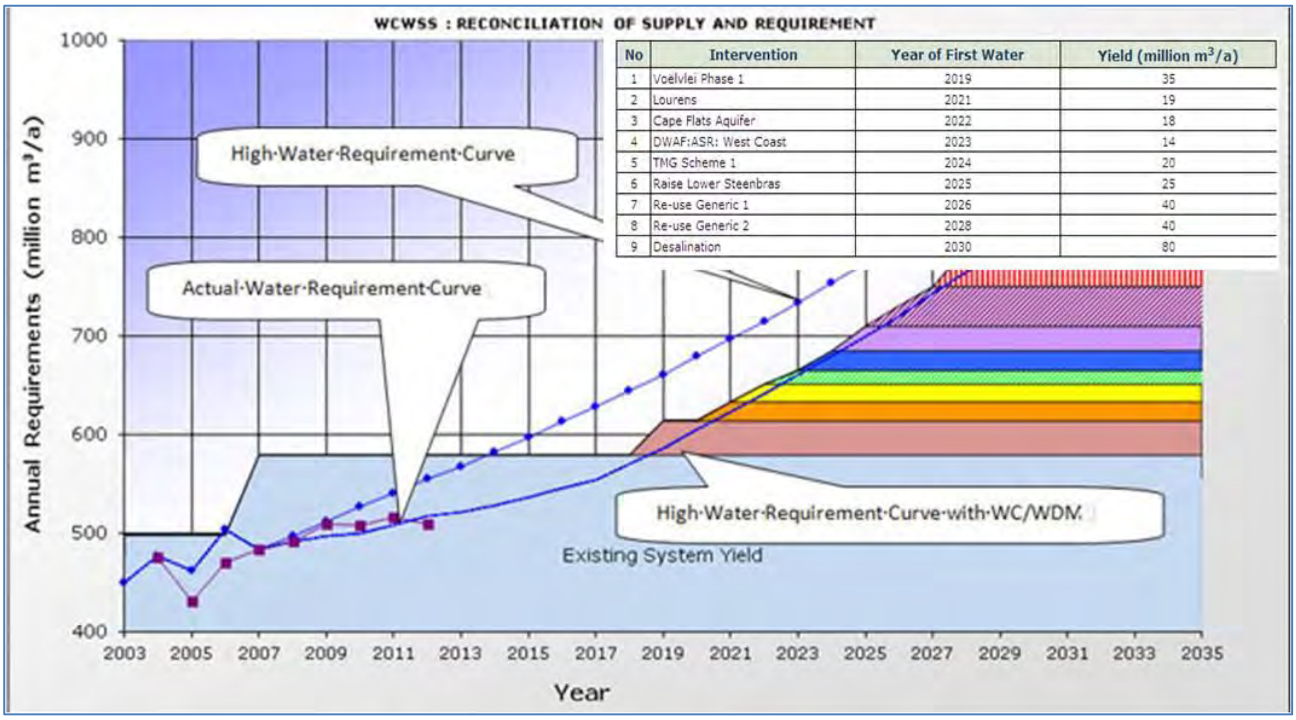


Figure 12: Water Reconciliation Strategies and anticipated impacts for water availability (DWAF 2007)

5.4 Freshwater Ecosystem Priority Areas

The understanding of wetlands and how to manage them has improved significantly in recent years. This has been supported by extensive wetland classification projects such as the National Wetlands Inventory Project and the National Spatial Biodiversity Assessment which provides an estimate of wetlands condition (Driver *et al.* 2004).

This information formed a basis for the National Freshwater Ecosystems Priority Areas (NFEPA) atlas and provides the basis for wetland ecosystem status assessments (health, services and importance) and sensitivity (vulnerability) for the purpose of effective ecological and management implementation (DWAF 1999, 2005 & 2007; Kotze *et al.* 2005; SANBI 2009; Nel *et al.* 2011).

Freshwater Ecosystem Priority Areas (FEPAs) describe the "*strategic spatial priorities for conserving freshwater ecosystems and supporting sustainable use of water resources*" (Nel *et al.* 2011). River and wetland FEPAs are mapped for the whole of South Africa and identify freshwater ecosystem resources that should receive priority management and be kept in a natural condition. FEPAs should inform the process of catchment planning, water resource classification, reserve determination, setting and monitoring of Resource Quality Objectives, as well as facilitating water-use license applications (Nel *et al.* 2011).

FEPAs are presented in more detail in the Biodiversity and Ecosystem Health Chapter of this report.

5.5 Invasive alien species

Targeted removal of invasive alien plants and maintenance of cleared areas should be a leading priority so that further spread can be prevented. Through eradication of invasive plants, the base flows of rivers would increase thereby augmenting the water supply. This is especially effective where clearing takes place up stream of existing dams. A key strategy should be targeted clearing with the aim of securing the ecological flow requirements of the rivers and estuaries.

A quantification of the impacts of invasive alien plants, as well as an understanding of the management needs, can only take place on the basis of ongoing and comprehensive monitoring – both the mapping of the extent of invasions, and monitoring of the actual benefits of rehabiltation. As there is an obligation under the Conservation of Agricultural Resources Act, 1983, to manage invasive plants on one's own property, some farmers have taken to clearing their catchments. The publication of their 'success stories' could encourage other farmers in the each WMA to take up similar responsibilities.

Problems identified in the Internal Strategic Perspectives for the different WMAs in relation to clearing of Invasive Alien Plants include the following:

- Maps are not up to date, which affect the effective monitoring of the alien invasive problem.
- The alien invasive vegetation is not of any economic value to the Western Cape Province and is therefore using up unnecessary resources such as land space and water.
- The estimates of the actual extent of invasive alien plants in the Western Cape Province, and the impact on water resources need to be improved. Estimates should include species, location (key area, and position in the landscape), and density.
- Catchment management tariffs may not necessarily internalise or consider the costs related to alien invasive clearing.

5.6 Adopt-a-River Programme

Moving beyond the civic and civil institutes, the National Aquatic Ecosystem Health Monitoring Programme coordinates the implementation of the River Health and "Adopt-a-River" programmes. These combine to provide a framework for public contributions to the protection of inland water resources through local clean-up events, local monitoring projects, capacity building of school learners and empowerment of women. The Adopt-a-River Programme has been rolled out to regional and local government level with implementation occurring at many of the pilot rivers in the country. This includes the Eerste and Doring rivers in the Western Cape along with rivers in each of the other provinces. The focus of the programme is now not only on awareness-building of school learners and the public, but also capacity building (monitoring, river safety, health and skills development), job creation (temporary employment during clean-up events and utilisation of locals by local water boards as monitoring champions), as well as of women empowerment and ownership.

5.7 Policy, tools and legislation

Responses in the form of policies, tools and legislation across all scales applicable to this theme are listed in the summary table:

Table 7: Summary of policy, tools and legislation for this theme

International Responses	1971	RAMSAR convention
	1998	National Water Act (International Obligations)
	2000	Millennium Declaration
	2002	World Summit on Sustainable Development Targets
National Responses	1997	Water Services Act
	1998	National Water Act
	2004 & 2013	National Water Resource Strategy I & II
	2008	Minerals and Petroleum Resources Development Act
	2009	Water for Growth and Development Strategy
	2010	New Growth Path
	2011	National Waste Management Strategy
	2011	National Government Outcomes 2, 5, 6, 7 8, 9, 10 and 12
	2011	National Development Plan 2030
		National Aquatic Ecosystem Health Monitoring Programme
Provincial Responses	2012	Sustainable Water Management Plan
		River Health Programme
		Input to various municipal Integrated Development Plans
		Considerations of NEMA principles and sustainable development issues in department approvals and programmes
		Development and implementation of compliance and enforcement guidelines
		Participation in catchment management forums
		Co-ordination with other provincial departments and local municipalities on EIA authorisations, mining authorisations and water use licenses
		Progressive implementation of National Waste Management Strategy
Local Authority Responses		Municipal Catchment Management Strategies, wetland assessments and water resource management policies

6 CONCLUSION

OUTLOOK: DECLINING

Water is needed in order to grow and sustain the economy, but also to sustain people and livelihoods. It is the National Department of Water Affairs' responsibility to respond to expected growth initiatives to provide guidance on water sources and supply. DWA is also responsible with ensuring, where economically viable, that the necessary water is available when it is required. Distribution of this resource, however, is the responsibility of the municipality. The rapidly growing population of the province and its popularity in the tourism industry places a huge demand on the sustainability of water resources and the responsibilities of the government to satisfy basic human needs as well as economic demands.

The status quo for surface water availability is currently in a deficit for three of the Western Cape's four water management areas. This often correlates with the ecological condition of the systems being degraded. On the other hand, the status quo for groundwater availability is optimistic in terms of potential for use on a small to medium scale, with much focus on utilising the significant Table Mountain Group Aquifer. However, the resource quality associated with the sustainable utilisation of inland resources will require much investment in terms of comprehensive monitoring, in order to provide a broader understanding of the resource availability. It can also be expected that treatment costs associated with these often naturally saline resources will be high.

Further emphasis needs to be placed on the effective management of land use activities, such as human settlement and development expansion, and agriculture. The allocation and actual use of water (surface and groundwater) for agricultural uses must be investigated properly and adjusted in the context of the resource availability in the province. This is particularly important in order to provide food security for the future.

Although much focus has been given to invasive alien plants, the primary strategy through which the problem of invasive alien plants should be addressed remains an approach that prioritises prevention over rehabilitation. In addition, a stronger awareness with regards to responsibility needs to be given on a civic and municipal level. Therefore the aim should be to control further infestations by limiting new sources of feedstock such as new forestry plantations or the encroachment of invasive plants into watercourses. Remote, scattered and outlying invasive plants must also be cleared before they become unmanageable.

The Sustainable Water Management Plan for the Western Cape Province aims to give effect to the identified implementation shortcomings in the water sector, in particular corporate governance (institution capacity and functioning). The verification and validation processes currently underway, with a stronger regulation of water use, will be vital in providing the basis for the sound implementation of water reconciliation strategies, climate mitigation measures and support of the establishment of our second economy. The further prioritisation of ecologically important catchments, the determination of significant groundwater reserves and the protection of mountain catchment areas, are essential into making strides into ensuring resource availability for our future generations.

The water situation of the Western Cape therefore remains complex. The implementation of strategic policy and plans from all levels of government will give effect to much needed pressure relief from a water use perspective. The functioning establishment of Catchment Management Agencies; and the implementation of Resource Directed Measures and Source Directed Controls for managing the significant water resources of our water management areas is a fundamental step in the right direction. Yet the implementation of the principles of integrated water resource management, shared public responsibility and ownership, greater participation and involvement of all stakeholders and corporative governance remains elusive.

The findings of the Inland Water chapter can be summarised as an overall declining outlook. Table 8 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action. Table 9 contains the anticipated changes or outlook for the future of water resources, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding of the dynamics.

Table 8: Summary of key aspects identified in the chapter

Aspect	Summary of key points
Pressures	• Human settlements • Agriculture • Invasive alien species • Climate change
Impacts	• Loss of ecosystem services • Living conditions • Eutrophication • Marine pollution
Challenges	• Water resource deficit • Allowances for ecological reserve • Incomplete reconciliation information
Progress	• Western Cape supply system • Berg River Improvement Plan • Water recycling initiatives
Critical areas for action	• Increase options for water reuse and curbing of reticulation water loses • Built environment and urban infrastructure innovations – rethink sanitation services • Manage alien invasive species • Drive adoption of conservation agriculture – "crop per drop"

Table 9: Summary of the outlook for inland water based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend
Water availability	• Water resource balance (2005): o Supply 2 522 million cumec o Demand 2 637 million cumec o Current deficit of 115 million cumec (was 90 in 2000)	Declining
Fitness for use	• River Health Water Quality assessment: o Overall – relatively good shape o 21% natural o 36% good o 34% fair o 9 % poor	Insufficient historical data
Freshwater ecosystem health	• River Health Ecostatus: o 6% natural o 30% good o 48% fair o 14% poor	Insufficient historical data

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BETTER TOGETHER.

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1 INTRODUCTION

The Western Cape has a coastline in excess of 1000 km, and consequently possesses both the longest coastline of South Africa's four coastal provinces and the largest percentage of coastline relative to total provincial jurisdiction, with roughly one third of the boundary of the Western Cape bordered by the sea (Celliers *et al*. 2010). The province was home to some 5.8 million people in 2011, which accounted for approximately 11% of South Africa's total population (StatsSA 2012), a significant figure considering that the majority of people in the province lives within 25 km of the coast (DEADP 2005). Biophysically, the coastline of the Western Cape consists of sandy beaches interspersed with occasional rocky outcrops, headlands and wave-cut platforms, and it has a number of important estuaries and coastal lakes, particularly in the Wilderness area (Celliers *et al*. 2010). Primary development nodes along the Western Cape coast include Cape Town, Saldanha Bay, George, Knysna, and Plettenberg Bay, while important ports are located at Cape Town, Saldanha Bay (one of only two deepwater ports in South Africa) and to a lesser extent, Mossel Bay (DEA 1998).

The Western Cape coast is rich in biodiversity, due in no small part to the conjunction of the warm Agulhas and cold Benguela ocean currents which occur in the region and which causes upwelling of nutrients (DEA 1998). Notable natural coastal assets include extensive fisheries resources which form the core of South Africa's commercial fishing industry; kelp, penguin and seal colonies; fynbos; and indigenous coastal forests at various points along the coastline (Celliers *et al*. 2010).

This chapter on Oceans and Coasts attempts to describe the current state of the coastal zone in the Western Cape and interpret the environmental changes that are evident along the coastline. Indicators which report on the state of the Western Cape ocean and coastal environment in the context of these pressures are described in Section 3. These include coastal water quality, estuary health, conservation areas, threats to marine ecosystems, as well as transformation of threatened ecosystems along the coastline. The impacts associated with these changes in environmental state are presented in Section 4. Section 5 lists responses to these impacts.

2 PRESSURES

Ecosystems are naturally dynamic but are stressed and pressured by human activity through the disturbance of natural processes such as energy flows and nutrient cycles

(Mateus & Campuzano 2008). Nowhere are these pressures more acutely felt than in ocean and coastal areas which are the ultimate recipients of the effects of local as well as distant human activities. Given that coastal areas are particularly desirable locations for settlement, industry, harvesting of natural resources as well as human recreation, pressure on these unique environments is greatly increased. These pressures range in scale and magnitude and include issues such as global climate change, interruption of dynamic coastal processes, the introduction of alien invasive species and the effects of multiple anthropogenic discharges of waste and toxins into rivers and the ocean (Mateus & Campuzano 2008; Pauw 2010).

Major coastal economic activities include shipping, nature and heritage based tourism (particularly the City of Cape Town, Hermanus for whale watching, and Knysna for scenery), commercial fishing, commerce; manufacturing, and agriculture. According to the 2005 Western Cape State of the Environment Report (DEADP 2005), and more recently Pauw (2010) as well as Tunley (2009), such activites imply a diverse range of pressures specific to the ocean and coastal environment of the Western Cape that include, but are not limited to, the following:

- Global climate change;
- Habitat modification through coastal development, extractive industries and destructive fishing practices;
- Beach erosion and interruption of sediment transport to and along the coast;
- Development in adjacent areas leading to increased activity levels and disturbance of dune dynamics;
- Reduced freshwater inflow into coastal areas;
- Inadequate resource and catchment management;
- Coastal mining;
- Desalination of seawater;
- Introduction of invasive alien species;
- Effluent discharges and stormwater runoff;
- Poor agricultural and farming practices;
- Pollution from both land-based and marine sources;
- Illegal harvesting/poaching;
- Overexploitation by shore anglers;
- Overexploitation of intertidal organisms;
- Increasing pressure by tourists and recreational users;
- Mariculture; and
- The lack of a strategic decision support framework.

Climate variability and change is one of the biggest threats to South Africa's coastal regions. Sea level rise and its interaction with increasing storm frequencies, intensities, wind velocities and local conditions presents a significant threat to the coastline. Over 80% of

South Africa's coast consists of sandy shores and is therefore highly susceptible to erosion (Pauw 2010).

3 STATE

3.1 Coastal water quality

Tracked indicators of the status of Oceans and Coasts

- Coastal water quality – Blue Flag status
- Quantity and extent of conservation and protected areas
- Classification of estuary health
- Marine ecosystem health status
- Extent of transformation of threatened ecosystems

The Blue Flag programme, implemented in South Africa by the Wildlife and Environment Society of South Africa (WESSA) is a voluntary international initiative aimed at standardizing and promoting world-class clean, safe and attractive beach environments. Blue Flag is categorized as an 'eco-label', and strict monitoring requirements are needed to both attain and retain Blue Flag status where beaches are assessed according to 25 criteria in four specific categories namely: water quality, environmental education and awareness, environmental management and safety and services (Foundation for Environmental Education 2011). Water quality measured at Blue Flag beaches, one of the assessment criteria, provides a useful indicator of the quality of ocean and coastal waters based on the monitoring undertaken at selected swimming beaches.

Prior to 2011, the specific water quality monitoring criteria relating to the measurement of faecal coliform *Escherichia coli* bacteria at Blue Flag beaches required compliance with a limit of 100 colony forming units per 100 ml seawater for 80% of samples taken over the agreed season. The remaining 20% of samples allowed for isolated short-term events that did not necessarily cause water quality to be compromised. This was in line with the World Health Organisation standards for recreational water quality (Foundation for Environmental Education 2011) as well as the South African Water Quality guidelines for Coastal Marine Waters: Volume 2: Guidelines for Recreational Use (DWAF 1995). These new criteria for monitoring water quality now apply a geometric mean to determine if water quality is acceptable, require fewer samples to be taken and four years of data to be applied. Application of the new criteria could potentially mean the loss of Blue Flags for beaches on the warmer east coast. Data collected (in respect to both *Enterococcus* and *E Coli*) to date and provided to WESSA are a useful indicator of water quality; however, the amendment to the monitoring requirement means it will be harder to show trends.

The Western Cape, while slow to join the Blue Flag programme and initially having mixed results, showed a dramatic improvement in water quality in 2010. While three beaches were above the limit, the frequency of poor water quality was below 20% of recordings for two of these beaches. From these trends it might appear that the number of beaches with poor water quality has increased with time, however, the frequency of high coliform bacteria counts is lower for the most part (WESSA 2010).

Coastal water quality data for Western Cape Blue Flag beaches' respective bathing seasons between 2007 and 2011 is summarised by Table 1.

Table 1: List of Blue Flag beaches within the Western Cape

District	Beach	Years Blue Flag status awarded	Results
West Coast	Yzerfontein	2009, 2011	No recorded exceedances.
Overberg	Kleinmond	2007, 2009-2011	Approximately 25% of samples exceeded allowable limits in 2007.
	Hawston	2007-2011	No recorded exceedances.
	Grotto	2007-2011	No recorded exceedances.
Eden	Witsand	2009, 2011	No recorded exceedances.
	Lappiesbaai	2007-2011	Unacceptably high levels of exceedances (>50%) noted during 2007. No further exceedances recorded between 2008 and 2011.
	Santos	2008-2011	Approximately 25% of samples exceeded allowable limits in 2010. No further recorded exceedances.
	Hartenbos	2007-2011	No recorded exceedances.
City of Cape	Camps Bay	2007-2011	In excess of 30% of records exceeded the allowable limit in 2007. No further exceedances between 2008 and 2011.
	Strandfontein	2008-2011	Between 9% and 12% of samples exceeded the allowable limit in 2009 and 2010 respectively. No exceedances were recorded in 2008 or in 2011.
	Muizenburg	2008-2011	No exceedances recorded.
	Bikini	2007-2011	Approximately 18% of samples exceeded allowable limits in 2008, and this was reduced to 10% of samples in 2009. No further exceedances were recorded.
	Mnandi	2007-2011	In excess of 30% of records exceeded the allowable limit in 2007. There were no exceedances in 2008 and 2011, while 2009 saw approximately 9% of samples exceeding allowable limits. This increased to 18% of samples in 2010.
	Clifton 4th	2007-2011	In excess of 30% of records exceeded the allowable limit in 2007. No further exceedances between 2008 and 2011.

It is thought that poor quality runoff from the rivers and stormwater outlets due to contamination from sewer blockages / overflows and runoff from informal settlements are the main contributing factors to poor water quality at certain bathing beaches. It should also be noted that water quality deteriorates during winter periods when pollutants that have accumulated during the preceding dry season as mobilized and washed from the catchments to the sea with the winter rains (CoCT 2012).

It is important to note that kelp wrack (the common name for several species of seaweed that have washed ashore after becoming detached from the kelp forest) on beaches is known as a breeding ground for bacteria and may therefore contribute to misleading water quality results. Despite this being a natural process, it must be taken into account with the monitoring of beaches which commonly experience kelp wrack.

3.2 Estuary health

Estuaries are unique environments where fresh water from rivers meets saline seawater. These dynamic ecosystems perform numerous essential ecological functions and support important subsistence, commercial and recreational activities. They also form a crucial link between terrestrial systems and processes, catchments and the ocean (Pauw 2010; Van Niekerk *et al*. 2012). Estuaries are amongst the most threatened habitats in South Africa, which is a result of a combination of factors including reduced freshwater inflow, coastal development and over-exploitation of living resources (Pauw 2010).

The Western Cape has 53 estuaries within its jurisdictional boundary stretching from the Olifants Estuary on the West Coast to the Bloukrans Estuary on the South East Coast. Table 2 is adapted from the 2011 National Biodiversity Assessment (NBA)(Van Niekerk & Turpie 2012) and summarises the number of estuaries of the Western Cape and percentage of the national estuarine area represented. As shown, the estuaries of the Western Cape make up roughly 21% of the national estuarine area.

Table 2: Western Cape estuaries by local authority as a percentage of total estuarine habitat (Van Niekerk & Turpie 2012)

Local authority	Number of estuaries	% of national estuarine area
West Coast	6	9%
City of Cape Town	16	1%
Overberg	11	5%
Eden	20	6%
Total	**53**	**21%**

Based on a classification system devised by Van Niekerk & Turpie (2011), estuarine health at District level is described in the section below. The different ecological categories used to indicate estuarine health are explained in more detail in Table 3.

According to the NBA 2011, ecosystem protection levels are assigned based on the proportion of each ecosystem's biodiversity target that is met in formal protected areas which are recognised by the Protected Areas Act or Marine Living Resources Act (SANBI 2012). For these calculations, targets for protection were set at 20% of the estuarine habitat area of each ecosystem type (SANBI 2012). Only optimum functional estuaries (not in health categories C, D, E and F) that are in formally protected areas (i.e. in national, provincial or municipal marine/protected areas) were considered as protected (i.e. contributing to biodiversity targets). Ecosystem protection level is divided into four categories: well protected, moderately protected, poorly protected and not protected (Table 4).

Table 3: Ecological management categories for estuaries

Ecological category	Description
A	Unmodified, natural.
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions and processes are essentially unchanged.
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions and processes are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions and processes have occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions and processes are extensive.
F	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions and processes have been destroyed and the changes are irreversible.

Table 4: Categories of ecosystem protection levels with all targets at 20% of area based on estuarine habitat (Van Niekerk & Turpie 2012)

Protection Level	Description
Well protected	≥ 100% of target in an MPA or PA
Moderately protected	50 to 99.99% of target in an MPA or PA
Poorly protected	5 to 49.99% of target in an MPA or PA
Not protected	0 to 4.99% of target in an MPA or PA

3.2.1 West Coast District Municipality

The health status of the six estuaries occurring within the West Coast District is described in Table 5. Modification levels are high for all estuaries within the West Coast District Municipality, with only two estuaries being classified as 'well protected' while the remainder have no protection. Half of the West Coast District Municipality estuaries are critically endangered in terms of threat status.

Table 5: Estuarine overview for the West Coast District Municipality (Van Niekerk & Turpie 2012)

Name	Bio-geographical Region	Whitfield type	Pollution	Habitat loss	Ecological Category	Protection Levels	Ecosystem threat status
Sout	Cool Temperate	Temporarily closed	Low	Medium	D	Well protected	Least threatened
Olifants	Cool Temperate	Permanently open	Medium	Medium	C	Not protected	Critically endangered
Jakkalsvlei	Cool Temperate	Temporarily closed	Medium	Low	D	Not protected	Vulnerable
Wadrift	Cool Temperate	Temporarily closed	Medium	High	E	Not protected	Critically endangered
Verlorenvlei	Cool Temperate	Estuarine lake	Medium	Medium	D	Not protected	Critically endangered
Groot Berg	Cool Temperate	Temporarily closed	Low	Medium	D	Well protected	Least threatened

3.2.2 City of Cape Town Metropolitan Municipality

The health status of the 16 estuaries occurring within the Metro is described by Table 6. The majority of the estuaries under the jurisdiction of the City of Cape Town are characterised by high levels of pollution; similarly the ecological categories for these systems tends towards high levels of modification. None of the City of Cape Town estuaries were protected at the time of reporting.

Table 6: Estuarine overview for the City of Cape Town Metropolitan Municipality (Van Niekerk & Turpie 2012)

Name	Bio-geographical Region	Whitfield type	Pollution	Habitat loss	Ecological Category	Protection Levels	Ecosystem threat status
Rietvlei/Diep	Cool Temperate	Temporarily closed	High	High	E	Not protected[1]	Critically endangered
Sout (Wes)	Cool Temperate	Temporarily closed	High	High	F	Not protected	Critically endangered
Houtbaai	Cool Temperate	Temporarily closed	High	High	E	Not protected	Critically endangered
Wildevoëlvlei	Cool Temperate	Temporarily closed	High	Medium	D	Not protected	Critically endangered
Bokramspruit	Cool Temperate	Temporarily closed	High	Low	C	Not protected	Critically endangered
Schuster	Cool Temperate	Temporarily closed	Low	Low	A	Not protected	Critically endangered
Krom	Cool Temperate	Temporarily closed	Low	Low	A	Not protected	Vulnerable
Buffels Wes	Cool Temperate	Temporarily closed	High	High	F	Not protected	Vulnerable
Elsies	Cool Temperate	Temporarily closed	High	High	E	Not protected	Critically endangered
Silvermine	Cool Temperate	Temporarily closed	High	High	D	Not protected	Critically endangered

[1] A proclaimed City of Cape Town Nature Reserve but not reflected as such in the 2011 NBA

Name	Bio-geographical Region	Whitfield type	Pollution	Habitat loss	Ecological Category	Protection Levels	Ecosystem threat status
Sand	Cool Temperate	Temporarily closed	High	Medium	D	Not protected[2]	Critically endangered
Zeekoei	Cool Temperate	Permanently open	High	High	E	Not protected[3]	Critically endangered
Eerste	Cool Temperate	Temporarily closed	High	High	E	Not protected[4]	Critically endangered
Lourens	Cool Temperate	Temporarily closed	High	Medium	C	Not protected[5]	Critically endangered
Sir Lowry's Pass	Cool Temperate	Temporarily closed	High	High	E	Zero	Critically endangered
Steenbras	Cool Temperate	Permanently open	Low	None	B	Zero	Least threatened

3.2.3 Overberg District Municipality

The health status of the 11 estuaries occurring within the Overberg is described by Table 7. Pollution levels for these systems are fairly evenly split between medium and low levels, with only the Onrus estuary considered to be experiencing high pollution levels in 2011. However, ecological categories which tend predominantly towards high modification levels, low protection levels and the predominance of critically endangered threat statuses raise concern regarding the health of the estuaries in this district. The exception to this trend is the Klipdrifsfontein estuary which is categorized as unmodified and natural, more than likely owing to the fact that it is well protected.

[2] A proclaimed City of Cape Town Nature Reserve but not reflected as such in the 2011 NBA

[3] A proclaimed City of Cape Town Nature Reserve but not reflected as such in the 2011 NBA

[4] This estuary defines the southern boundary of the Helderberg MPA but is not reflected as 'protected'by the NBA 2011

[5] This estuary defines the eastern boundary of the Helderberg MPA but is not reflected as 'protected' by the NBA 2011

Table 7: Estuarine overview for the Overberg District Municipality (Van Niekerk & Turpie 2012)

Name	Bio-geographical Region	Whitfield type	Pollution	Habitat loss	Ecological category	Protection Levels	Ecosystem threat status
Rooiels	Cool Temperate	Temporarily closed	Low	Low	B	Not protected	Critically endangered
Buffels (East)	Cool Temperate	Temporarily closed	Low	Low	B	Not protected	Critically endangered
Palmiet	Cool Temperate	Temporarily closed	Low	Medium	C	Not protected	Critically endangered
Bot/ Kleinmond	Cool Temperate	Estuarine lake	Medium	Medium	C	Not protected	Critically endangered
Onrus	Cool Temperate	Temporarily closed	High	High	E	Not protected	Critically endangered
Klein	Cool Temperate	Estuarine lake	Medium	Medium	C	Not protected	Critically endangered
Uilkraals	Cool Temperate	Temporarily closed	Medium	Medium	D	Not protected	Critically endangered
Ratel	Cool Temperate	Temporarily closed	Medium	Low	C	Not protected	Critically endangered
Heuningnes	Warm Temperate	Permanently open	Medium	Medium	D	Well protected	Critically endangered
Klipdrifsfontein	Warm Temperate	Temporarily closed	Low	None	A	Well protected	Least threatened
Breë	Warm Temperate	Permanently open	Low	Low	B	Moderately protected	Least threatened

3.2.4 Eden District Municipality

Most of the 20 estuaries within Eden District are characterised by low levels of modification and pollution, while more than half of the estuaries are considered to be well protected (Table 8). Only one system is considered to be critically endangered in terms of threat status, while the remainder are described as least threatened.

Table 8: Estuarine overview for the Eden District Municipality (Van Niekerk & Turpie 2012)

Name	Bio-geographical Region	Whitfield type	Pollution	Habitat loss	Ecological category	Protection Levels	Ecosystem threat status
Duiwenhoks	Warm Temperate	Permanently open	Low	Low	B	Moderately protected	Least threatened
Goukou	Warm Temperate	Permanently open	Medium	Medium	C	Moderately protected	Least threatened
Gourits	Warm Temperate	Permanently open	Medium	Medium	C	Moderately protected	Critically endangered
Blinde	Warm Temperate	Temporarily closed	Medium	Low	B	Well protected	Least threatened
Hartenbos	Warm Temperate	Temporarily closed	High	Medium	D	Well protected	Least threatened
Klein Brak	Warm Temperate	Temporarily closed	Medium	Medium	C	Moderately protected	Least threatened
Groot Brak	Warm Temperate	Temporarily closed	Medium	High	D	Moderately protected	Least threatened
Maalgate	Warm Temperate	Temporarily closed	Low	None	B	Well protected	Least threatened
Gwaing	Warm Temperate	Temporarily closed	Medium	Low	B	Not protected	Least threatened

Name	Bio-geographical Region	Whitfield type	Pollution	Habitat loss	Ecological category	Protection Levels	Ecosystem threat status
Kaaimans	Warm Temperate	Permanently open	Low	Low	B	Not protected	Least threatened
Wilderness	Warm Temperate	Estuarine lake	Medium	Medium	B	Well protected	Least threatened
Swartvlei	Warm Temperate	Estuarine lake	Low	Medium	B	Moderately protected	Least threatened
Goukamma	Warm Temperate	Temporarily closed	Low	Low	B	Well protected	Least threatened
Knysna	Warm Temperate	Estuarine bay	Medium	Low	B	Well protected	Least threatened
Noetsie	Warm Temperate	Temporarily closed	Low	Low	B	Well protected	Least threatened
Piesang	Warm Temperate	Temporarily closed	Medium	Medium	C	Well protected	Least threatened
Keurbooms	Warm Temperate	Permanently open	Low	Low	A	Moderately protected	Least threatened
Matjies	Warm Temperate	Temporarily closed	Low	Low	B	Well protected	Least threatened
Sout (Oos)	Warm Temperate	Permanently open	Low	None	A	Well protected	Least threatened
Groot (Wes)	Warm Temperate	Temporarily closed	Low	Low	B	Well protected	Least threatened

3.3 Conservation and protected areas

Marine protected areas (MPAs) are the foundation of marine conservation in South Africa and are essential for fisheries management (Tunley 2009). MPAs are categorised as either "no-take" or "not no-take" in South Africa where no-take MPAs are areas where no extractive resource use is allowed, while not no-take areas are those areas where certain types of extractive resource use are permitted. MPAs are often the only areas in which viable numbers of reproductive fish are found, and no-take MPAs or no-take zones within MPAs function most effectively in this conservation role (SANBI 2009). Paradoxically, MPAs that are not declared no-take can sometimes become nodes for increased exploitation of fisheries by recreational, subsistence and/or commercial fishers and thus contribute to over-exploitation (Tunley 2009). According to the National Protected Areas Expansion Strategy (NPAES) of 2008 (SANBI 2009), at a national level the focus for MPA expansion from 2008 to 2013 was predominantly on offshore MPAs and the Namaqua inshore bioregion. There is currently a need to increase the extent of no-take zones within existing MPAs, and to reduce the impact of exploitation in controlled zones within MPAs (SANBI 2009).

Seven of South Africa's 23 gazetted MPAs are found in the Western Cape, in three different inshore bioregions (Figure 1). While not reflected in the NBA 2011, it is noted that the Helderberg MPA has been demarcated within the City of Cape Town.

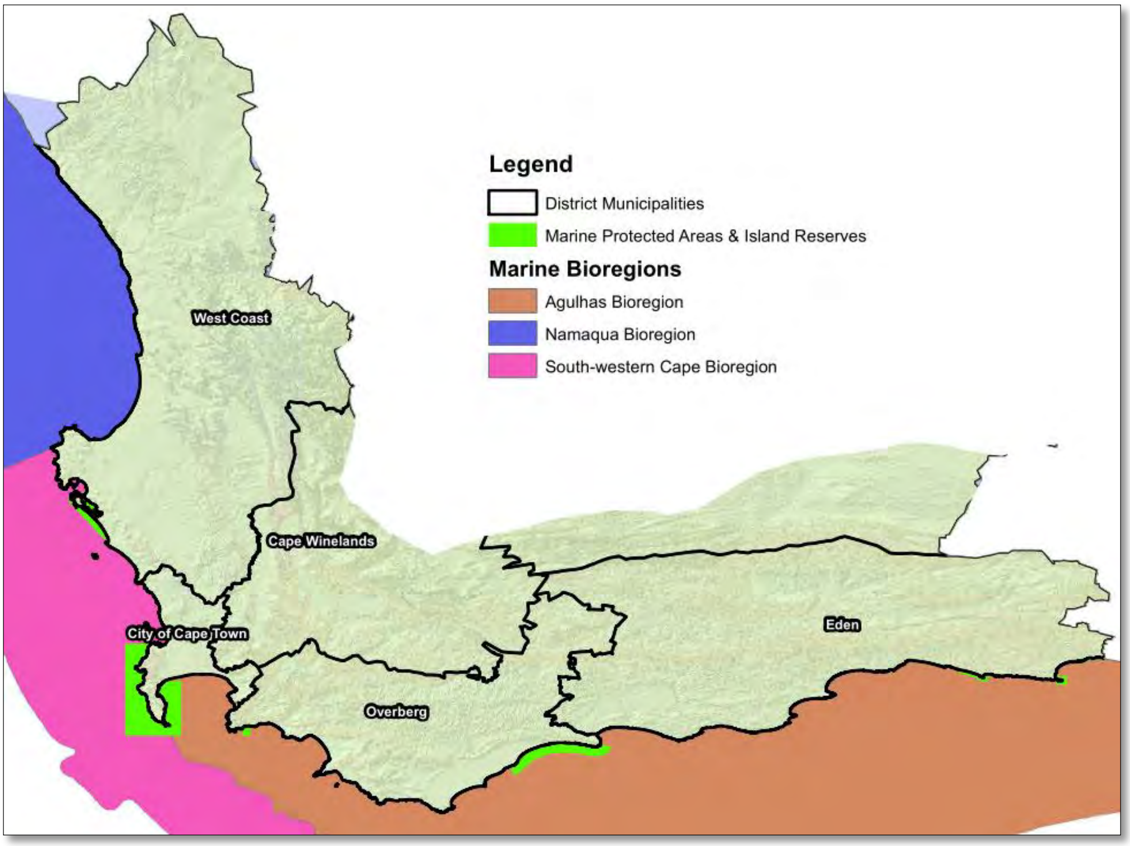


Figure 1: Marine bioregions and marine protected areas of the Western Cape (SANBI 2011)

In terms of protection, each of these marine bioregions was at a different stage in the planning process in 2009, with different authorities and role players being involved in planning for expansion of the marine protected area network (SANBI 2009). WWF South Africa undertook an assessment of the country's MPAs in 2009 to report on and acknowledge the progress made through the actions of national and provincial agencies involved in MPA management, and the NGOs supporting MPA management, as well as to re-prioritise actions for the near future (Tunley 2009). Interviews with key stakeholders, site visits as well as literature reviews were undertaken to develop a scoring system to describe the state of management of South Africa's MPAs. The seven Western Cape MPAs are summarised in terms of this assessment in the tables below. Table 9 show the key features and scores of each MPA, while Table 10 provides a brief description of the MPA[6].

[6] The scores presented here have been adapted from the original assessment by consolidation for ease of reference and conciseness. The consolidated MPA score is merely the average of the preceding scores, and the reader is referred to the original report for more detailed discussion on each MPA.

Table 9: Summary of Western Cape Marine Protected Area features and scores (Adapted from Tunley 2009)

Marine Protected Area	*West Coast National Park*	*Table Mountain National Park*	*Tsitsikamma National Park*	*Betty's Bay*	*De Hoop*	*Goukamma*	*Robberg*
Management Agent	CapeNature	South African National Parks	South African National Parks	CapeNature	CapeNature	CapeNature	CapeNature
Status	Not no-take	Not no-take	No-take	Not no-take	No-take	Not no-take	Not no-take
Size (ha)	2097.2	99849.5	1488.4	2097.2	29780.6	3466.9	2659.5
MPA design score	67%	67%	89%	67%	67%	56%	67%
MPA management plan score	73%	58%	74%	73%	54%	49%	62%
MPA management system score	48%	89%	94%	48%	58%	63%	81%
MPA process score	46%	69%	67%	46%	58%	59%	69%
Consolidated MPA score	**59%**	**71%**	**81%**	**59%**	**59%**	**57%**	**70%**

Table 10: Description of Western Cape Marine Protected Areas and scores (Adapted from Tunley 2009)

Marine Protected Area[7]	Description
West Coast National Park	The five MPAs that together form the West Coast National Park MPA are considered to be of both national and global significance, and comprise the only true lagoon system in South Africa at Langebaan which is important from a biodiversity and ecosystem goods and services perspective for local communities(Tunley 2009). Generally low scores across all areas resulted in a consolidated score of 58% for these MPAs.
Table Mountain National Park	The Table Mountain National Park MPA, which is located at the transitional zone between the South-western Cape and Agulhas bioregions and incorporates a high diversity of marine species, is important for commercial and recreational fisheries as well as research and education (Tunley 2009). This MPA scored relatively well across all areas with the exception of the MPA management plan score, resulting in a consolidated score of 71%.
Tsitsikamma National Park	The Tsitsikamma National Park MPA is the oldest MPA in Africa, having been declared in 1964. It is zoned entirely as a no-take MPA, one of two in the Western Cape as at 2012. This MPA protects approximately 11% of the Warm Temperate South Coast rocky shoreline and is an important reef fish nursery ground and ecotourism attraction (Tunley 2009). The MPA scored highly in all but one area, this being the MPA process score. An excellent consolidated score of 81% highlights the efficacy of this MPA.
Betty's Bay	The Betty's Bay MPA forms part of the core zone of the United Nations Educational and Scientific Organisation (UNESCO) designated Kogelberg Biosphere Reserve (Tunley 2009). Diverse habitats are present within the MPA and include rocky shores, exposed sandy beaches, estuaries, subtidal reefs and kelp forests (Tunley 2009). The area is productive and supports a rich diversity of fish, invertebrate and algal species as well as populations of two Red Data species, namely the African penguin and bank cormorant (Tunley 2009). The Betty's Bay MPA scored highly in MPA design and for its management plan, but this was offset by poor scores in its management system and process, resulting in a relatively poor consolidated score of 59%.
De Hoop	The De Hoop MPA includes rocky platforms, boulder bays, sandy beaches, sub tidal rocky reefs and sandy benthos and supports a rich diversity of intertidal biota, protects reef fish, provides a refuge for several over-exploited fish species and is a critically important nursery area for the Southern Right whale (Tunley 2009). Importantly, the MPA is also a key breeding area for African Black oystercatchers (Tunley, 2009). This MPA is one of only two entirely no-take protected areas in the Western Cape. The De Hoop MPA scored highest in terms of MPA design, with the remainder of its scores being relatively poor, resulting in a consolidated score of 59%.
Goukamma	The Goukamma MPA consists of rocky and sandy shores and a semi-closed estuary. There are offshore reefs and soft sediment within the MPA, and no offshore angling is allowed while shore angling is permitted for the entire length of the MPA (Tunley 2009). The Goukamma MPA scored highest in

[7] The City of Cape Town manages the Helderberg MPA on behalf of DEA however this is not reflected in Tunley (2009)

Marine Protected Area[7]	Description
	terms of its management system, with low scores for the remaining areas resulting in a consolidated MPA score of 57%.
Robberg	The Robberg MPA consists mainly of rocky shores with two sandy beaches comprising approximately 10% of the shoreline. Offshore, the MPA includes subtidal reefs and sandy benthos (Tunley 2009). The area supports exploited reef fish species, a Cape Fur seal colony and oystercatchers. Shore angling is the only permitted extractive activity (Tunley 2009). High scores in terms of the MPA's management system and MPA process resulted in a consolidated score of 70%.

3.4 Marine ecosystem threat status

State of the Environment documents traditionally report on the state of fish stocks as an indicator of pressures on marine ecosystems. The Marine and Coastal Component of the National Biodiversity Assessment 2011, which is proposed to be replicated every 5 years, presents ground-breaking research which includes the first national marine and coastal habitat classification and national habitat maps for the coast, ocean floor and the open ocean; a comprehensive review of pressures on marine and coastal biodiversity; and the first data driven assessment of ecosystem threat status and protection levels for 136 habitat types (Sink *et al*. 2012). This assessment was therefore prioritised over an indicator related exclusively to fisheries stocks, as it provides a more holistic overview of the state of the marine environment whilst still taking the exploitation of resources into account as a pressure on marine ecosystems (Figure 2). The methodology used to assign marine ecosystem threat status is shown by the figure below.

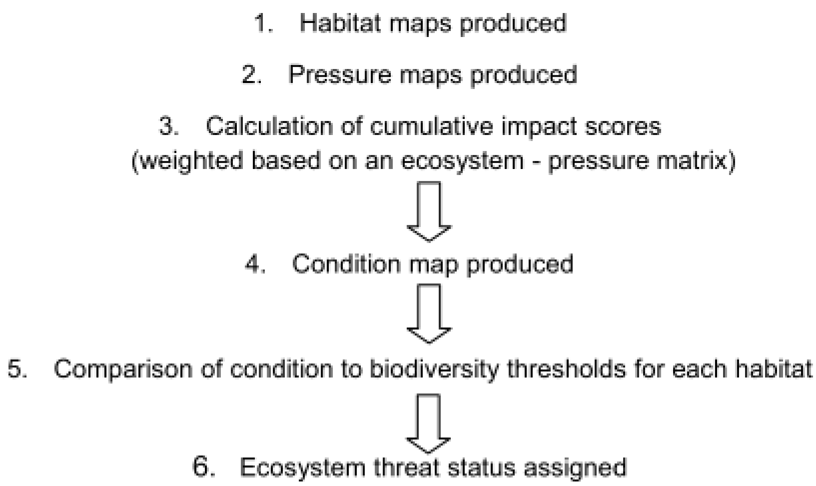


Figure 2: Methodology used to determine marine ecosystem threat status (Sink *et al*. 2012)

The threat status of an ecosystem was determined by evaluating the area of each habitat in a specific condition against a series of thresholds. Four ecosystem threat categories were defined, and are described by Table 11.

Table 11: Condition thresholds and descriptions of marine ecosystem threat status categories (Adapted from Sink *et al*. 2012)

Ecosystem threat status	Condition thresholds	Description
Critically endangered	Less than 20% Good	These are habitat types where the area in good condition is less than the identified biodiversity target (20%). Conceptually, these are habitat types where there are very few remaining areas of pristine or natural habitat, and it is expected that important components of biodiversity pattern have been lost and that processes have been heavily modified.
Endangered	Less than 35% Good	These are habitat types where the area in good condition is less than the identified biodiversity target plus 15% (i.e. 35%). Conceptually, this is a "red flag" category for habitat types that are approaching the point where it is expected that important components of biodiversity pattern and process will be lost.
Vulnerable	Less than 80% Good and Fair	These are habitat types where the remaining area in good condition is greater than the identified biodiversity threshold plus 15% (i.e. are not Critically Endangered or Endangered), but where the remaining area of habitat type in good or fair condition is less than 80%. Conceptually, these are habitat types where there are sufficient areas of intact biodiversity of this type to meet the biodiversity target, but outside of these areas there has been habitat degradation and some loss of ecosystem processes.
Least threatened	More than 80% Good and Fair	These are habitat types where the area that is estimated to be in good condition is greater than the identified biodiversity target plus 15% (i.e. they are not Critically Endangered or Endangered), and where the area of habitat type in good or fair condition is greater than 80%. Conceptually, there are sufficient areas of intact biodiversity of this habitat type to meet the biodiversity target, and it is anticipated that there has been little broad modification of ecosystem processes. Relatively large portions of the habitat type are perceived to be in a relatively pristine or natural state based on the available pressure data.

These threat categories assume that the condition of ecosystems and habitats is directly related to pressures and anthropogenic drivers of ecosystem change, of which extractive resource use, such as fishing, forms part (Sink *et al*. 2012). The results of this assessment are depicted spatially for the offshore and coastal benthic habitat of the Western Cape by Figure 3.

Critically endangered habitats are distributed predominantly along the West Coast nearshore, Eden and Overberg offshore areas, as well as the continental shelf edge, due to high levels of multiple pressures in these areas (Sink *et al*. 2012). Endangered areas are concentrated between Langebaan in the northwest and Cape Agulhas in the southeast, while vulnerable coastal and benthic habitats stretch from Cape Town to the Knysna area, often for vast distances offshore. The continental shelf is characterised mostly by vulnerable benthic habitats, interspersed with pockets of critically endangered habitats (Figure 3).

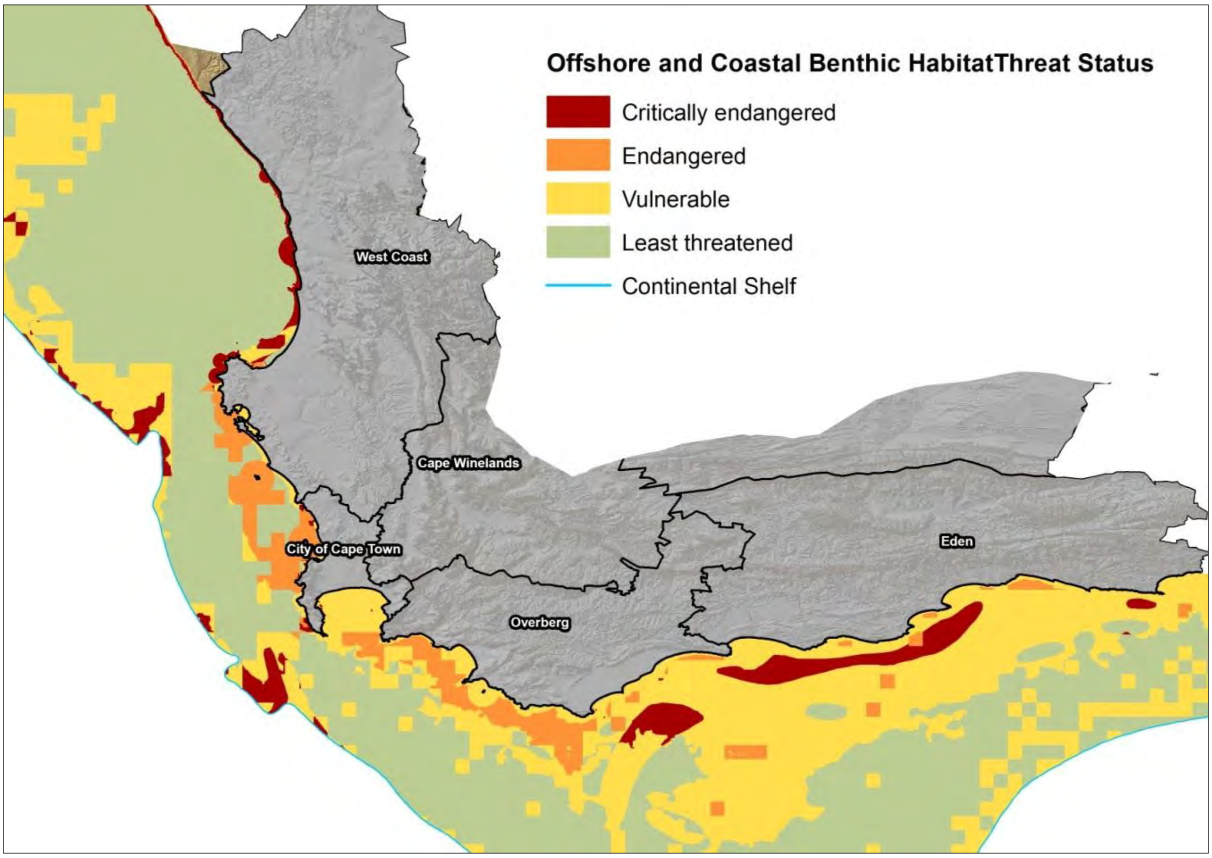


Figure 3: Ecosystem condition for the coastal and offshore benthic environment in the Western Cape region (Adapted from Sink *et al*. 2012)

3.5 Transformation of threatened ecosystems in the coastal belt

The National Environmental Management: Biodiversity Act (Act No. 10 of 2004) provides for the listing of threatened or protected terrestrial ecosystems in one of four categories: critically endangered, endangered, vulnerable or protected. The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction, including sites of exceptionally high conservation value by preventing further degradation and loss of structure, function and composition of these threatened ecosystems (SANBI 2011). Within the Western Cape, approximately 12.5 % of the province consisted of threatened terrestrial ecosystems as of 2009, of which 23.2 % were categorised as critically endangered, 9.5 % as endangered, and 67.2 % as vulnerable (SANBI 2011).

In order to assess transformation of threatened ecosystems for the coastal environment of the Western Cape for the purposes of this report, a coastal belt of approximately one kilometre from the shoreline was delineated, and spatial data for this area was extracted from the national biodiversity datasets developed by SANBI. The remaining extent of the threatened ecosystems was subtracted from original extent within this coastal belt, which indicates the habitat loss as percentage of change between 2001 and 2009[8].

In order to contextualise this habitat loss, Table 12 shows the area of the coastal belt occupied by threatened ecosystems as a percentage of the entire Western Cape coastal belt. At the provincial level, threatened ecosystems accounted for approximately 38% of the coastal belt in 2001, but only 24% of the Western Cape's coastal belt was still characterised by remaining threatened ecosystems in 2009. By implication, transformation of 36% of these areas resulted in a loss of threatened ecosystems along 14% of the coastline between 2001 and 2009.

At the district level, the Overberg District is characterised by the highest level of transformation between 2001 and 2009, showing transformation of 48% of the threatened ecosystems, which accounts for 11% of the coastline. This is followed by the City of Cape Town at roughly 40% transformation. The high levels of transformation can be attributed to, respectively, extensive agriculture and high levels of urbanisation. The West Coast and Eden Districts display lower rates of transformation at approximately 28% and 29% respectively between 2001 and 2009.

Table 12: Transformation of threatened ecosystems in the Western Cape coastal belt (SANBI 2011)

District	Size	Original Extent	Remaining Extent	Percentage Change
West Coast	Area (ha)	8143.31	5849.05	28.17%
	Percentage of coastal belt	19.80%	14.22%	5.58%
City of Cape Town	Area (ha)	19836.05	11941.89	39.80%
	Percentage of coastal belt	99.80%	60.09%	39.72%
Overberg	Area (ha)	6559.60	3431.35	47.69%
	Percentage of coastal belt	23.48%	12.28%	11.20%
Eden	Area (ha)	11484.52	8096.18	29.50%
	Percentage of coastal belt	37.19%	26.22%	10.97%
Western Cape	Area (ha)	46068.77	29350.78	36.29%
	Percentage of coastal belt	37.99%	24.20%	13.79%

[8] This refers to change in the area covered by threatened ecosystems, not to change in percentage of the coastal belt.

Threatened ecosystems are furthermore categorised into critically endangered, endangered and vulnerable in terms of the NBA 2011 (Van Niekerk & Turpie 2012). Of the threatened ecosystems identified in the Western Cape coastal belt, approximately 54% are categorised as endangered, 26% as vulnerable, and 20% as critically endangered (). The high percentage of endangered ecosystems is of concern at a provincial level in the Western Cape.

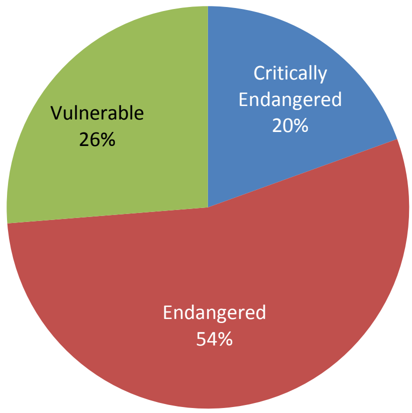


Figure 4: Threatened ecosystems in the Western Cape coastal belt by threat category (SANBI 2011)

4 IMPACTS

Impacts on receiving environments and ecosystems may be thought of as the results of pressures on these environments. In the case of the oceans and coasts of the Western Cape, impacts, which have been identified, include:

- Pollutants from marine and land based sources which results in fluctuations in coastal water quality will lead to a reduction in the ability of coastal and marine environments to provide 'free' ecosystem goods and services such as waste processing and dilution of pollutants;
- Estuarine environments characterised by poor health and low levels of protection are indicative of the reduced ecological integrity and functioning of these ecosystems;
- The presence of critically endangered and endangered marine ecosystems indicates an overall reduction in marine and coastal ecosystem integrity, not least of which as a result of over-exploitation of resources and permanent compromise through transformation (Sink *et al*. 2012);
- Dynamic coastal processes interact with land transformation and other pressures on the coastline to increase coastal environmental risks which manifest in impacts such as mobile sand dunes, increased intensity, frequency and duration of extreme events as well as decreased ecosystem resilience; and
- Transformation of threatened ecosystems in the coastal belt leads to alteration of natural coastal dynamics, the introduction of alien invasive species and decreased resilience to the impacts of climate change.

5 RESPONSES

Managing human activities in the coastal zone is necessary to lessen anthropogenic impacts, protect people from the risks and hazards that arise from changes in climatic conditions, as well as to prevent current poor coastal development practices from recurring and increasing. This is especially critical in the face of increasing environmental change related to climatic shifts and increased levels of human activities along the coastline.

Responses to the impacts described in Section 4 are categorised into responses which are aimed at addressing specific indicators highlighted in this report, followed by more general policy, tools and legislative responses which occur at national, provincial and local levels. Responses to address pressures in the coastal zone may also include coastal by-lays; coastal overlay zones and various other coastal management specific policies. Coastal set-back lines and estuary management plans are two responses described in more detail below.

5.1 Coastal set-back lines

The prediction of climatic changes and calculation of the related risk along the coastline has become a necessity and is acknowledged in terms of the National Environmental Management: Integrated Coastal Management Act's requirement for the designation of coastal set-back lines. Coastal set-back lines propose to define an amount of space that should be left between buildings and infrastructure and the shoreline, as a means to mitigate the impacts related to development and reduce the risk to infrastructure (DEADP 2012a). The intended outcome is to use coastal set-backs to protect or preserve coastal public property; coastal private property; public safety; the coastal protection zone; and the aesthetics of the coastal zone (Celliers *et al*. 2010).

The Western Cape Province has taken the national lead with the delineation of set-back lines. This process commenced with a study conducted during 2010 to determine a standardised methodology for the delineation of coastal set-backs in the province. This study aimed to ensure consistency in the application of the coastal set-backs for the Western Cape, and was based on two small study sites in Milnerton and Langebaan (DEADP 2012a). Subsequent roll-out of the programme has seen the completion of set-back lines for the Overberg District, and the commencement of a similar exercise for the West Coast District. The City of Cape Town has proceeded with the determination of coastal set-back lines for its municipal area in parallel to the Provincial programme.

Studies have also been conducted to determine the risk associated with potential sea level rise for the Eden, Overberg and West Coast District Municipalities (DEADP 2010; DEADP 2011; DEADP 2012b).

5.1.1 Overberg District Municipality

The Overberg assessment of sea level rise and flood hazard risk categorised areas along the Overberg coast as being low, medium or high risk to three potential consequences of sea level rise: groundwater contamination from salt water intrusion; coastal erosion / inundation; and extreme events (e.g. large storm surges and tsunamis). Most of the Overberg coast was classified as being at low to moderate risk to these three categories (DEADP 2012b).

The Western Cape demarcated coastal set-back lines for the Overberg District in collaboration with the Overberg District Municipality and the Overstrand, Cape Agulhas and Swellendam local municipalities, as well as CapeNature and SanParks. The demarcation of the lines was informed by an analysis of coastal zone processes such as wave action, erosion or accretion trends, dune migration, and the location of existing developments. The process identified that the implementation of the various development restrictions needed to make provision for existing development and development planning that extends into the coastal hazard zone. It was realised that any development regulation would significantly affect existing or assumed property rights as well as development precedents, and consequently it was recommended that implementation should differentiate between the modelled long-term erosion hazard and more pragmatic development controls. More emphasis should also be placed on local knowledge, planning considerations, existing development and structural alternations to the shoreline as well as local regulatory capacity (DEADP 2012).

Areas at greatest risk of impact from coastal dynamics in the Overberg include Rooi Els; Pringle Bay; Betty's Bay; Hawston; Pearly beach; Quoin Point; Agulhas; Struisbaai; Arniston; Skihaven; Infanta and the extensive undeveloped mobile dune fields on the eastern side of the district (DEADP 2012).

5.1.2 West Coast District Municipality

The West Coast assessment of sea level rise and flood hazard risk categorised most of the West Coast's coastline as being at low to moderate risk to erosion and inundation, extreme events and groundwater contamination (DEADP 2011). Set-back lines are to be determined for the West Coast District Municipality during 2013. Langebaan, however, featured as one of the two test sites in the original Western Cape Province Set-backs Methodology pilot study. The same methodology as used for the Overberg set-backs study will be applied in the West Coast in order to ensure as much consistency as possible across the province.

5.1.3 City of Cape Town

In response to the pressing coastal environmental risks, the City is in the process of establishing a variety of coastal spatial panning and regulatory mechanisms. The City has developed a methodology for its set-back and has subsequently submitted a formal report to DEA&DP requesting the formalisation of the City's set-back in terms of the requirements of ICMA. The delineation of the City's set-back followed an extensive stakeholder engagement proves which was also undertaken through, and integrated with the formal public participation process undertaken for the Cape Town Spatial Development Framework. The City's set-back was defined based on a variety of biophysical and conceptual informants. These included risk from storm surges and coastal erosion, biodiversity concerns, coastal dynamic process, heritage, aesthetics, sense of place and socio-economic elements relating to coastal access. Key to this approach was the exclusion of property with existing development rights from the set-back to avoid impacting on those development rights. The exclusion of property with development rights along some parts of the coastline has required the development of additional spatial planning and land use mechanisms in built up areas as more appropriate mechanisms to deal with the complex issue of property with development rights which are currently at risk from coastal processes. In addition to this the City is in the process of developing a coastal by-law which will focus on the regulation of activities along the City's shoreline (CCT, 20012).

The 5th phase of the City's sea-level rise risk assessment disaggregated risk per location based on exposure to coastal processes and identified vulnerable locations as: Melkbosstrand; Blouberg; Table View beachfront; Milnerton; Green Point and Sea Point; Glen Beach and Camps Bay; Bakoven Cottages; Kommetjie; Witsands; Glencairn; Fish Hoek; Kalk bay; Muizenberg corner; Strandfontein/Bayden Powell Drive; Monwabisi; Strand; and Bikini Beach.

5.1.4 Eden District Municipality

While no set-back lines have yet been determined for the Eden District Municipality, an assessment of sea level rise and flood hazard risk has been completed. This assessment indicated that most of the Eden coastline is at medium to high risk of erosion and inundation, groundwater contamination and extreme events (DEADP 2010). Areas identified to be at greatest overall risk include: Sedgefield-Swartvlei; Wilderness East; Wilderness West; Knysna; Plettenberg Bay; Hartenbos; Keurbooms-Bitou; Nature's Valley; Klein-Brakrivier; Groot-Brakrivier; Walker's Bay and Mossel Bay (DEADP 2010).

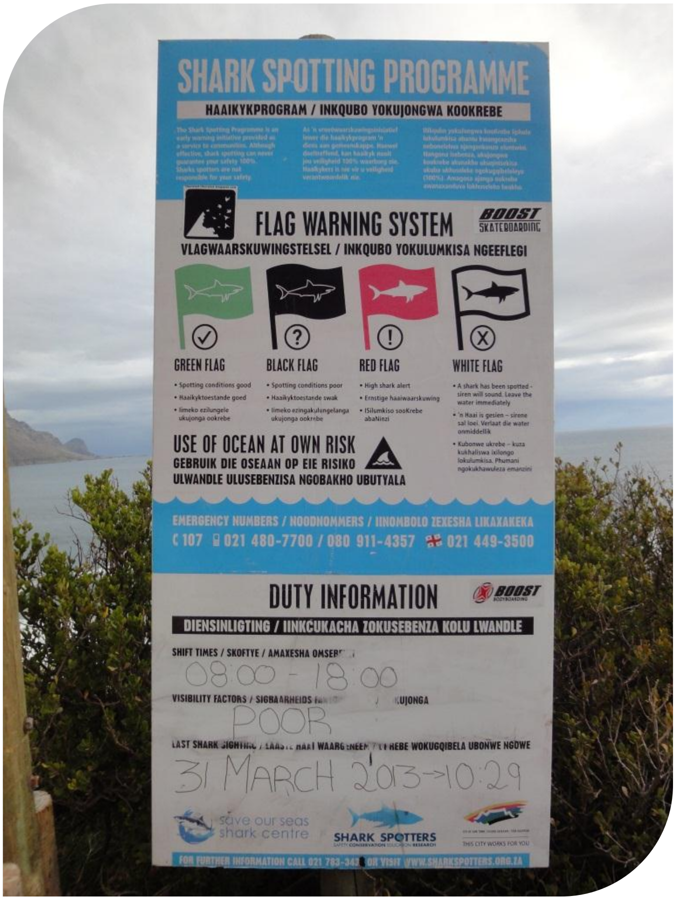
5.2 Estuary management plans

Table 2 in Section 3.2 shows the state of the majority of estuarine systems in the Western Cape, and indicates that they are in good or fair condition. Despite this, the overall data highlights the need to intensify biodiversity conservation and management efforts since a high proportion of the estuaries are critically endangered and protection levels are low (Van Niekerk *et al*. 2012).

As a response to this, estuary management plans were in the process of being developed for 16 estuaries at the time of reporting, representing only 30% of the total number of estuaries in the Western Cape. Draft estuary management plans exist for 15 of the 16 estuaries. Only six of these have been reviewed taking the new (2012) draft National Estuarine Management Protocol into consideration (Van Niekerk *et al*. 2012). Table 13 summarises the progress of each of the estuary management plans considered at the time of reporting.

Table 13: Status of estuary management plans in the Western Cape in 2012 (Van Niekerk *et al*. 2012)

Estuary	District Municipality	Plan Status
Olifants	West Coast	Plan completed and an interim estuary management forum established to include fisher community.
Groot Berg	West Coast	Plan completed and estuary management forum established.
Verlorenvlei	West Coast	Plan completed and estuary management forum established.
Diep (Rietvlei)	City of Cape Town	Plan completed and estuary management forum established.
Sand (Zandvlei)	City of Cape Town	Plan completed and estuary management forum established.
Bot	Overberg	Plan completed and estuary management forum established.
Klein	Overberg	Plan completed and estuary management forum established.
Uilkraals	Overberg	Plan completed and estuary management forum to be established in 2012.
Heuningnes	Overberg	Plan completed and estuary management forum established.
Breede	Eden	Plan completed and estuary management forum established.
Goukou	Eden	Plan completed and estuary management forum will be finalised in 2012.
Gouritz	Eden	Plan completed and estuary management forum established.
Klein Brak	Eden	Plan completed and estuary management forum will be finalised in 2012.
Groot Brak	Eden	Plan completed and estuary management forum will be finalised in 2012
Knysna	Eden	Plan completed and incorporated into PA plan, and PA forum exists but not fully integrated into broader government structures.
Keurbooms	Eden	Plan completed and estuary management forum established.



5.3 Focus areas for future protection

Many of South Africa's most productive offshore habitats that support marine biodiversity are not included in the current MPA network (Sink *et al*. 2012). To address this, the NBA 2011 identified several strategic geographic priority areas for the establishment of new MPAs and other types of spatial management measures. These include priority areas in KwaZulu-Natal and the Agulhas ecoregion as determined from fine-scale plans and focus areas for offshore protection based on a national analysis (Sink *et al*. 2012). Figure 5 shows the focus areas for offshore protection adapted for the Western Cape region (Sink *et al*. 2012). Finer-scale investigation and collaboration with stakeholders are needed to determine proposed boundaries within these focal areas (Sink *et al*. 2012).

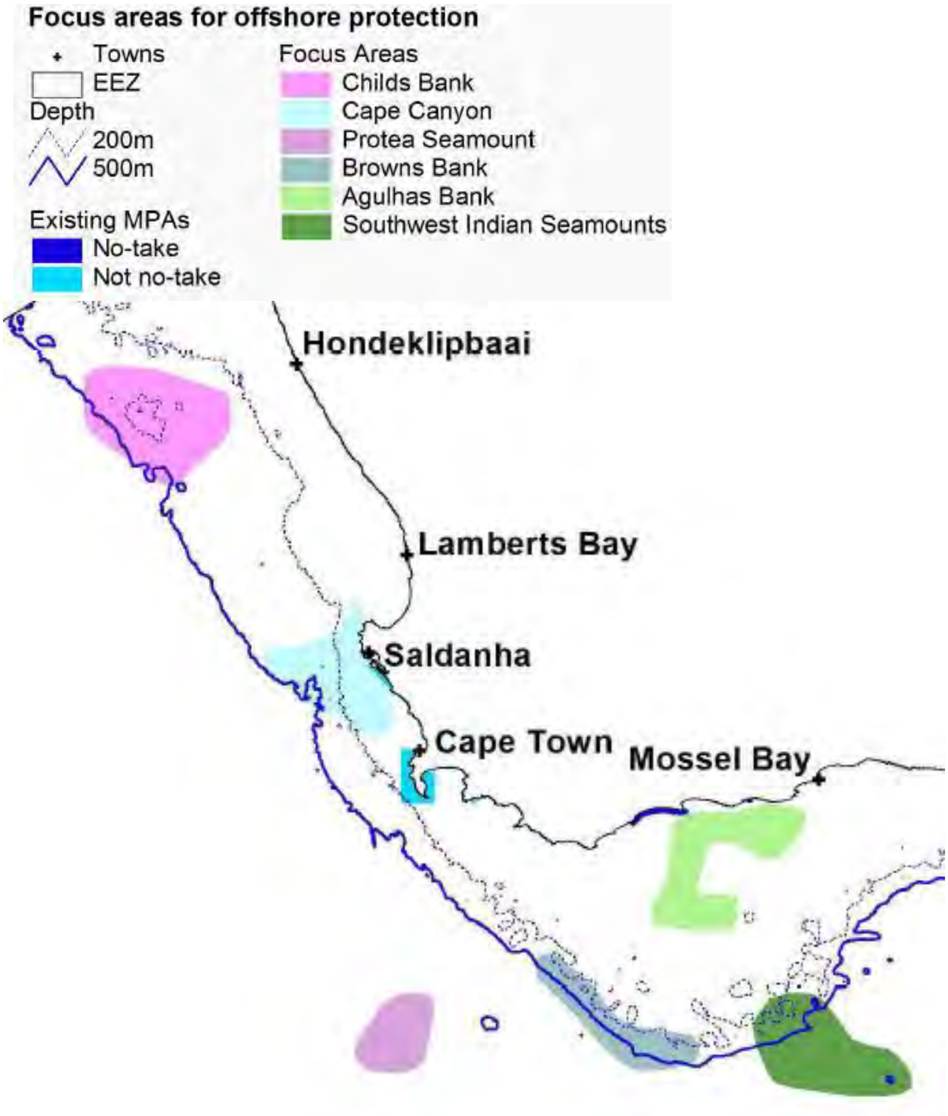


Figure 5: Focus areas for offshore protection (Adapted from Sink *et al*. 2012)

5.4 Policy, tools and legislation

Responses in the form of policies, tools and legislation across all scales applicable to this theme are listed in the summary table:

Table 14: Summary of policy, tools and legislation

International Responses	2009	Inter-governmental Panel on Climate Change (IPCC): South Africa Country Report: Sea-level rise: trends, impacts and mitigation for South Africa Phase I: Qualitative overview and analysis
National Responses	1998	Marine Living Resources Act, Act 18 of 1998
	2004	Southern African Sustainable Seafood Initiative
	2005 (and 2013)	State of the Environment reporting (including State of the Oceans)
	2008	National Environmental Management: Integrated Coastal Management Act, Act 24 of 2008
	2010	Environmental Impact Assessment Regulations - coastal specific listed activities
	2011	National Biodiversity Assessment
	2011	National Climate Change Response White Paper
	2012	Recreational Coastal Marine Waters Quality Guideline
	2012	Draft National Environmental Management of the Oceans (NEMO)
	2012	Draft National Estuarine Management Protocol
		South African Network for Coastal and Oceanic Research
		Working for the Coast
Provincial Responses	2003	Bioregional planning manual
	2005	Provincial urban edge guidelines
	2005	Guidelines for Environmental Management Plans
	2007	Aquaculture Guidelines in the Western Cape
	2007	Guidelines on biodiversity offsets
	2010	Western Cape Provincial Plan of Action (WCPPA) for Reducing Land-based Pollution to the Marine Environment
	2010	Eden District Municipality Sea Level Rise and Flood Hazard Risk Assessment
	2011	West Coast District Municipality Sea Level Rise and Flood Hazard Risk Assessment
	2011	Checklist for the determination of the applicability of the NEMA EIA regulations 2010-2012
	2012	Overberg District Municipality Sea Level Rise and Flood Hazard Risk Assessment
	2013	Development parameters guidelines
		CAPE Estuaries Program – several estuary management plans
Local Authority Responses	2003	City of Cape Town Coastal Zone Management Strategy
	2005	City of Cape Town By-law Relating to Stormwater Management
	2009	City of Cape Town Floodplain and River Corridor Management Policy
	2009	City of Cape Town Management of Urban Stormwater Impacts Policy
	2010	City of Cape Town Coastal Protection Zone draft by-laws
	2010	City of Cape Town Sustainable Coastal Management Plans
	2010	Eden District Coastal Management Programme (in preparation)
	2010	West Coast District Coastal Management Programme (in preparation)
	2010	City of Cape Town Set-back – method and process report
	2010	City of Cape Town draft Integrated Protection Policy
	2010	City of Cape Town draft General Coastal Over-lay zones
	2010	City of Cape Town draft Large Marine Animal Stranding Policy
	2010	City of Cape Town Coastal Events and Filming Policy
	2012	City of Cape Town Inland and Coastal Water Quality Improvement Strategy and Implementation Plan
	2013	Draft Integrated Coastal Management Strategy

6 CONCLUSION

OUTLOOK: DECLINING

The trends described for the oceans and coasts of the Western Cape Province highlight many areas of concern with regards to the impact human populations are having on the dynamic and often sensitive coastal and marine environments. Of particular concern is the threat status of large areas of marine ecosystems and the high levels of transformation of terrestrial threatened ecosystems in the coastal belt, mostly as a result of human activity. These impacts are exacerbated by global environmental problems such as climate change, together resulting in a deteriorating state of the marine and coastal environment.

Effective responses to the impacts and pressures on the receiving environment are heavily dependent on the best available data and information. With this in mind, data and information needs with respect to the Western Cape oceans and coasts are as follows:

- Standardised and widespread monitoring of coastal water quality for all district municipalities, according to the most recent national water quality guidelines;
- Rates of coastal erosion and movement of mobile sediment needs to be tracked in risk prone areas of the province; and
- Transformation of threatened coastal vegetation needs to be monitored going forward (i.e. beyond the 2009 dataset) and at a finer scale.

The 2005 State of Environment Report for the Western Cape (DEADP 2005) expressed concern that the health of the coastal zone was of deteriorating, citing increasing pressure from tourism, economic growth and over exploitation of fish stocks as the primary drivers of this situation. The indicators presented for the 2013 report point towards a similar conclusion, in that the health of the oceans and coasts of the Western Cape remain a concern, perhaps more so in light of new data such as the results of the NBA 2011. Impacts such as coastal erosion are being more acutely felt, evidenced by the increased responses to these issues.

However, significant progress has been made since 2005 in terms of conservation and protected areas, monitoring and reporting, as well as legal and institutional responses to environmental issues in the Western Cape. The development of estuary management plans, set-back lines, new monitoring programmes and the continued expansion of marine protected areas are just a few examples of the ways in which government and the private sector are responding to some of the aforementioned areas of concern.

The findings of the Oceans and Coasts chapter can be summarised as an overall declining outlook. Table 15 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action. Table 16 contains the anticipated changes or outlook for the future of oceans and coasts, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding of the dynamics associated with the ocean and coastal management.

Table 15: Summary of key aspects identified in the chapter

Aspect	Summary of key points
Pressures	• Human settlements • Tourism • Resource extraction (legal and illegal)
Impacts	• Reduced productivity • Disrupted coastal dynamics • Economic value compromised
Challenges	• Mandate paralysis • Understanding sustainable resource extraction levels • Climate change
Progress	• Development of Coastal Set-back Lines • CAPE Estuaries Programme • Coastal Management Plans
Critical areas for action	• Implement coastal management plans • Protect sensitive marine and estuarine ecosystems • Sustainable coastal livelihoods programme • Extend Blue Flag beach programme

Table 16: Summary of the outlook for oceans and coasts based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend
Coastal water quality	• Blue Flag Beaches monitoring shows acceptable state	Improving ↑
Estuary health	• Poor health, highly modified, poorly protected and highly threatened (Eden District is the exception to this)	High concern ↓
Conservation areas	• 8 marine protected areas • Mixed results in terms of management	Improving ↑
Marine area threats	• Critically endangered marine habitats: o West Coast nearshore o Eden and Overberg offshore areas o Continental shelf edge • Endangered habitats: o Langebaan o Cape Agulhas	High concern ↓
Transformation	• Loss of threatened ecosystems along 14% of the coastline between 2001 and 2009	Decline ↓

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BETTER TOGETHER.

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Human Settlements Chapter

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ABBREVIATIONS

BRT	Bus Rapid Transport
CoCT	City of Cape Town
CRR	Cumulative Risk Rating
CSIR	Council for Scientific and Industrial Research
du/ha	dwelling units per hectare
DWAF	Department of Water Affairs and Forestry
IRT	Integrated Rapid Transport
NMT	Non-motorised transport
PRASA	Passenger Rail Association of South Africa
PSDF	Provincial Spatial Development Framework
SANS	South African National Standard
SDF	Spatial Development Framework
WWTW	wastewater treatment works

GLOSSARY

Pollution	The accumulation of harmful or poisonous substances in the environment that leads to environmental degradation
Ecological footprint	The use of natural resources to support human settlements is drawn from a larger area than the actual settlement and therefore has a much wider impact
Conservation agriculture	Conservation agriculture aims to achieve sustainable and profitable agriculture and subsequently aims at improved livelihoods of farmers through the application of the three CA principles: minimal soil disturbance, permanent soil cover and crop rotations.
Breaking New Ground	In September 2004, Cabinet approved a comprehensive plan for the development of sustainable human settlements. This plan is commonly known as "Breaking New Ground". The fundamental principle is to ensure that settlements are sustainable and habitable over-and-above the goal of delivering affordable housing. Sustainable Human Settlements are defined in "Breaking New Ground" policy as "*well-managed entities in which economic growth and social development are in balance with the carrying capacity of the natural systems on which they depend for their existence and result in sustainable development, wealth creation, poverty alleviation and equity*" (DHS 2004).
Green Building Council of South Africa	The Green Building Council of South Africa (GBCSA) was established with the mission of "promoting, encouraging and facilitating green building in the South African property and construction industry primarily through market-based solutions". Its vision is to "lead the transformation of the South African property industry to ensure that all buildings are designed, built and operated in an environmentally sustainable way that will allow South Africans to work and live in healthy, efficient and productive environments" (GBCSA 2013).

1 INTRODUCTION

Human settlements are closely related to patterns of environmental change. The growth of human settlements, large cities or small rural towns, has an impact on the natural resource base. This manifests as an increased demand for both renewable and non-renewable resources such as water, land, minerals and energy leading to their depletion and scarcity. Human settlements can also result in the destruction of ecologically sensitive habitats and biodiversity, loss of productive land, particularly agricultural land and the pollution of natural systems through the use of natural resources and resultant waste products.

The approach to human settlements in the Western Cape is aligned to the national objective which aims to ensure that all have access to services irrespective of shelter type. For those awaiting social housing should be able to do so with dignity. The approach is further aligned with the national "*Breaking New Ground Policy*" which aims at providing more appropriate housing and suburb design (DHS 2012).

This chapter assesses the quality of the living environment as opposed to social conditions. Social indicators such as population growth, poverty, education, employment and food security are included in the introductory chapter as conditions that determine the overall ability of society to respond to environmental issues. This chapter presents information about the condition and quality of the environment in which people live and on conditions that threaten human health and well-being. It looks at various indicators that reflect the state of human settlements in relation to the natural resource base and that impact on the natural environment. Various indicators have been selected as proxies of environmental states, such as housing type and housing delivery, access to basic services, the quality of available drinking water (Blue Drop) and quality of wastewater treatment (Green Drop), transportation services, and the provision and function of open space resources. These indicators provide insight into the state of human settlements with respect to the impact on natural resource base and ecological functioning.

The chapter also provides a discussion on the pressures related to human settlements, the environmental impacts of changing conditions in human settlements, as well as an overview of responses to the challenges.

2 PRESSURES

2.1 Migration and urbanisation

Migration (from other provinces/countries) and urbanisation (shift between rural and urban living) reflect key demand-side pressures in the Western Cape. The principal reason for migration to urban areas or to more dense rural areas is the search for income and employment and consequently a better quality of life. Other causes include the search for better infrastructure and services, including housing, schools, health facilities and access to transport.

The Western Cape Growth Potential study (DEADP 2010) looked at the characterisation of towns outside the City of Cape Town, in order to identify growth opportunities and development needs in the 131 smaller settlements of the province. There is a great diversity in the character and potential of the various towns, with some showing strong growth whilst others are stagnating, or focussing heavily on particular residential or industrial characters. Deterioration of urban settlements in the interior and arid parts of the province is due to declining economic activity and prospects results in rural – urban migration.

Figure 1 below illustrates the trend of migration into the province. As can be seen, the number of people migrating into the province has increased from approximately 278 000 to 321 000 persons, according to the results obtained during the 2001 and 2011 Censuses.

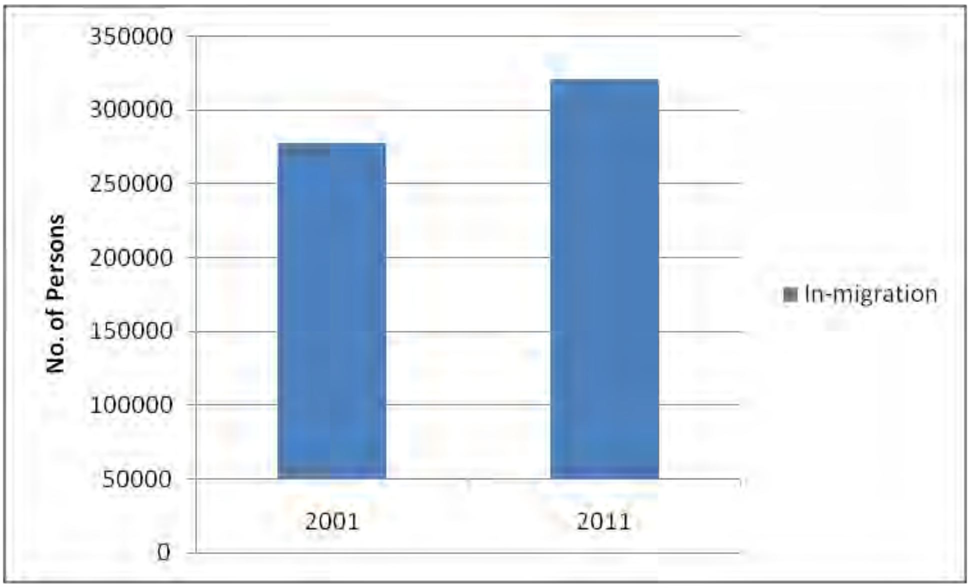


Figure 1: Migration into the Western Cape (StatsSA 2013)

2.2 Growing human settlements

Human settlements are one of the most important drivers of environmental change in South Africa. According to the CSIR (2001), urban human settlements cover only 7% of the total area of the country, yet they generate more than 90% of all economic activity and house over 70% of the total population. The Western Cape is the fourth largest of the country's nine provinces in terms of area (11% of the land area of South Africa). Continued growth of human settlements is inevitable due to increasing population and demand for services and infrastructure. Managing the impact of human settlements on natural systems is therefore a critical aspect for the State of Environment Outlook for the Western Cape.

According to the Census 2011 results 11.3% of the national population (5 822 734 people) lives in the Western Cape (StatsSA 2012). The City of Cape Town (CoCT) has the largest number of households in the province while the Central Karoo District Municipality has the least (StatsSA 2012). Most of the inhabitants in the province live in Cape Town, and other concentrations of inhabitants are in the Southern Cape (George - Knysna) and West Coast (Saldanha - Vredenburg).

Population growth in the Western Cape has been steadily increasing, with growth of 14.3% experienced between 1996 and 2001 (equivalent to annual growth of 2.6%), and 28.7 % growth between 2001 and 2011 (equivalent to annual growth of 2.5%). This has undoubtedly been bolstered to a great extent by immigration from other provinces and countries (StatsSA 2012).

According to the Provincial Spatial Development Framework, 90% of the province's population is urbanized which could be attributed to various factors such as (DEADP 2009b):

- Favourable climatic conditions limited to specific portions of the province;
- Non-existence of a "homeland" area, a characteristic during the apartheid era, which resulted in the settlement of people in urban areas;
- Easier access to better quality services such as health, education, and housing in urban centres compared to the rural areas; and
- Improved job and economic prospects.

High urbanisation rates and population growth result in a continued increasing need for provision of basic services (such as waste removal, housing, water and sanitation). These represent supply-side pressures in the built environment. The capacity to provide these services is in some instances are already overstretched or only limited resources are available to expand the services. The high rate of nett in-migration for the province means that an increasing rate of service delivery is required as the population grows. The result is further pressure on the resilience of the natural environment to cope with these pressure or shocks, and to still function optimally. Inadequate access to services also has an impact on the receiving environment and may lead to problems like increased solid waste volumes and illegal dumping; contamination of groundwater reserves; poor water quality from pollution and effluent discharge.

The relationship between people and the natural environment is important in a developing province characterised by unemployment, poverty, prevalence of HIV/AIDS and a widening gap between rich and poor. The prevalence of poverty and inequality has a detrimental impact on the biophysical environment as people become more dependent on ecological goods and services, and conversely their vulnerability and lack of resilience to environmental degradation and pollution increases.

South African cities are faced with the spatial distortions and inefficiencies which are as a result of the racially segregated spatial structure of the past. This has generally resulted in the poor being located on the periphery of cities and towns historically far away from essential services and employment opportunities. Pressure to create more liveable and sustainable settlements is a key driver but is fraught with difficulty.

Resilience in urban settings

"There are two different ways of interpreting and defining urban resilience. The first, which is somewhat narrower than the second, refers to the capacity of a city to withstand and recover from an external shock, such as an economic downturn or climatic disaster… It implies coping with or ameliorating the effects of the problem and restoring the position that existed beforehand. This definition provides little sense of development or progression to a more secure or favourable situation – economically, socially or environmentally... The second definition of urban resilience is broader and more dynamic, and refers to the capacity of a city to chart a different pathway in challenging conditions… It involves adapting and shaping the development trajectory in order to improve the city's position in some deeper, structural respect. This is a more active concept and may imply transforming local conditions for the better, based on experimentation, creativity and innovation".

South African Cities Network. 2011

3 STATE

The state of human settlements reflects the current condition of various features and how these have changed over time. A key indicator is population growth as the driver of change in human settlements.

Figure 2 indicates an increase in the population of the various District Municipalities and the City of Cape Town which in turn is driving the growth of settlements in the province.

Tracked indicators of *status* of Human Settlements:

- Housing type
- Housing delivery
- Access to basic services includes water, sanitation, refuse removal, electricity
- Access to transportation / transport network
- Open space provision
- Blue Drop Certification
- Green Drop Certification

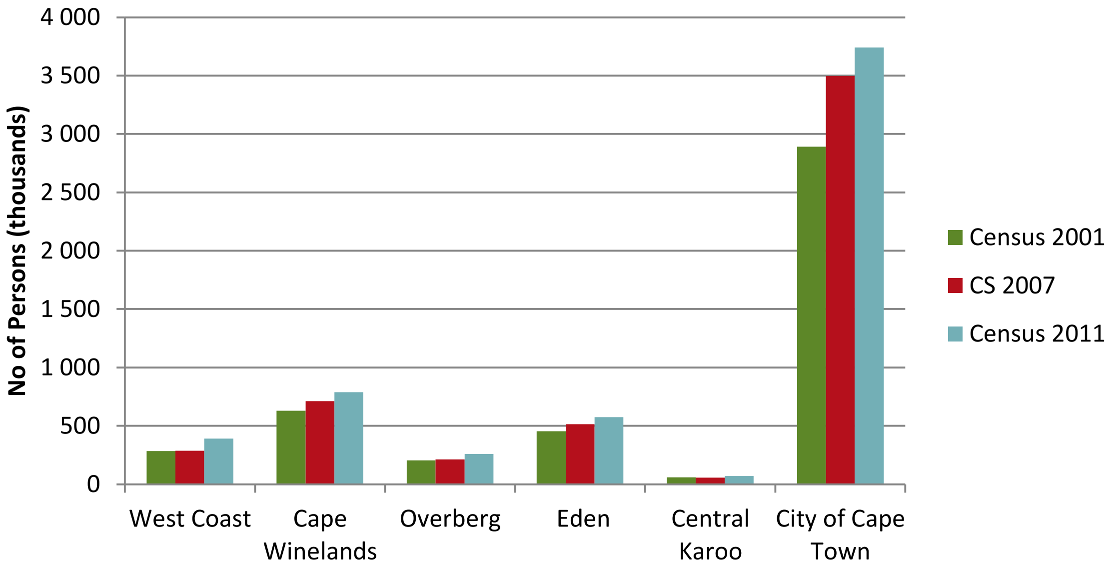


Figure 2: Population growth in the Western Cape (StatsSA 2013)

Figure 3 provides an overall picture of the growth of human settlements in the Western Cape from 1992 to 2009 as analysed from NASA night lights satellite images. This reflects the spatial distribution of trends, but not the transformation of land from one use to another. The spatial distribution of settlements and land use is addressed in the Land chapter. The red areas reflect the most change and these are located in the City of Cape Town in the northern suburbs and towards the West Coast with an increase in Vredenburg and Langebaan, a concentration in the Eden District in Mossel Bay, George, Knysna and Plettenberg Bay, and in most rural towns including Malmesbury, Worcester, Wellington, Robertson, Caledon, Oudsthoorn, Bredasdorp, Swellendam, Riversdale and Beaufort West. The blue areas reflect the least change and can be seen in the established southern suburbs of Cape Town, and areas in the Overberg, Cape Winelands and Eden Districts.

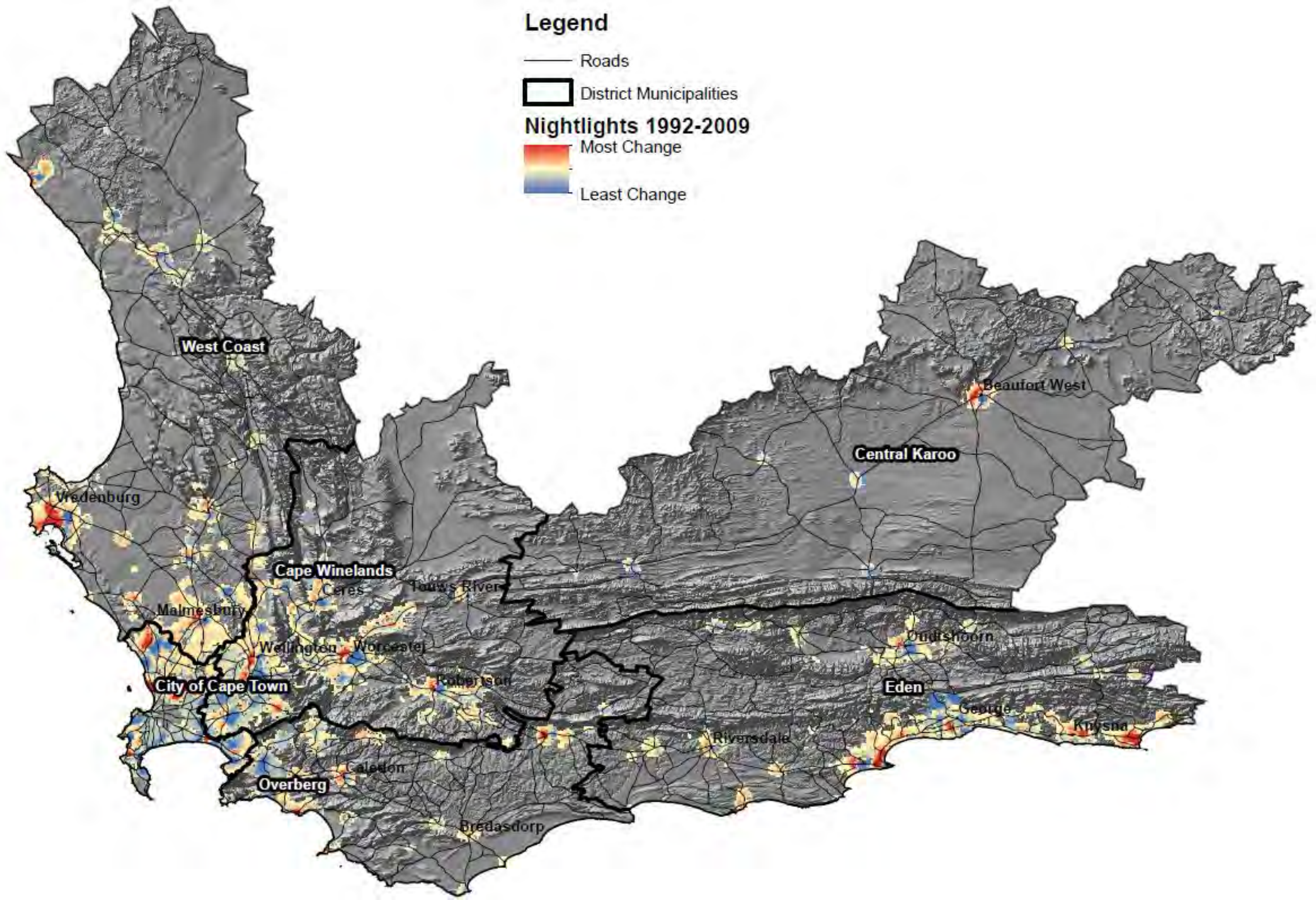


Figure 3: Night lights aerial photography for Western Cape (NASA night lights satellite images)

The Port of Saldanha has experienced high levels of growth due to the infrastructural expansion relating to the deep water port for the export of iron ore and bulk crude oil, a growing number of industrial developments and residential areas. Large tracts of vacant land have been rezoned within Saldanha to industrial land, specifically for incorporation into the planned Industrial Development Zone which envisages the development of a multi-port facility.

3.1 Housing

3.1.1 Housing type

The inhabitants of the Western Cape reside in a variety of housing types or dwellings. Figure 4 depicts the dwelling type per District Municipality and the CoCT metropolitan area. This indicates the quality of housing in relation to human settlements. Analysis of the dwelling types in the Province during the 2011 Census in general, reveals that formal dwellings in the form of a house or brick structure are the most common totalling 1 021 163 (62.5%) out of 1 634 000 compared to 296 950 (18,2%) of informal dwellings counted as shown in Figure 4.

According to the 1996, 2001 and 2011 Censuses, the percentage of formal dwellings in the province showed slight fluctuation with the 2011 Census figure decreasing by 0.9 % from the 2001 Census. Conversely, the prevalence of informal dwellings shows a slight increase from 16.7 % of households in 1996 living in informal structures, to 18.2% in 2011 (the number of households increased from 162 873 in 1996 to 189 545 in 2001 to 297 017 in 2011) (StatsSA 2012).

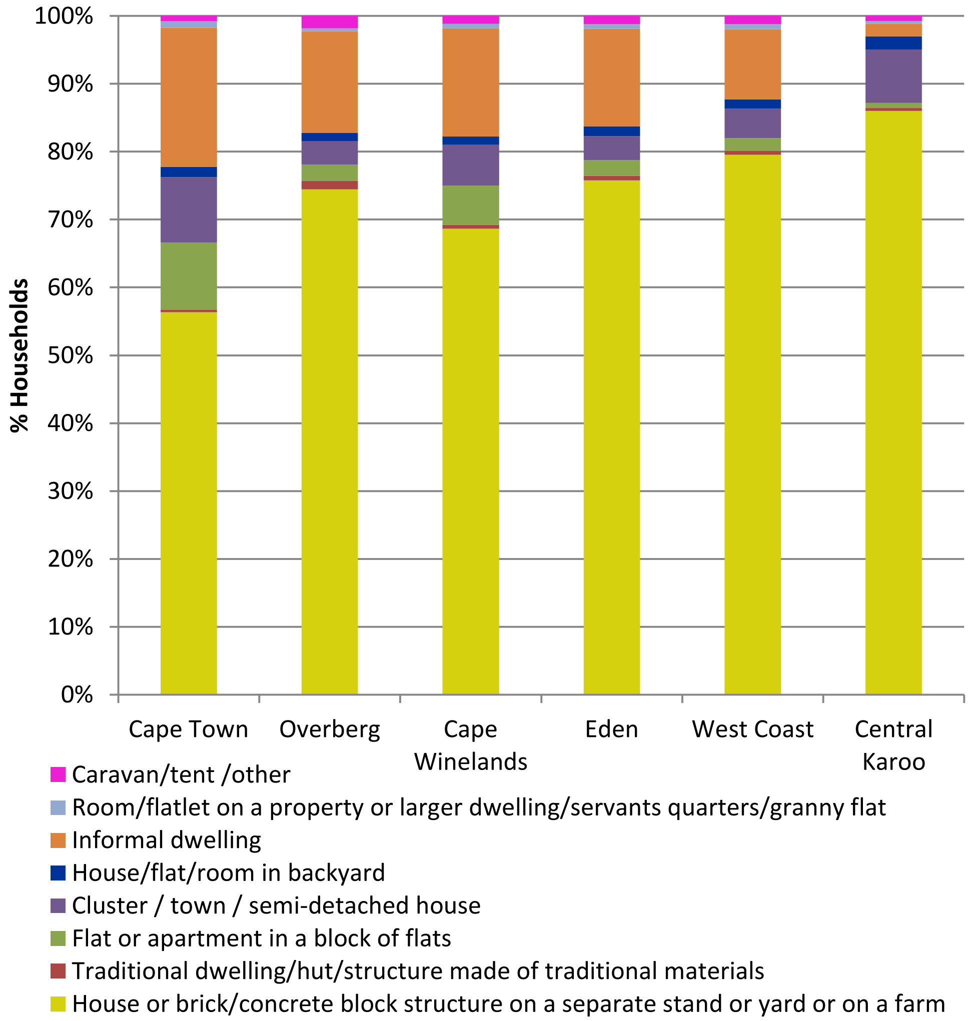


Figure 4: Types of Dwelling in the Western Cape (StatsSA 2012)

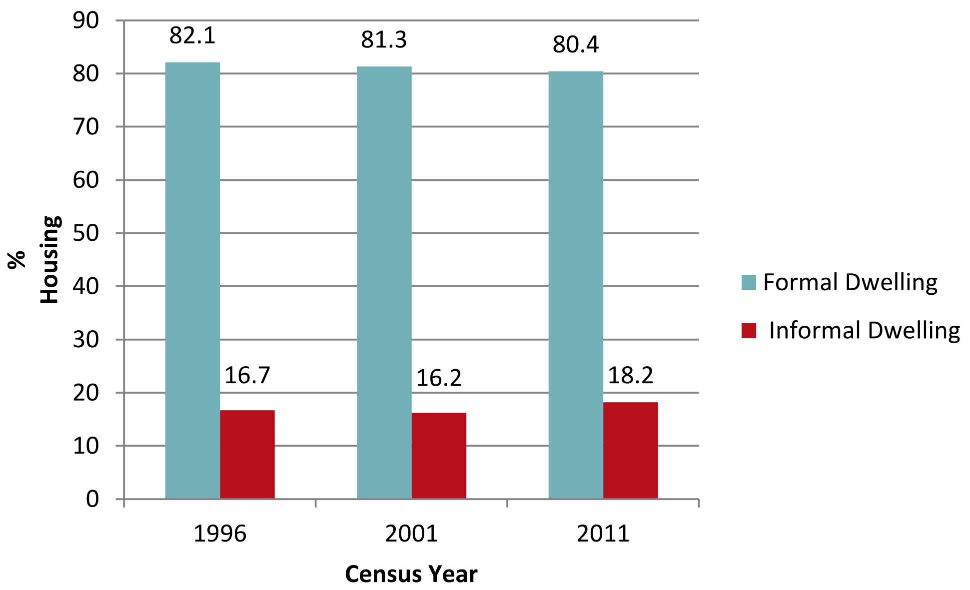


Figure 5: Spread of formal and informal dwellings (excluding traditional dwellings) (StatsSA 2012)

According to a study conducted by the CoCT (2010), it was estimated (using the results of the Census 2011 as a baseline) that the number of households living in informal settlements in 2012 was 198 000 and this figure was predicted to rise to 260 000 in 2019.

The establishment of informal settlements in the Western Cape is largely influenced by:

- Expectations in availability of jobs;
- Expectations in availability of economic and social infrastructure in the area; and
- Access to government services.

3.1.2 Housing delivery

The City of Cape Town has been the largest beneficiary of new social houses built over the financial period 2010-2012 followed by the Overberg, Eden and West Coast District Municipalities (DHS 2012). Figure 6 reveals that there is a trend towards increased numbers of social houses being built outside of the metropolitan area and an overall slowing in delivery in recent years. This is indicative of Provincial strategies to improve the quality of formal housing being provided, in order to create sustainable human settlements rather than large quantities of inefficient housing structures.

The following factors have been identified as delivery challenges (DHS 2012):

- *Historical ineffective/non-existent forward planning*
- *Slow progress on relocation of families out of areas for re-development*
- *Community unrest*
- *Authorisation processes (planning, Environmental Impact Assessment, water licensing etc.)*
- *Incorrect target setting (insufficient project information & inaccurate assessment of project readiness)*

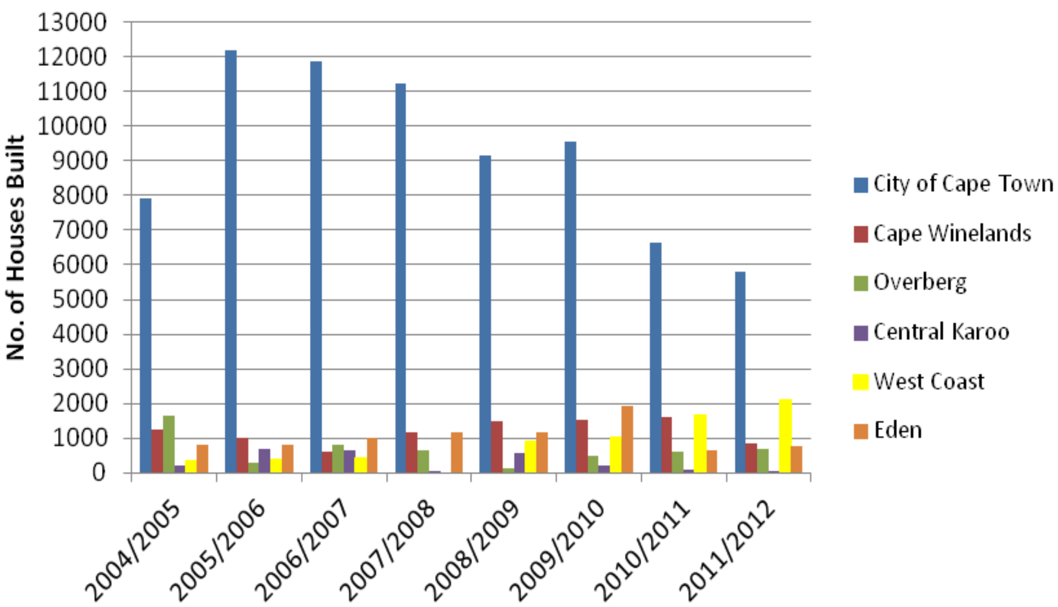


Figure 6: Number of Houses Built in the Western Cape, 2004-2012 (DHS 2012)

Table 1 indicates the "*the number of households living in inadequate dwellings in a specific geographical area at a specific time*" (DHS 2010). The City of Cape Town faces the largest challenge with a backlog of more than 300 000 units.

Figure 7 shows the spatial distribution of public housing projects in the Western Cape where the size of the circle indicates the more projects have been implemented and the blue circles indicate strategic economic development points. Public housing projects are generally located throughout the province and are predominantly in the City of Cape Town and rural centres, in alignment with economic development centres.

Table 1: Housing Backlog in the Western Cape (DHS 2010)

District Municipality	Total Existing Housing Backlog
West Coast	15 876
Central Karoo	2 522
Eden	35 380
Overberg	17 427
Cape Winelands	38 522
City of Cape Town	300 100
TOTAL	**409 827**

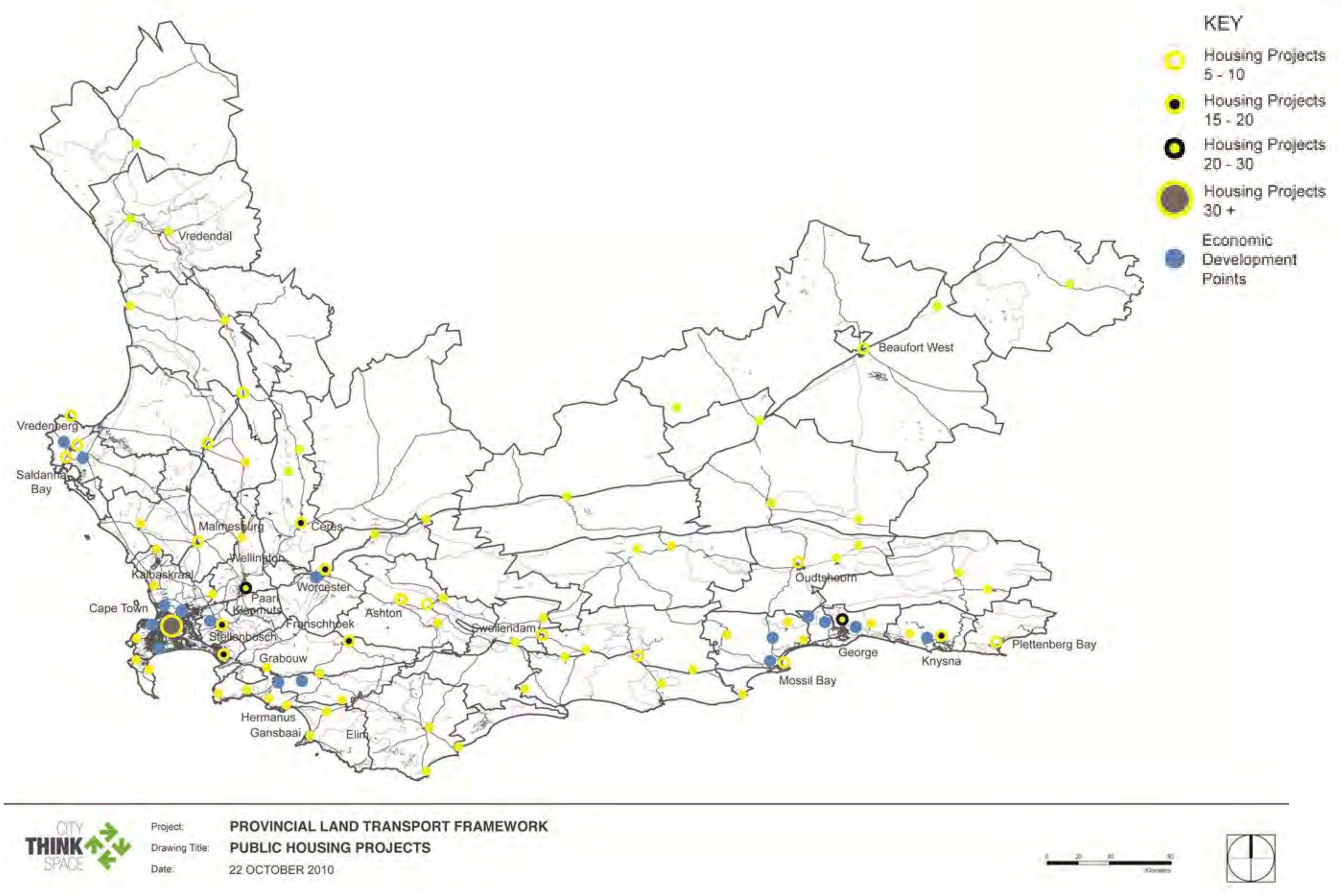


Figure 7: Spatial distribution of public housing projects in the Western Cape (DTPW 2011)

3.1.3 Servicing of sites

The number of sites serviced in the Western Cape varies according to the municipality and financial year (DHS 2010). The CoCT has benefited from a sustained and large proportion (over 11 000) of sites that have been serviced during the financial years from 2004-2008. However, this has declined with the least households serviced in 2011/12 and which has been attributed to limited budget availability, delays in the planning processes, allocation of funds for top structures and infrastructure, etc. (DHS 2010).

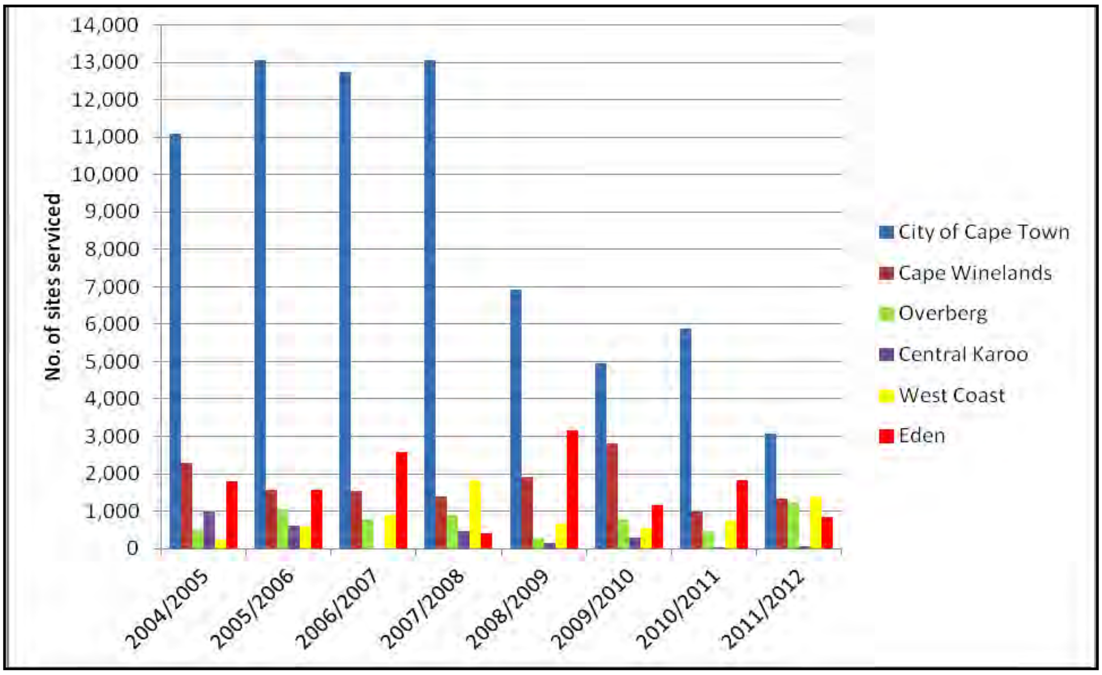


Figure 8: Number of sites serviced in the Western Cape, 2004-2012 (DHS 2012)

Among the various District Municipalities levels of sites serviced have fluctuated from year to year with Eden having experienced the greatest (over 3 000) number of sites serviced in 2008/09. For the financial year 2011/12, all District Municipalities with the exception of Central Karoo and Eden have over 1 000 serviced sites. The CoCT had just over 3 000 serviced sites.

It is worth mentioning that the province has also embarked on a process of providing rental housing options. This is relevant to this report because these are usually blocks of flats in well-located areas and therefore support the provision of sustainable human settlements because of the density i.e. more efficient land use as well as improved access to transport etc.

3.1.4 Private housing market

The private housing market also has an impact on the environment particularly where developers seek landscapes of natural scenic attraction or large tracts of land for their developments. The development of large residential and commercial estates as well as golf estates and lifestyle-estates, have proliferated over the last decade. Natural unspoilt areas and land on the periphery of cities are often targeted resulting in the loss of productive land or intact natural vegetation.

In addition, the private sector is also instrumental in providing subsidised housing and bonded low cost housing. "Vacant" or undeveloped land is often under pressure for development yet these are often fulfilling a role as public open space, or providing ecological goods and services. All these forms of private sector housing developments need to be carefully assessed in terms of their impact on the environment.

On the positive side, private development is responding quicker to the push for green or environmentally efficient buildings and developments. Certified 'Green' buildings are being rolled out at increasing pace, and housing development companies are finding ways of developing inclusionary housing developments as a form of mixed income sustainable urban development.

3.2 Access to basic services

The Western Cape is ahead of all other provinces in providing municipal services of sanitation, electricity and refuse removal. Only in terms of the provision of water to the dwelling or yard is the Western Cape below Gauteng and the Free State (StatsSA 2012).

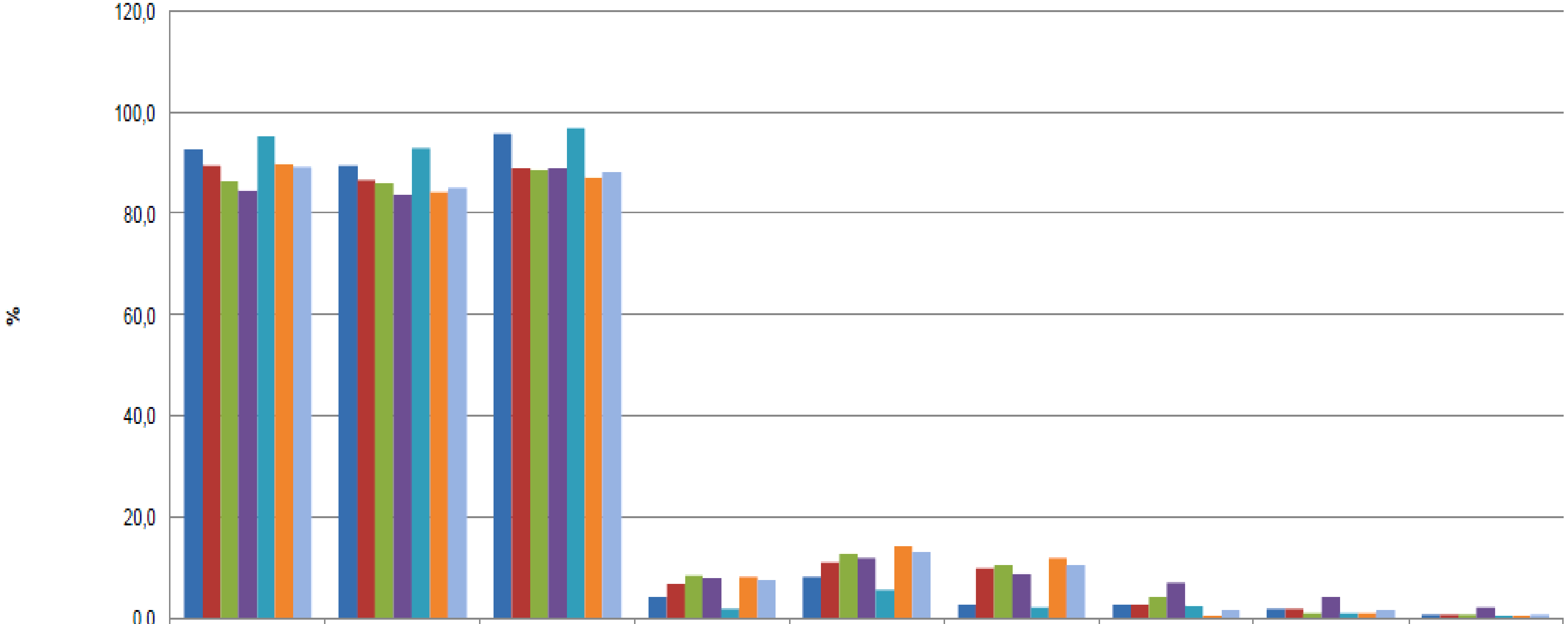
Access to basic services reflects the quality of living conditions and human settlements, but also provides a barometer about the demand for natural resources and the impact on the natural environment. The associated environmental costs of inadequate maintenance and lack of provision of infrastructure can be seen as pollution and contamination of water, soil and air; loss of biodiversity and high potential land; and unsustainable use of resources (water, energy, land etc).

3.2.1 Access to potable water

Section 26 of the Bill of Rights of the Constitution of the Republic of South Africa directs that, every citizen has a right to basic water. In support of this, government has rolled-out the provision of free basic services particularly to the poor and previously disadvantaged communities.

The results of access to piped (tap) water from the 1996, 2001 and 2011 Censuses are shown in Figure 9 and summarized below.

- In the City of Cape Town, the percentage of households with access to piped (tap) water inside a dwelling/ yard has increased by 2.9% from the previous 2001 Census.
- A decrease of 2.3% from the previous Census was recorded in 2011 for households with access to piped (tap) water on a communal stand.
- The percentage of households with no access to piped (tap) water has decreased from 1.2% in the 1996 Census to 0.7% in the 2011 Census.
- It may be deduced that access to piped (tap) water inside a dwelling/ yard for households has increased seeing that access to piped (tap) water on a communal stand and with no access has reduced.
- *(list continues on page 15)*



	Piped (tap) water inside dwelling/yard			Piped (tap) water on a communal stand			No access		
	1996	2001	2011	1996	2001	2011	1996	2001	2011
West Coast	92,6	89,7	96,0	4,2	8,3	3,0	3,0	2,0	1,0
Cape Winelands	89,5	86,6	89,1	6,8	11,3	10,1	2,9	2,0	0,8
Overberg	86,4	86,0	88,7	8,6	12,8	10,5	4,4	1,2	0,8
Eden	84,7	83,7	88,9	7,9	12,0	8,9	7,1	4,3	2,2
Central Karoo	95,4	93,1	97,1	1,9	5,7	2,3	2,5	1,1	0,6
City of Cape Town	89,8	84,4	87,3	8,3	14,3	12,0	0,6	1,2	0,7
Western Cape	89,4	85,2	88,4	7,8	13,1	10,7	1,8	1,7	0,9

Figure 9: Provision of potable water in the Western Cape (StatsSA 2012)

- For the five District Municipalities, over 80% of all the households had access to piped (tap) water inside the dwelling/ yard. From the more recent results of the 2011 Census, Central Karoo had the highest (97.1%) percentage of households, while the Overberg had the least (88.7%).
- All the District Municipalities had less than 20% of households with access to piped (tap) water on a communal stand. The Overberg had the highest (10.5%) percentage of households while the Central Karoo had the least (2.3%).
- According to the 2011 Census results, 1.1% of households (on average) have no access to any form of piped (water) in all the District Municipalities.

3.2.2 Quality of available drinking water (Blue Drop)

In September 2008, the Minister of the erstwhile Department of Water Affairs and Forestry (DWAF) introduced the concept of the Blue Drop Certification Programme for drinking water quality management regulation and the Green Drop Certification Programme for wastewater quality management regulation. Together, these two incentive-based regulation programmes form a holistic and transparent approach to drinking water quality management and wastewater quality management. To promote continual improvement, the standards are increased every year that the Blue and Green Drop Certification process takes place. These standards are published by DWA and are available for scrutiny on the departmental website.

In 2011, the number of systems found to be 'excellent' in South Africa increased to 66, compared to 38 Blue Drop awards in 2010. Despite the national improvement in performance, not all provinces showed a positive trend. This can be attributed to a number of factors including increasingly rigorous requirements for the assessment, a growing demand for water, inadequate maintenance and operational deficiencies. These declines also have implications for maintaining potable water quality.

The Blue and Green Drop Programme has had a remarkable impact on improving the water sector over the past four years due to the information being available in the public domain and government's focused attention on the performance ratings. As it stands in 2012, the Western Cape Province holds a 94.2% score for Blue Drop certification (drinking water), second only to the Gauteng Province (Table 2).

Table 2: Provincial Blue Drop scores from 2010 to 2012 (DWA 2012a)

Province	Blue Drop Score
Gauteng	98.1%
Western Cape	94.2%
KwaZulu-Natal	92.1%
Eastern Cape	82.1%
Limpopo	79.4%
North West	78.7%
Free State	73.6%
Northern Cape	68.2%
Mpumalanga	60.9%

The general trend, however, for the Western Cape shows continually improving water quality from 2010 to 2012. This is the case for the majority of the local municipalities (see Table 3).

Table 3: Municipal Blue Drop scores from 2010 to 2012 (DWA 2012a)

	Water Service Authorities	2010	2011	2012	Performance trend
1	City of Cape Town	98.20	97.61	98.14	→
2	Bitou LM	97.70	96.12	97.74	→
3	Witzenberg LM	93.30	97.56	97.63	↑
4	George LM	96.90	96.26	97.41	↑
5	Overstrand LM	71.60	90.56	96.82	↑
6	Drakenstein LM	91.70	95.72	96.26	↑
7	Mossel Bay LM	84.50	95.27	95.68	↑
8	Stellenbosch LM	94.90	95.74	95.56	↑
9	Saldanha Bay LM	80.80	87.69	95.40	↑
10	Swartland LM	68.60	92.89	95.24	↑
11	Beaufort West LM	83.80	92.01	94.91	↑
12	Bergrivier LM	62.70	85.20	92.15	↑
13	Knysna LM	75.20	89.76	92.00	↑
14	Breede Valley LM	74.00	85.93	89.02	↑
15	Cape Agulhas LM	78.60	73.01	86.64	↑
16	Swellendam LM	67.30	80.50	85.16	↑
17	Cederberg LM	60.00	51.05	80.39	↑
18	Theewaterskloof LM	49.00	75.41	71.50	↓
19	Laingsburg LM	63.90	80.54	71.16	↓
20	Matzikama LM	30.10	32.98	70.29	↑
21	Prins Albert LM	55.00	70.72	70.09	↑
22	Oudtshoorn LM	44.80	36.88	64.58	↑
23	Langeberg LM	0.00	32.39	51.62	↑
24	Hessequa LM	46.20	14.10	35.59	↑
25	Kannaland LM	19.40	22.05	28.47	↑
	Key:	↑ = improved		→ = stable trend	↓ = deteriorating

3.2.3 Quality of treated wastewater (Green Drop)

The National Green Drop Certification Programme for Wastewater Quality Management Regulation aims to ensure effective and efficient delivery of sustainable water services by using both an incentive-based (municipal green drop certification) as well as a risk-based regulatory approach (municipal Critical Risk Rating or CRR profiles). The programme is comprehensive in its outlook and provides a very good indication of the standards of treatment works service by assessing the operational efficiency of works (design capacity throughputs and outputs) and works operations (human capacity) to standards and norms acceptable to human and ecological health.

The results of Western Cape Green Drop Certification display good compliance to the programme, with all treatment works assessed and a continual improvement in terms of its performance trend (Table 4). From a national perspective, the Western Cape has the best Provincial Green Drop Score, at 83.1%, as well as the lowest risk score of 51.5% (Table 6).

Table 4: Western Cape: Green Drop Certification Comparative Analysis for 2009, 2011 and 2012 (DWA 2012b)

Performance Category	2009	2010/11	Performance Trend
Number of Municipalities Assessed	20	27 (100%)	↑
Number of Wastewater Systems Assessed	107	155	↑
Average Green Drop Score	47%	(64.70%)	↑
Number of Green Drops ≥50%	46 (44%)	117 (74.80%)	↑
Number of Green Drops <50%	61 (56%)	38 (25.20%)	↑
Number of Green Drop Awards	10 (6.45%)	19 (12.26%)	↑
Average Site Inspection Score	N/A	65.40%	**N/A**
Provincial Green Drop Score	N/A	83.10%	**N/A**

N/A = Not Applied ↑= improve ↓ = decline → = no change

When comparing 2010/11 Green Drop results with 2009, the following trends are observed (Table 5):

- 48 more systems were assessed in 2010 (155) compared to 2009 (107)
- 19 systems achieved Green Drop Certification for achieving an 'excellence' status (i.e. >90% compliant), marking an increase from 10 excellent systems achieved in 2009
- 2% 'good systems' increased to 17% in 2010/11
- 42% 'average systems' in 2009 improved to 47% in 2010/11
- 45% of systems were in 'very poor and critical state' in 2009, compared to 25% in 2010/11
- 19 systems were in 'critical state' in 2009 compared to only 9 systems in 2010/11.

The Western Cape performance for cumulative risk associated with treatment works improved from 2009, to 2011 and 2012 (Table 5 and Table 6). The local municipalities with the best overall risk positions achieved in the province were Beaufort West, Bitou, Breede Valley and Cape Agulhas; and those with the best progress in risk abatement included Beaufort West, Breede Valley, Cape Agulhas, Langeberg, Oudtshoorn, Saldanha Bay, Stellenbosch, City of Cape Town, Swartland and Theewaterskloof. It should also be noted that the Western Cape has improved its risk position from third lowest in 2011 (61.1%) to the lowest risk province in the country in 2012 (51.5%).

Table 5: Western Cape Green Drop Cumulative Risk Ratio comparative analysis for 2009, 2011 and 2012 (DWA 2012b)

Performance category	2009	2011	2012	*Risk trend (2011-2012)
Highest CRR	27	26	26	→
Average CRR	12.4	11.9	9.6	↓
Lowest CRR	5	4	3	↓
Average Design Rating (A)	1.4	1.3	1.3	→
Average Capacity Exceedance Rating (B)	3.3	3.7	3.3	↓
Average Effluent Failure Rating (C)	6.2	4.7	3.1	↓
Average Technical Skills Rating (D)	1.7	2.5	2.1	↓
Average % deviation from maximum - CRR	62.5	61.1	51.5	↓

Key: ↓ = improve → = no change, ↑= deteriorating

Table 6: South Africa: Comparative Analysis: Green Drop Scores for 2012 (DWA 2012b)

Province	Number of Works	Provincial Green Drop Score	Risk Profile [CRR as % of CRR(Max)]	Average Green Drop Score	Green Drops Awarded	% Systems that achieved >50%	Position on Performance log
WC	155	83.10%	51.5	65.00%	19	75.00%	1
KZ	143	82.00%	57.9	61.00%	11	66.00%	2
GT	56	78.80%	62.8	68.00%	5	68.00%	3
EC	123	67.20%	75.4	33.00%	3	26.00%	4
MP	76	56.00%	68.7	42.00%	1	41.00%	5
NW	35	50.00%	59.8	29.00%	1	17.00%	6
FS	95	31.50%	83.5	24.00%	0	12.00%	7
LP	67	24.00%	77.6	24.00%	0	15.00%	8
NC	71	23.00%	66.1	26.00%	0	13.00%	9
SA Total	**821**				**40**		

*Risk Profile according to the cumulative risk rating is expressed as percentage with <50%=low risk; 50-70%=medium risk; 70-<90%=high risk and 90-100%=critical risk

Implications of Storm Water Ingress on Wastewater Treatment Systems

The City of Cape Town wastewater treatment works (WWTW) and associated infrastructure is under pressure as a result of excessive stormwater being directed into the sewer system. WWTW are designed to handle specific volumes of wastewater. Excessive inflows as a result of stormwater in the sewer system can lead to treatment works being overloaded and effluent being released before it has been treated to the required standard. During heavy rains, overflows are often observed at manholes, outside drains and in severe cases from drainpipes inside properties. Such flooding poses a serious health risk and impacts negatively on the environment, e.g. nutrient loading of riparian zones. This problem is commonly referred to as "stormwater ingress" and the overflow as "sewer surcharge".

Stormwater ingress and the resulting sewer surcharge can result from a number of sources, some of which include:

- Rain showers, particularly when heavy and continuous, result in large volumes of stormwater entering the system through man-holes and defective or damaged sewer pipes,
- Gutters or downpipes erroneously connected to the wrong outside drains thus directing rain water/ stormwater into the sewer system, and
- Paving sloped towards sewer system drains.

The CoCT has embarked on a 3 year project to address the problem of stormwater ingress into the sewer system. In particular it aims to:

- Reduce inflow into municipal sewer systems, by:
    - o Removing illegal/ erroneous connections
    - o Redressing historical infrastructural connections which allow stormwater to be directed into the sewer system
    - o Identifying infrastructure that requires maintenance
- Raise awareness amongst the various sectors of the public to avoid illegal / erroneous connections in the future.

Source: City of Cape Town, Eradication of Stormwater Ingress into the Sewer System project, 2012.

3.2.4 Access to sanitation

Provision of sanitation services by local municipalities is fundamental in the preservation of human dignity and prevention of disease outbreaks, as well as reducing the impact on natural resources though pollution in non-serviced areas.

Figure 10 indicates that in the City of Cape Town and across all District Municipalities, the most common form of sanitation among households are flush toilets while the number of households with no form of sanitation services occurs across the board notably at less than 5%. In the CoCT, as expected the predominant service is flush toilets. Of concern though is the relatively high use of bucket toilets which is problematic in terms of potential environmental pollution and health risks. The need to radically rethink sanitation provision is further prompted by our high water use and reticulation losses. Large scale waterless sanitation technology will need to be investigated in the future.

Further analysis is presented in the table below:

Table 7: Analysis of sanitation forms across the District Municipalities (StatsSA 2012)

District Municipality	Most common form of sanitation	Second most common form of sanitation	Least common form of sanitation
Overberg	Flush toilet	Other	Chemical toilet
Cape Winelands		Bucket toilet & other	
Eden		Pit toilet	
West Coast		Other	
Central Karoo		Pit toilet	

While access to sanitation services has increased over the past 14 years, there is still a noteworthy percentage of the population that does not have access to flush or chemical toilets. These communities usually make use of facilities such as pits, latrines and bucket systems. The environmental consequences of this include potential contamination and pollution of ground and surface water resources, and the associated social problems of declining human health and well-being.

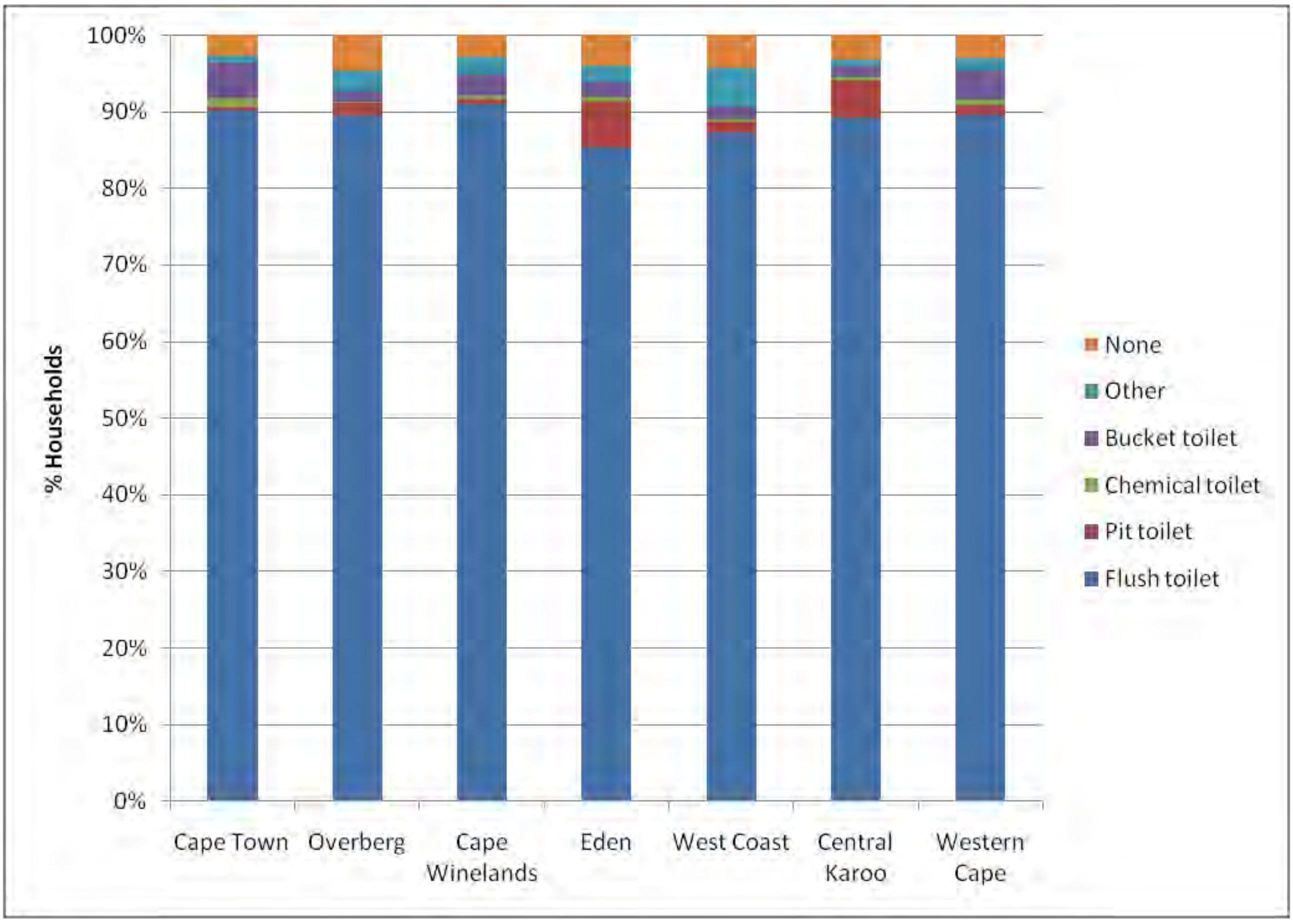
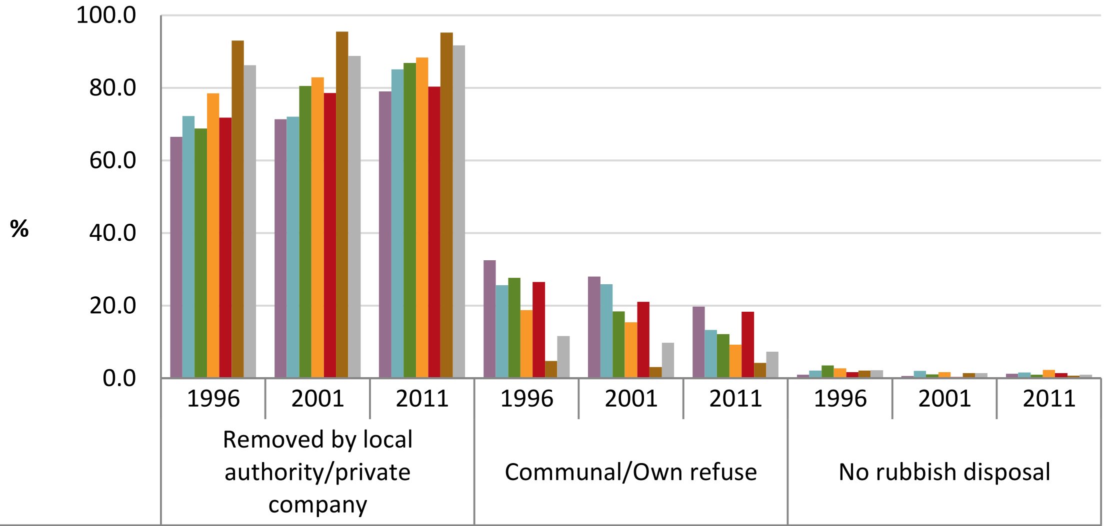


Figure 10: Provision of sanitation services in the Western Cape (StatsSA 2012)

3.2.5 Refuse removal

Refuse removal services by local municipalities and private companies have consistently increased across the Western Cape, from 86.2% in 1996 to 91.7% in 2011. This trend is substantiated across all District Municipalities and the CoCT by the 2011 Census. It is worth noting that this has had an expected effect in terms of reducing reliance on the use of communal or personal refuse dumps. However, it still remains a concern with many areas not receiving adequate removal services which results in illegal dumping of waste, unlicensed waste disposal sites and burning of waste as disposal methods. All of these activities result in negative impacts for the environment and human health and wellbeing.

Figure 11 compares the refuse removal services and the progress that has been made from 1996 to 2011.



	Removed by local authority/private company			Communal/Own refuse			No rubbish disposal		
	1996	2001	2011	1996	2001	2011	1996	2001	2011
West Coast	66.5	71.3	79.0	32.5	28.0	19.7	1.0	0.6	1.2
Cape Winelands	72.2	72.0	85.1	25.6	25.9	13.3	2.1	2.0	1.6
Overberg	68.8	80.5	86.8	27.7	18.4	12.2	3.5	1.1	1.0
Eden	78.5	82.9	88.3	18.8	15.4	9.3	2.7	1.7	2.3
Central Karoo	71.8	78.6	80.3	26.5	21.1	18.3	1.7	0.4	1.4
City of Cape Town	93.0	95.5	95.2	4.8	3.1	4.2	2.1	1.4	0.7
Western Cape	86.2	88.8	91.7	11.6	9.8	7.3	2.2	1.4	1.0

Figure 11: Provision of refuse removal services in the Western Cape (StatsSA 2012)

3.2.6 Access to electricity

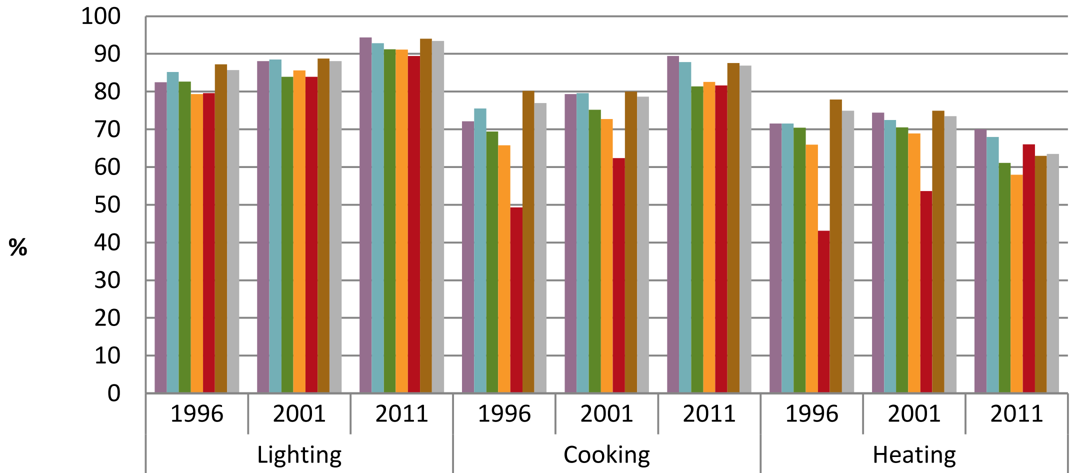
The availability of electricity is important precondition in the growth of the Western Cape economy, particularly as a driver in encouraging investment. Electricity provision also has social consequences through ensuring the upliftment of communities by providing safe and healthy living conditions.

Records from the National Electricity Regulator reveal that in 2002, approximately 84% of households in the Province were provided with electricity, while 31% of rural and 16% of urban homes respectively had none (DEADP 2005). From 2005 to 2007, an additional 21 688 households were electrified in the Western Cape mostly in urban areas (NERSA 2006). From the results illustrated in Figure 12, it can be deduced that the number of households using electricity for lighting means that they evidently have access to electricity. Therefore, access to electricity in the Province has shown steady increase during the various Censuses from 85.7% in 1996 to 88.1% in 2001 and finally to 93.4% in 2011.

The slower pace of providing access to electricity for households in rural or unelectrified areas of the Province can be attributed to the higher costs of connecting houses to the grid compared to urban areas where homes are closer or infrastructure (DEADP 2005). It is critical to consider the transition to non-traditional forms of electricity from renewable sources for future electrification.

3.2.7 Electricity uses

Electricity in the Western Cape is used for a variety of functions in the home including lighting, heating and cooking. In all the District Municipalities and CoCT, use of electricity for lighting is the highest while access to electricity for heating is the lowest.



	Lighting 1996	Lighting 2001	Lighting 2011	Cooking 1996	Cooking 2001	Cooking 2011	Heating 1996	Heating 2001	Heating 2011
West Coast	82.5	88.1	94.4	72.1	79.3	89.4	71.5	74.4	70.0
Cape Winelands	85.2	88.5	92.8	75.5	79.6	87.8	71.5	72.5	68.0
Overberg	82.6	83.9	91.2	69.4	75.2	81.4	70.4	70.5	61.1
Eden	79.3	85.6	91.1	65.8	72.7	82.6	65.9	68.9	58.0
Central Karoo	79.6	83.9	89.4	49.3	62.4	81.6	43.1	53.6	66.0
City of Cape Town	87.2	88.8	94.0	80.2	80.0	87.6	77.9	74.9	63.0
Western Cape	85.7	88.1	93.4	77.0	78.7	86.9	74.9	73.5	63.5

Figure 12: Uses of electricity in the Western Cape (StatsSA 2012)

3.3 Access to transportation and transport networks

Generally the Western Cape has well-developed transport infrastructure compared to other South African provinces, and a network of transport routes linking it to the rest of South Africa and the African continent by road, rail and sea. The Provincial Spatial Development Framework (PSDF) emphasises that transport is seen as a basic need for the inhabitants of the Western Cape and is an important driver in social growth by enabling the movement of people and fostering economic growth by accessing and creating opportunities (DEADP 2009b).

The PSDF outlines the diverse modes of public transport found in the province, namely metered taxis, buses, minibus taxis and commuter trains. Despite this diversity, it is reported that most inhabitants of the Districts except for Eden (up to 77% in the Central Karoo) still walk, cycle, hitchhike or use donkey-carts to get to their destinations, which is partly due to high transportation costs (up to 30% of income, especially in low-income households), non-availability of public transport and low population densities. This is not sustainable especially if large distances need to be covered while moving from town to town (DTPW 2011). In the urban areas it is reported that private transport constitutes 44% of passenger transport in the City of Cape Town, whereas public transport is used for 48% of trips. Private transport dominates in Eden at 46% of trips, with 34% of the people still walking or hitch-hiking to their destinations (DTPW 2011).

The most utilised and least utilised transport modes in the Western Cape are summarised in Table 8 below.

Table 8: Transport modes across the District Municipalities (DTPW 2011)

District Municipality	Most Utilised Transport Mode	Least Utilised Transport Mode
West Coast	Walking, cycling, and other Non-motorised transport (NMT)	Bus and train services
Central Karoo	Walking and other NMT	Bus service
Eden	Private motor transport	Bus service
Overberg	Walking and other NMT	Bus service and minibus taxi
Cape Winelands	Walking and other NMT	Minibus taxi and train service
City of Cape Town	Private motor transport	NMT

A public transport system which could be an ideal solution hasn't been able to ease the situation as it is burdened with challenges such as:

- A high reliance on poorly maintained or unsafe public transport systems, brought on by necessity rather than choice;
- Poor coverage especially in rural areas due to low demand;
- Unsustainable over-reliance on government subsidies;
- Long lead times for service roll-out; and
- Poorly maintained infrastructure.

All District Municipalities, City of Cape Town and Western Cape Government have Integrated Transport Plans which aim to chart the provision of transport services. The modal shift to public transport will result in decreased reliance on fossil fuels for energy and reduced emissions.

There are three main axes in the Western Cape on which road and rail links are located namely, "*to the north through Beaufort West, to the northwest through the West Coast, and to the east through the Southern Cape and the Garden Route*" (DEADP 2003). The road network of the Western Cape is composed of three National roads which converge in Cape Town namely:

- N1 which runs to the North East traversing the Cape Winelands and Central Karoo District Municipalities;
- N2 runs to the East traversing the Overberg and Eden District Municipalities; and
- N7 which runs to the North traversing the West Coast District Municipality into the Northern Cape up to Namibia.

In addition to the National roads, there are numerous other trunk, main, divisional, and minor roads of various lengths. Besides the roads and rail transport network, the Western Cape is also served by numerous small civil airports and airstrips, as well as Cape Town and George airports. There are also numerous small vessel harbours along the coast and two deep water harbours (Cape Town and Saldanha). The coverage of the main roads, airports and ports is illustrated in Figure 13.

The Provincial Land Transport Framework (DTPW 2011) states that the original purpose of the establishment of the rail network in the Western Cape was to ferry materials such as timber and cement for industries and provide a means of transport to the farming community. This rail network infiltrated the interior of the province and also reached the neighbouring provinces. The framework further reveals that the last rail line laid down (around 1976) is the one that is used to ferry iron ore from Sishen (Northern Cape) to the Port of Saldanha from where the ore is exported to foreign countries. The rail network spans a length of 4 944 km within the province consisting of main and branch lines. Out of this total length, 610 km owned by the Passenger Rail Association of South Africa (PRASA) is found servicing the suburbs of the CoCT and in particular, marginalized communities (DTPW 2011). It is noted that a shortage of rolling stock which has been widely reported often causes service delivery concerns.

According to the Provincial Land Transport Framework (DTPW 2011), results of rail censuses conducted in 2007 and 2008 indicate that about 632 000 and 760 000 passengers respectively were transported by commuter trains in the Province. This represents an increase of approximately 20% annually. The result is over-crowding in the commuter trains as people utilize buses and minibus taxis less and less. Although the use of commuter trains

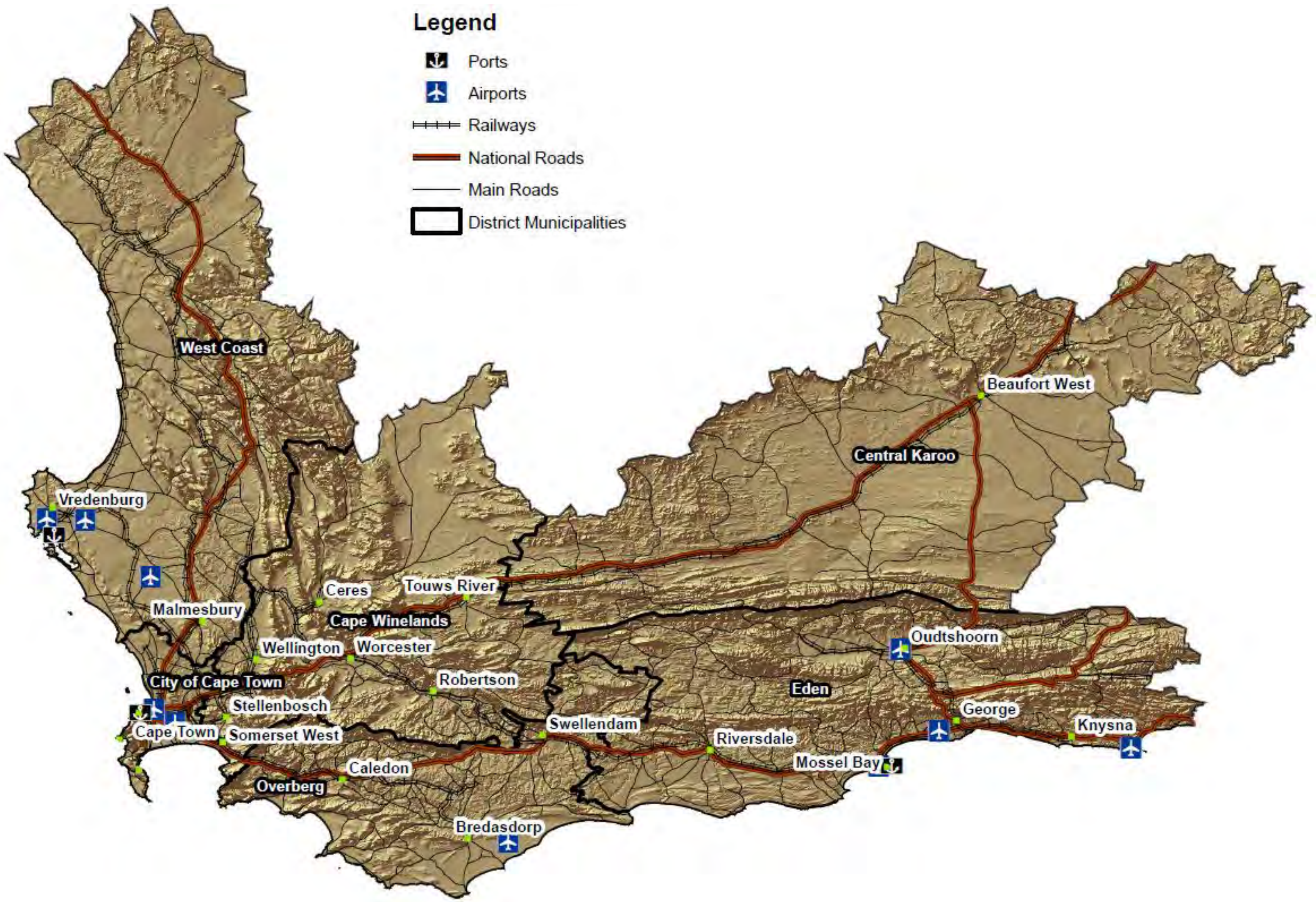


Figure 13: Transportation network in the Western Cape (DTPW 2011)

in the Western Cape is popular, a number of issues still need to be resolved and these include:

- Poor quality of service offered to the majority low income passengers;
- Inadequately maintained long distance stations;
- Lack of integration with facilities such as trading centres resulting in transport inefficiencies; and
- Weak security provision leading to incidents of crime.

3.4 Open space provision

Open space contributes significantly in the quality of the living environment. It is important for social, cultural, economic and ecological functioning. This is particularly important in dense urban areas. Open Space can be defined as areas that are predominantly undeveloped and free from buildings and infrastructure, and that provide ecological, social, economic, recreational functions across all scales from metropolitan to local, and contribute to the sense of place.

The Western Cape Spatial Development Framework (SDF) (DEADP 2009b) indicates that the open space in Western Cape settlements is insufficient. Where there is provision of open space, often the design does not facilitate its original intended use or is disused because of a lack of maintenance and safety concerns (DEADP 2009c). Open spaces are used for diverse functions both for the environment and community and are therefore important features of sustainable human settlements. These functions include:

- Recreational parks;
- Hosting of music and art festivals, civic and state events;
- Reduction of visual impact in urban areas;
- Provision of buffers along roads;
- Acting as ecological corridors; and
- Acting as sites for agriculture and conservation of fauna and flora.

The City of Cape Town City Parks recognises the vital role that open space plays in an urban environment and provides an integrated service which ensures that Public Open Space and other 'green' areas of City land are conserved and developed in a sustainable way, for present and future generations (CoCT 2004). City Parks manages open spaces allocated for various kinds of Public Open Space (POS) namely district / regional and community parks, greenbelts, sports facilities, cemeteries, coastal amenities, road verges and amenities, community gardens, servitudes, and undeveloped public open space, and areas that are important for biodiversity value (CoCT 2011).

Public Open Space can be used creatively to generate income for the local municipalities that manage them by means of hiring fees. In addition, they can be used for local community upliftment by means of providing space for small businesses and providing room for relaxation. However, a number of challenges have been encountered in the past in availing these spaces to the public (CoCT 2004).

The City of Cape Town developed a Biodiversity Network (CoCT 2012) as part of the implementation of the Biodiversity Strategy and specifically aimed at the conservation of

Critical Biodiversity Areas. This network forms the backbone of the City's open space system and is based on a prioritisation of remnant indigenous vegetation units based on factors such as connectivity between units, habitat condition and the location of threatened flora. The most important ecological sites identified for the Biodiversity Network in this way are indicated in Figure 14.

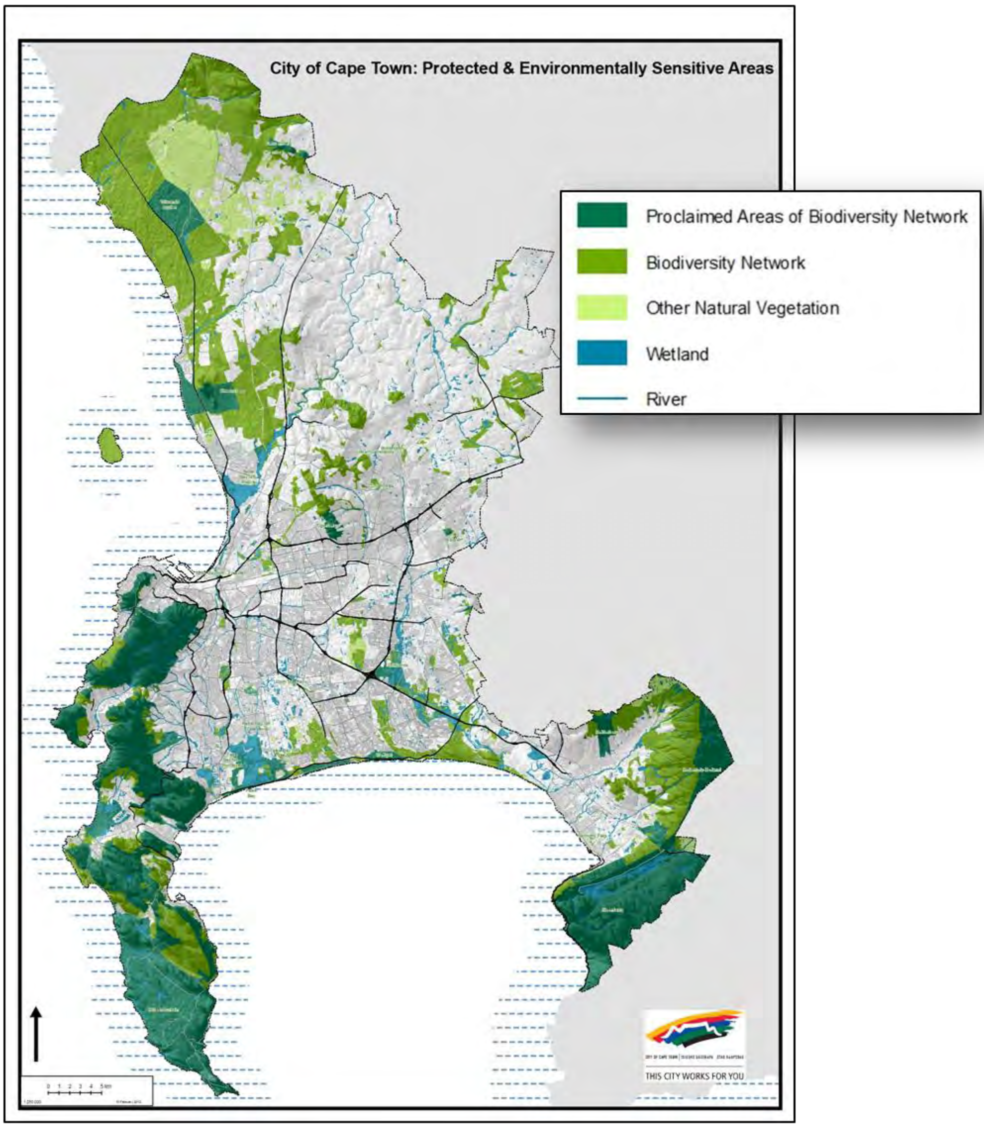


Figure 14: City of Cape Town Protected & Environmentally Sensitive Areas (CoCT 2013)

4 IMPACTS

As a result of the pressures outlined above as well as the state of human settlements, the impacts on the environmental state are as follows.

4.1 Habitat fragmentation

Ever expanding cities and towns have a major impact on habitat fragmentation. This is particularly apparent in the dissection of continuous areas of natural vegetation, ridges, water courses and wetlands, into smaller pieces that are partially or totally isolated and disconnected. The loss of habitat has the resultant negative impact on biodiversity loss as species rely on suitable habitat size and connectivity.

Urban sprawl on the periphery can result in degradation of land and environmental resources and places pressure on the availability of resources due to encroachment on sensitive natural systems and productive agricultural areas, and transformation of land for infrastructure and services.

Urban sprawl has a disproportionate impact on the natural environment and degradation of sensitive environmental features, demonstrated by the loss of habitat and biodiversity, and an increased reliance on transportation due to greater distances from home to work resulting in exhaust emissions and deteriorating air quality. In addition, the use of fossil fuels for household energy use and industrial processes causes increased concentrations of air pollutants.

The private housing market also contributes to urban sprawl in the province as a result of increasing middle and high income low density residential retirement and holiday developments. The loss of agricultural land as well as sensitive natural areas is of concern, particularly in the northern suburbs of Cape Town and along the Garden Route. These areas are prime tourism attractions and rely on natural scenic beauty and unspoilt landscapes.

4.2 Biodiversity loss

Biodiversity loss often results from changes in the use of land through human intervention such as the conversion of near-natural land for agricultural production; forest plantations; provision of infrastructure and services; and the development of human settlements. Biodiversity loss in the Western Cape is also linked to the development of tourism facilities that rely on areas of natural beauty and biodiversity (ecologically sensitive habitats) and rapid coastal development.

Biodiversity is a critical resource for many communities in the Western Cape and sustains local economies and livelihoods. Demands on natural resources to meet basic needs and provide ecosystem goods and services will increase as populations grow and cities expand. Despite being fundamental to the provision of goods and services such as the prevention of erosion, provision of clean air and water, flood attenuation, and the storage of carbon to counteract global warming, the role of ecosystem is often misunderstood or disregarded. The survival of species may be threatened as habitats are reduced and transformed, and there may be limited ecological goods and services such as the provision of food, fuel and medicine. The loss of these services tends to harm the poor more directly due to higher levels of dependence and vulnerability to change. The National Spatial Biodiversity Assessment sums this up by stating that "our path towards poverty reduction and enhancement of human well-being is dependent of how effectively we conserve biodiversity" (Driver *et al*. 2005).

4.3 Pollution and waste

Pollution is a typical consequence of the concentration of humans. Human activities generate waste as by-products of resource extraction, materials processing, goods transportation and consumables use, and ultimately through the disposal of waste products. These manifest in the pollution of natural resources, such as water courses and wetlands, coasts and estuaries, and areas of natural vegetation.

A reduction of water and air quality impacts on particularly vulnerable communities. This manifests in increased disease and diminished health and productivity, with resultant negative impacts on economic growth and social well-being.

The persistence of informal settlements with poor living conditions has a significant impact on the environment. These impacts arise primarily as a result of the lack of access to basic services, e.g. electricity, water, sanitation and refuse removal. The situation is often exacerbated due to the unsuitable location of these settlements in close proximity to natural features such as rivers, wetlands and natural open spaces. Degradation of environmental resources occurs due to overcrowding and reliance on natural resources for the provision of water, fuel and food. Lack of or unreliable refuse removal services force people to look for alternatives which then results in the proliferation of illegal dumping sites or indiscriminate burning of waste causing further land and air pollution.

Investment in maintenance programmes is critical to ensure that infrastructure does not negatively impact on the environment through effluent spillages and leakages, air pollution, etc. Polluted environments have lower or even no naturally functional ecosystems present, and therefore lose productivity and ability to provide ecosystem services on which humans rely even if it is simply the ability of the ecosystem to dilute the pollutants to non-toxic levels.

4.4 Increased resource use and consumption

Human settlements place increasing pressure on the availability of natural resources (land, water, air and energy) as well as the ability of these systems to function optimally. The increased demand for resources is further dealt with in other Chapters, notably land, biodiversity, air and atmosphere and energy.

Increased demand for human and commercial water consumption adds stress to water resources, which is compounded by poor water management, limitations to the use and access of water resources, and poor water quality.

The use of natural resources to support human settlements is drawn from a larger area than the actual settlement and has a much wider impact. This is referred to as the ecological footprint of the settlement. Natural resource use includes the "abstraction of fresh water for domestic and agricultural purposes, generation of electricity, deforestation for timber products, and agricultural over-use of soils. These kinds of over-exploitation take place at regional and sometimes global scales, as these resources are often supplied from places that are geographically remote from the area where the demand exists" (DEAT 2007).

As indicated in the PSDF, agriculture forms a significant part of the provincial economy, generates exports, and shows potential for increased job creation in certain sub-sectors. The expansion of agriculture however is a major pressure on the natural environment, particularly in terms of water use and loss of natural habitat. This is most pressing on the West Coast. Intensive agriculture is concentrated on the productive lowland coastal plains, while extensive agriculture is the dominant land use in the interior of the Province. These factors need to be carefully balanced in decisions about how and where to grow the provincial agricultural economy (DEADP 2009a). The approach to farming and irrigation is important in lowering the environmental impact and approaches such as "conservation agriculture" and organic farming must be embraced.

5 RESPONSES

A number of responses have been developed relating to the spatial efficiency, environmental management and sustainability of human settlements. These range from policy and legislative frameworks that give effect to overall legislative requirements and provide policy direction; to actual implementation where the state has invested heavily in the provision of housing as well as infrastructure and transport services to create more sustainable human settlements.

5.1 Sustainable human settlements

"Vulnerable populations have limited capacity to protect themselves from current and future environmental hazards, such as polluted air and water, natural disasters, and the adverse consequences of large-scale environmental change, such as land degradation, biodiversity loss, and climate change. In a developing country, such as South Africa, people living in poverty tend to be the most vulnerable to environmental disturbance, because they have fewer resources to help them cope with disaster" (DEAT 2007).

It is evident that human settlements in South Africa are faced with the spatial distortions and inefficiencies which are a result of the racially segregated spatial structure of the past. This has generally resulted in the poor being located on the periphery of cities and towns far away from essential services and employment opportunities. Human settlements therefore need to be restructured and re-organised spatially to be more efficient and to promote better social integration.

Human settlements reflect the inter-relationship between vulnerability and environmental change. In order to limit the degradation and effects of environmental change as well as improve socio-economic conditions, a great deal of effort and resources needs to be directed to the eradication of poverty and inequality thereby reducing the vulnerability of communities. Environmental sustainability incorporates the programmes and strategies that are being implemented to target poverty, unemployment and social inequalities.

Strategies to reduce environmental degradation and indiscriminate use of resources need attention in addition to the focus on developing and empowering people. Human settlements are in many instances characterised by unsustainable practices such as the depletion of water resources, poor air and water quality, increasing volumes of waste, pollution of air and soil, and the reliance of fossil fuels for energy. The Western Cape Government is responding to these challenges within its mandate; primarily through policy formulation, regulatory controls and programmes for the development and maintenance of infrastructure and services. Society at large is responding becoming more aware of sustainability issues and options for action. Increasingly communities are adopting green practices; such as recycling and upcycling of materials, reduced reliance on private vehicles, and use of environmentally friendlier products; and more efficient use of energy and water. Some of these behaviour changes are due to broadened awareness and some due to necessity as resource costs increase relative to income.

The Western Cape has responded to the planning challenges through the PSDF which contains the policies and action plans divided into three main areas of intervention: socio-economic development, urban restructuring, and environmental sustainability (DEADP 2009b). The policies contained in the report are concerned with the "what", i.e. what is it that must be done to put the Western Cape on an ecologically sustainable, socially just, and economically efficient path. Each section includes an action plan which outlines "how" this should be done. The following PSDF objectives, principles, strategies and actions are critical to the creation of sustainable human settlements and improvements in the environmental outlook of the Western Cape (Table 9). It should be noted that a review and update of the PSDF has recently been initiated.

The private sector is similarly responding, specifically in terms of driving investment and uptake of 'green' developments that incorporate resource efficiency into buildings, spatial planning and user behaviour. The private sector is also a critical partner in the roll-out of inclusionary housing as part of Government's objective of redressing our restrictive spatial development legacy.

Table 9: Summary of PSDF objectives

Main area of intervention	Objectives
Socio-Economic Development	Objective 1: Align the future settlement pattern of the Province with areas of economic potential and the location of environmental resources. Objective 2: Deliver human development programs and basic needs programs wherever they are required. Objective 3: Strategically invest scarce public resources where they will generate the highest socio-economic returns. Objective 4: Support Land Reform. Objective 5: Conserve and strengthen the sense of place of important natural, cultural and productive landscapes, artefacts and buildings.
Urban Restructuring	Objective 6: End the apartheid structure of urban settlements. Objective 7: Conveniently locate urban activities and promote public and non-motorised transport
Environmental Sustainability	Objective 8: Protect biodiversity and agricultural resources. Objective 9: Minimise the consumption of scarce environmental resources, particularly water, fuel, building materials, mineral resources, electricity and land – in the latter case especially pristine and other rural land, which is the Province's 'goldmine-above-the-ground'.

5.1.1 Green Buildings

Increasingly, new and innovative ideas are emerging around the more sustainable use of resources especially through green buildings and technology. Awareness and knowledge of green design and technological solutions has increased significantly over the last decade. The establishment of the Green Building Council of South Africa in 2007 is testimony to the importance placed on reducing our impact on the environment and utilising resources more wisely. The City of Cape Town has seen the development of numerous 5-star green buildings most of which are corporate offices.

5.1.2 Energy

To improve access to basic energy for poor households, the Free Basic Alternative Energy Policy was launched by the erstwhile Department of Minerals and Energy in 2003 to provide poor households with an alternative for electricity. According to this policy, free basic energy in the form of paraffin, liquefied petroleum gas (LPG), coal and bio-ethanol are proposed as energy sources. Local authorities are tasked with the implementation of this.

5.1.3 Waste

Waste management provides the opportunity for many other beneficial opportunities if it is seen as resource. This includes waste-to-energy generation, which in turn could be used to power households and industrial activities. Other initiatives focus on the use of waste or other by-products to generate products and forms of art, e.g. up-cycling and recycling are often used in local upliftment projects. An exciting initiative is to align industries who can use by-products or waste energy from other production processes in a form of industrial symbiosis. Most importantly, industry that is focused on a cradle-to-cradle approach to production and waste management will eliminate many of the negative impacts associated with waste to landfill.

5.1.4 Open space

Currently, the growth of settlements is indirectly proportional to the allocation of open spaces (DEADP 2009c). Therefore, to reduce this trend, consideration should be given to the provision of adequate, practical and good quality open spaces / green infrastructure during the establishment of urban settlements. These areas not only provide an ecological function but also provide space for socialisation and recreation as important indicators linked to quality of life.

Open space resources, including natural areas or developed parks and recreation areas, can also be used to mitigate against development impacts and to limit negative environmental impacts.

The increased requirement for provision of housing also has an impact on the environment and presents a challenge in balancing the social need for housing with the increased demand on natural resources as cities grow and develop. Sprawling settlements and low population densities have been identified as key areas that need to be addressed. The PSDF (DEADP 2009b) proposed an increase of the average density of approximately 12 dwelling units (du) per hectare (ha) to 25du/ha, with 3-6 du/ha on the urban periphery and 40-60 du/ha in the urban core.

The Sustainable Human Settlement Strategy (2007) advises that elimination of the housing backlog by 2030 would require funding of approximately R2 billion annually and infrastructure provision for wastewater and solid waste management services and the provision of water. For housing delivery to work optimally particularly in urban areas, integrated settlement between middle, high and poor income areas should be encouraged (DEADP 2009c). This type of inclusionary housing ensures limited but affordable housing supply and concurrently, helps to eliminate historically segregated communities (DEADP 2009c).

The Western Cape has embarked on a focused delivery programme to improve "Access to Basic Services". This programme is in direct response to the basic service needs identified in this chapter, specifically in terms of water and sanitation provision in informal settlements. The "Affordable Housing Programme" which aims to provide better social and economic conditions. In this instance, rental housing options typically entail the building of apartment complexes on well-located land and this densification promotes more efficient land use as well as improved access to transport services.

In support of sustainability considerations in the provision of housing opportunities, the Western Cape has introduced "sustainability criteria" into the Project Approval Process thereby supporting more resilient and sustainable housing development. There are on-going investigations relating to the impact of compliance to the South African National Standard (SANS) 10400 XA Requirements for Energy Efficiency in Buildings on the housing delivery process and particularly the housing subsidy. These initiatives will have a significant impact in years to come.

With the assistance of government departments, research organisations, and international funding organisations, the Department of Human Settlements is also introducing more sustainable technologies and designs into the housing delivery programme. These include the installation of solar water geysers and solar panels, energy efficient design, appropriate orientation of structures, and water harvesting.

5.1.5 Transport

The PSDF states that transport as a basic need for the inhabitants of the Western Cape is an important driver in social growth by enabling the movement of people and fostering economic growth by accessing and creating growth opportunities (DEADP 2009). Consequently, the Western Cape planning for the transport system for the future 20 to 30 years is documented in the Provincial Land Transport Framework (DTPW 2011) as the key policy. In this framework, the state of the transport system by 2050 and beyond is expected to be founded on the principles of safety, sustainability, equity, accessibility and economic efficiency. Sustainability aspects include the provision of non-motorised transport services and infrastructure; efficient and reliable public transport; providing transport services for people with special needs; public transport provision in rural areas; and ongoing maintenance of infrastructure.

The PSDF (DEADP 2009b) proposes an integrated public transport service which will include non-motorised transport modes and a Bus Rapid Transport (BRT) system. The BRT is proposed for towns that are defined in the SDF as "functionally linked" such as Saldanha-Vredenburg, Oudtshoorn-Dysselsdorp, and City of Cape Town-Paarl-Wellington.

Future development of the transport system will require land use and transport planning integration in order to function efficiently and serve the people that it is intended for well (DTPW 2011). For instance, road interchanges should be well designed to include facilities such as shops at stations so as to take advantage of the high pedestrian traffic while at the same time creating employment opportunities (DEADP 2009b). Furthermore, the challenge for planning of a future transport system will be to supply a system that is all inclusive by (DTPW 2011):

- Fostering economic development
- Accessible and affordable to all income groups
- Alleviating poverty

At present, the implementation of the Integrated Rapid Transport (IRT) system in the City of Cape Town is underway and it will consist of numerous modes of transport, including conventional and feeder bus services, minibus taxis, metered taxis, road based services as well as transport facilities and infrastructure such as pedestrian walkways, bicycle access, Metrorail park and ride services (DTPW 2011). All these initiatives to promote non-motorised transport and public transport present an important opportunity to reduce reliance on consumption of fossil fuels, as well as air pollution resulting from vehicular emissions.

Kleinmond: Green Interventions in Housing Provision

Four hundred and ten specially designed housing units have been allocated to the Kleinmond community. The houses - built on a new model with durable materials and efficient energy usage - were part of the Kleinmond Housing Project and one of the first projects to reintroduce modular masonry to South African low-cost housing. The Kleinmond low-cost housing project was conceptualised in 2007 as a collaborative initiative between the Department of Science and Technology, the Council for Scientific and Industrial Research (CSIR), the Western Cape Provincial Department of Human Settlements, and the Overstrand Local Municipality.

The new technologies developed by the CSIR include a modular and expandable design of the house itself, reinforced ring beams, prefabricated plumbing, zero-waste construction methods and insulated ceiling boards.

The houses also have alternative water and energy saving options such as rainwater harvesting, solar water heating and photovoltaic panels which were all carefully considered to assist the municipality in achieving its goal to conserve scarce resources.

Internal and external painting and tiling in showers were specifically managed to enhance hygiene awareness and improve cleanliness while maintaining the aesthetic appeal of the houses and the settlement in its entirety.

The municipality has used various sources of funding for the Kleinmond project, ranging from housing-subsidy funding, a municipal infrastructure grant, funding from the then Department of Minerals and Energy and the Department of Science and Technology's funding amounted to R18.5 million, which translates to about R35 800 extra (above standard subsidy) for each unit house.

Source: South African Government News Agency, compiled by the Government Communication and Information System, 13 December 2011

5.2 Policy, tools and legislation

Responses to the challenges surrounding human settlements tend to be multi-sectoral due to the integrated nature of the built environment. Environmental governance and the development of human settlements are embedded in a plethora of policies, strategies and legislative tools. At a national level most responses are linked to legislative requirements and provide the policy and strategic direction for the development and management of sustainable human settlements. At a provincial level, more specific and targeted programmes are developed to address specific provincial needs and circumstances.

Responses in the form of policies, tools and legislation across all scales applicable to human settlements are listed in the following summary table:

Table 10: Summary of policy, tools and legislation for this theme

International Responses	2000	Millennium Development Goals
		Multi-national Conventions, Treaties and Agreements
National Responses	1966	National Housing Act
	1985	Land Use Planning Ordinance
	1996	The Constitution of South Africa
	1998	National Environmental Management Act
	1999	National Heritage Resources Act
	2000	Municipal Systems Act
	2005	Breaking New Ground - A comprehensive plan for the development of sustainable human settlements (National Department of Housing
	2007	National Rural Transport strategy
	2008	National Framework for Sustainable Development
	2008	South African Inclusionary Housing Policy
	2009	National Land Transport Act
	2010	New Growth Path
	2011	National Outcome 8 for Human Settlements
	2011	National Strategy for Sustainable Development
	2012	National Development Plan – Vision for 2030
		Arrive Alive campaign
Provincial Responses	1999	Western Cape Planning and Development Act
	2005, 2009	Western Cape Spatial Development Framework (SDF)
	2007	Western Cape Provincial Growth and Development Strategy
	2007	Western Cape Sustainable Human Settlement Strategy - The Road Map to Dignified Communities
	2009	Western Cape Spatial Development Framework - Inclusionary Housing Discussion Document
	2010	Western Cape Growth Potential Study
	2012	Access to Basic Services Programme Western Cape Housing Demand database
		Affordable Housing Programme
		Rural mobility projects
		Bus Rapid Transport system
		Strategic Objective 3: Increasing access to safe and efficient transport Strategic Objective 4: Increasing wellness Strategic Objective 5: Increasing safety Strategic Objective 6: Developing Integrated and Sustainable Human Settlements Strategic Objective 8: Increasing social cohesion Strategic Objective 10: Integrating service delivery for maximum impact Strategic Objective 11: Creating opportunities for growth and development in rural areas.
Local Authority Responses		Integrated Development Plans
		Municipal sectoral plans, strategies and policies
		Municipal by-laws

6 CONCLUSION

OUTLOOK: IMPROVING

Human settlements are a key driver of environmental change and therefore need to be developed and managed in a sustainable manner. Increased population, consumption patterns and growth of human settlements have an impact on the natural resource base through an increased demand for resources leading to their depletion and scarcity. Furthermore, human settlements can result in the destruction of ecologically sensitive habitats, the loss of productive land, and the pollution of natural systems through the unsustainable use of natural resources or resultant waste products. This in turn results in the loss of biodiversity, decrease in ecosystem health, and changes to the provision of ecological goods and services which are fundamental for our quality of life and survival.

The challenge is to reduce and mitigate negative environmental resource use and unsustainable consumption patterns associated with growing human settlements, while at the same time addressing the social and economic imperatives for housing, infrastructure and services. In response, a number of national and provincial policies, plans and strategies have been developed to address the housing demand, provide quality places and promote well-functioning human settlements. The successful implementation of these, as well as good monitoring and evaluation, will result in improved quality of life of people and sustainable human settlements.

The findings of the Human Settlements chapter can be summarised as an overall improving outlook. Despite increasing population size and migration patterns, and associated pressures of growth and urban development, the outlook is still seen as positive for a number of reasons. Improvements in technology allow for improved efficiency of use of resources, improved design, restrictions on pollution, and so on. Improved understanding of physical processes and modelling of environmental and climatic change, also allows for behavioural and management shifts. This suggests that there is an improvement, and an improving outlook for the future of settlements.

Table 11 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action. Table 12 contains the anticipated changes or outlook for the future of human settlements, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding of the dynamics.

Table 11: Summary of key aspects identified in the chapter

Aspect	Summary of key points

Pressures	• Exponential Western Cape population growth
	  ○ 14.3% (1996-2001)
	  ○ 28.7% (2001-2012)
	  ○ In-migration
	• Urbanisation

Impacts	• Encroachment on habitats • Compromise ecosystem services • Pollution and waste • Demand for resources
Challenges	• Need for integrated planning • Restrictive regulatory and administrative systems • Increasing the rate of delivery
Progress	• Service delivery keeping pace with population growth and migration • Blue Drop and Green Drop improvement • Plans for incremental housing delivery • Green Buildings • Disaster risk management
Critical areas for action	• Remove obstacles to innovative (green) urban development • Revolutionize transportation systems • Improve climate change adaptation

Table 12: Summary of the outlook for human settlements based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend
Housing	• Informal dwellings constitute 18.2% of households in 2011 (up from 16.7% in 2001) • Housing shortage of 400 000 units	Backlog Increasing
Access to basic services	• 99.1% piped water (up 0.8% from 2001) • 93.4% electricity (up 5.3% from 2001) • 90.5% sanitation services (up 2.2% from 2001) • 91.7% refuse removal (up 2.9% from 2001)	Improving

Indicator	Quantification	Trend
Access to transportation	• Well developed, but historic patterns dominate • New forms of public transport taking off	Improving
Open space provision	• Insufficient and often inappropriate	Insufficient data

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BETTER TOGETHER.

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Air Quality Chapter

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ABBREVIATIONS

$\mu g/m^3$	Micrograms per cubic meter
AQMP	Air Quality Management Plan
ARI	Acute Respiratory Illness
CO	Carbon Monoxide
CO_2e	carbon dioxide equivalent
DEADP	Department of Environmental Affairs Development and Planning
GHG	Greenhouse Gas
IAAQS	International ambient air quality standard
NAAQS	National ambient air quality standard
NEM:AQA	National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
PAH	Polycyclic aromatic hydrocarbons
PM	Particulate Matter
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 μm
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 μm
SO_2	Sulphur Dioxide
tpa	Tonnes per annum
VOC	Volatile organic compounds
WHO	World Health Organization

GLOSSARY

Air Quality A measure of exposure to air which is not harmful to your health. Air quality is measured against health risk thresholds (levels) which are designed to protect ambient air quality. Various countries including South Africa have Air Quality Standards (legally binding health risk thresholds) which aim to protect human health due to exposure to pollutants within the living space.

Concentration When a pollutant is measured in ambient air it is referred to as the concentration of that pollutant in air. Pollutant concentrations are measured in ambient air for various reasons, i.e. to determine whether concentrations are exceeding available health risk thresholds (air quality standards); to determine how different sources of pollution contribute to ambient air concentrations in an area; to validate dispersion modelling conducted for an area; to determine how pollutant concentrations fluctuate over time in an area; and to determine the areas with the highest pollution concentrations.

Criteria Pollutant Criteria pollutants are air pollutants which cause smog, acid rain and health hazards. Primary pollutants are emitted by sources such as mining, industry, power generation, agricultural activities and transportation. These include Particulate Matter, Oxides of Nitrogen, Sulphur Dioxide, Carbon Monoxide, Lead and Benzene. Secondary pollutants are formed as a result of chemical interactions of primary pollutants, and these include Ozone and Particulate Matter.

Emissions The discharge of pollution from a source of pollution

Greenhouse Gases Gases which absorbs and emits radiation within the earth's atmosphere.

Particulate Matter (PM) The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles. Particulate matter is classified as a criteria pollutant, thus national air quality standards have been developed in order to protect the public from exposure to the inhalable fractions. PM can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions:

* PM_{10} (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung);
* $PM_{2.5}$, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less);
* $PM_{10\text{-}2.5}$, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
* Ultra-fine particles generally defined as those with an aerodynamic diameter of less than 0.1 microns.

1 INTRODUCTION

Air pollution is not just a "city problem", but a form of pollution that easily crosses boundaries and that can affect substantially large areas. Many air pollutants are dispersed over large ranges, hundreds of kilometres from their source, where they affect many different ecosystems. Pollutants can also remain toxic in the environment for extended amounts of time, where they continue to affect water resources (i.e. ponds, streams, wetlands, lakes, dams), and are taken up by plant material and accumulate in faunal species (including humans). Air pollution is thus emerging globally as a key threat to human health, quality of life and the biophysical environment.

This chapter on Air Quality details the current state of atmospheric air quality and pollution in the Western Cape, and offers discussion on the drivers and impacts of air quality as well as the responses from the provincial and local authorities. Specifically, the state of air quality is tracked using the following indicators: particulate matter, oxides of nitrogen, sulphur dioxide and greenhouse gas emissions. Data is also provided in terms of the spatial distribution of the sources of these pollutants.

2 DRIVERS

Human activities are the primary drivers and pressures determining atmospheric air quality. Typically, the sectors acting as main determinants of air pollution include transportation, industry, residential uses and commerce. They generate airborne pollutants primarily through combustion processes that release exhaust gas emissions but also through the release of fugitive emissions from industrial processes or the built environment.

The local climate system also determines the characteristics and spread of air pollution. The Western Cape is typified by a Mediterranean climate, comprising of cool wet winters and hot dry summers. Winter weather is driven by cold fronts pushing in from the southern Atlantic Ocean, whilst summers are governed by a high pressure system that pushes wet systems to the South and East (Figure 1). Its highly varied topographical profile, however, creates microclimates through interactions between the coastal zone, topographical obstructions and land use patterns.

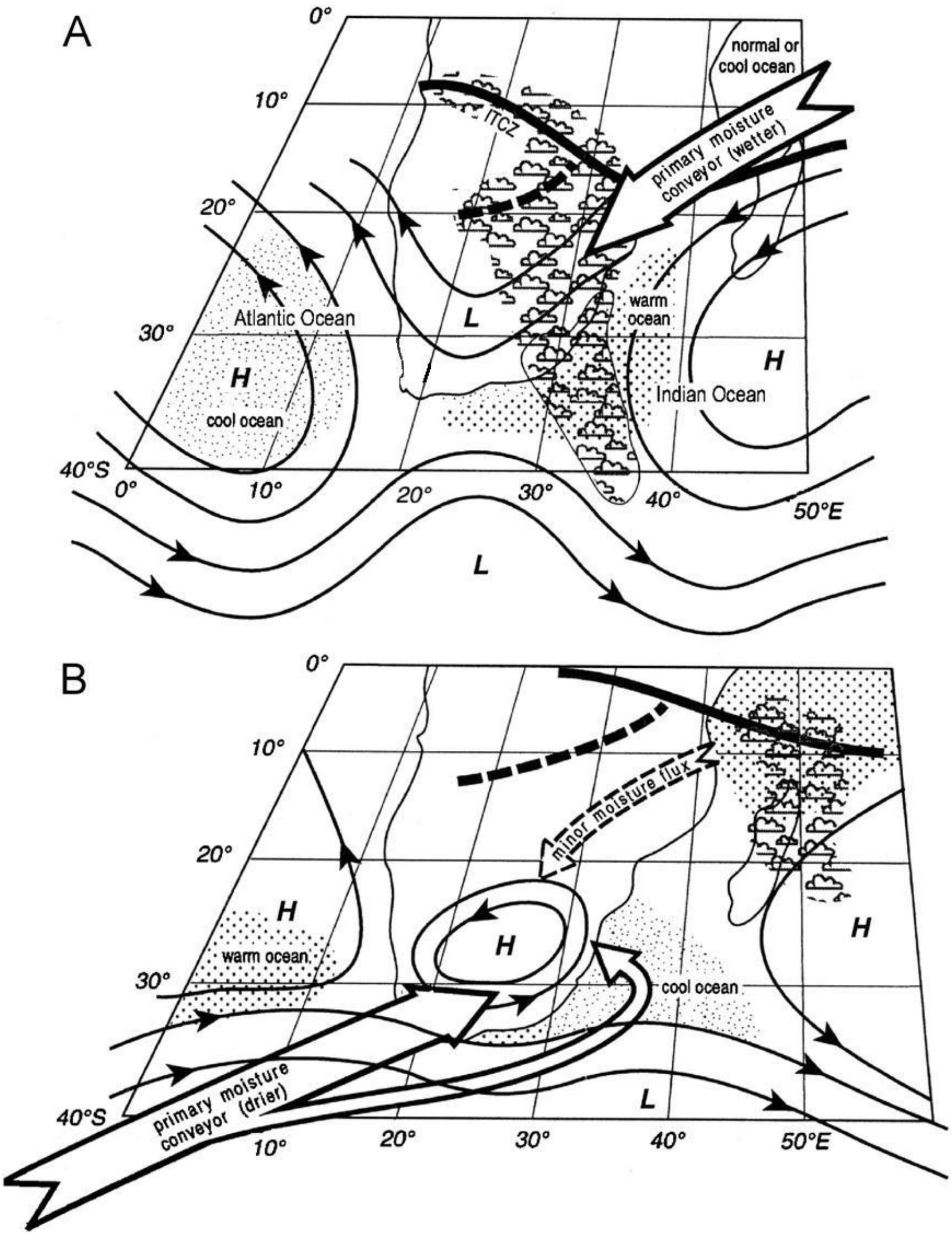

Figure 1: Generalised Southern African summer (A) and winter (B) circulation patterns (Tyson 1999)

3 PRESSURES

3.1 Transportation

Vehicles are a major source of hazardous air pollutants such as oxides of nitrogen (NO_x), carbon monoxide (CO), particulate matter (PM), volatile organic compounds (VOC), hydrocarbons (HC), lead (Pb) and sulphur dioxide (SO_2). Increased traffic volumes will generally result in an increase in vehicle emissions, unless new low emissions technologies become pervasive. Provincial traffic volumes are highest within the City of Cape Town Metropolitan area as approximately two thirds of the province's population reside in Cape Town.

The Port of Cape Town is a major source of localised pollution. On average approximately 10 vessels enter the Cape Town Port on a daily basis, which accumulates to 3300 vessels per annum (DEADP 2010b). The port further has a number of bunkering points where marine fuel, oil, gas and other blends are stored and supplied from. Diesel freight trains also enter and leave the port. The number of trains entering the port is approximately 1008 per annum (DEADP 2010b).

Emissions from Airports are an important contributor to atmospheric pollution. There are two major airports located in the Western Cape; the Cape Town International Airport and the George Airport. An aircraft engine emits CO, CO_2, NO_x, SO_2, particulates, trace compounds and incompletely combusted hydrocarbons or volatile organic compounds. Emissions are released at different rates depending upon the phases of operation such as takeoff, landing, idling, climbing and taxiing (Schlenke and Walker 2011), and also have different impacts depending on the height at which they are released. Nitrogen oxide emissions are higher during high power tasks, such as take off and CO emissions are higher during low power tasks such as taxiing. NO_x and CO emissions are highest during idling than any other operational stage (USEPA 1996).

3.2 Industrialisation

Industrial sources in the province contribute to elevated gaseous and PM emissions. For instance, the metal industries will generate emissions such as CO, NO_x, SO_2 and PM. The combustion of various fuels that are utilised in the energy sector such as paraffin, coal, heavy fuel oil and diesel, will result in various levels of VOCs and heavy metals being released into the environment wherever industrial activities are taking place. In the case of the use of electricity, the energy-related emissions will, however, be displaced to the source of the electricity generation.

There are a number of brickfields distributed throughout the province, 9 located in the Cape Winelands, 8 in the Eden District, 2 in the West Coast District, 1 in the Central Karoo district and 6 located in the City of Cape Town (DEADP 2011). Emissions released from brickworks are associated with operational processes, such as fugitive dust which is released during grinding and crushing of raw materials. SO_x, NO_x, CO and CO_2 are released during the combustion process, while VOC and methane are released from the dryers and kilns.

3.3 Domestic fuel burning

According to the 2011 national census, 93.4% of households within the province are electrified (StatsSA 2013). However, the burning of domestic fuels for heating and cooking purposes remains a common occurrence within both rural and urban settlements, especially in informal dwellings. Even in electrified areas, households make use of domestic fuels, which can be attributed to high energy tariffs or a personal preference to continue with the traditional use of such fuels.

Domestic fuel burning gives rise to indoor air pollution. Indoor air pollution refers to the air quality, or lack of quality, within and around a building or structure especially as it relates to the health of the building occupants. Exposure to indoor air pollution from the combustion of biomass and coal exposes people to a large number of pollutants, including PM, CO, NO_2, SO_2, formaldehyde and polycyclic organic matter and known health hazards.

3.4 Fires

Veld fires, which can mostly be attributed to human activities, contribute to poor air quality as a form of distinct pollution events with a high dispersion effect. Within the Western Cape Province, veld fires occur naturally during the dry seasons between the months of November to March when temperatures rise and the Fynbos vegetation dries out. The size and intensity, as well as the occurrence (both in space and time), of veld fires depend directly on factors such as the weather conditions, the composition of the vegetation (e.g. moisture content, volatile oils, percentage of moribund materials), and the weight of the consumable fuel per hectare (i.e. available fuel loading). The major pollutants from veld burning are PM, CO and VOCs. NO_x are emitted at rates of from 1 – 4 g/kg burned, depending on combustion temperatures. Emissions of SO_x are negligible (USEPA 1996).

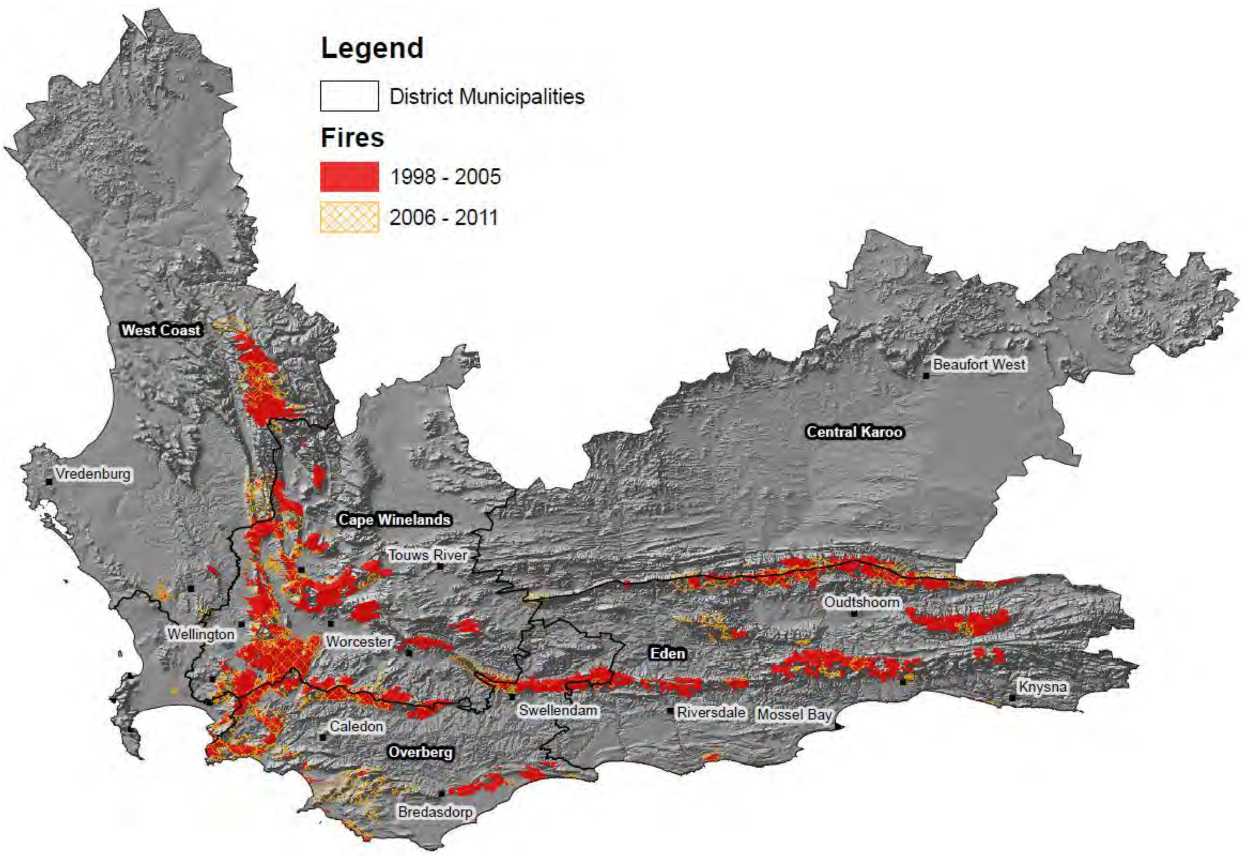

Figure 2: Veld fires located on CapeNature properties - 1998-2011 (SANBI 2013)

Figure 2 shows the spatial distribution of fires that occurred on conservation areas under the care of CapeNature during the periods 1998 to 2005 and 2006 to 2011. Both the extent and timing of the fires are shown, and it can be seen that fires during the latter period had a lower total extent, but that new areas burned in the Overberg and that there were repeat fires in the Hottentots-Holland Mountains between Wellington and Worchester. Similar patterns of burning in natural areas outside of CapeNature conservation areas can be expected, adding to the overall fire impact. The fires impact on general health because they release significant amounts of PM over a short period of time. The burned areas also remain sources of dust and particulates for long periods of time. Similar exposure patterns would exist for the areas outside of CapeNature's jurisdiction. The City of Cape Town, in particular, experiences several hundred fires each year, most of which take place close to human habitation.

In addition to veld fires, other types of fires are also present. This includes fires used for the disposal of agricultural wastes and informal combustion of waste. The burning of flammable organic compounds, such as tyres and plastics, breaks down volatile organic compounds resulting in the emission of a dense black smoke or soot consisting of impure carbon particles. Other contaminants released include carcinogens (i.e. cancer-causing substances) such as polycyclic aromatic hydrocarbons (PAHs), dioxins, polychlorinated biphenyl (PCB) and volatised heavy metals.

3.5 Agriculture

Agricultural activities can be considered a significant contributor to particulate emissions. Dryland and wetland agricultural activities impact on air quality by activating particulate matter (dust) and releasing gases such as CO_2 during ploughing, harvesting and other activities associated with field preparation. The emissions are strongly seasonally based, such as the high pollen counts during the flowering season of canola in the Overberg District.

Spraying of insecticides and pesticides are episodic occurrences during the length of the growing season. Exposure to pesticides is a serious problem within agricultural communities as it poses a threat to human health and the environment. Pesticides such as Organochlorins have the potential to impact and pollute any living tissue, air and water (Aktar *et al*. 2009). The use of pesticide spray is especially problematic as it could land on non-target areas, volatise from the subject area and contaminate air, soil and affect non- target plants. Use of the herbicide 2,4-D has been known to injure nearby trees and shrubs, while the herbicide Glyphoshate can severely impact seed quality and increase susceptibility of certain plant species to diseases. Conflicts between residential land uses and agricultural crop spraying are especially prevalent in the Cape Winelands District.

Emissions associated with the farming of pigs, sheep, goats and chickens include ammonia and hydrogen sulphide (USEPA 1996). Livestock also produce significant quantities of methane through their digestive processes, mostly through burping of ruminate. In fact, the significance is regarded serious enough that an Agricultural Emission Research Levy was proposed in New Zealand in 2003, which would have imposed a 'carbon tax' on livestock farmers.

3.6 Waste water treatment works

The emissions that are released during operation of a waste water treatment works (WWTW) are mostly odour and aerosols. Airborne pathogens are also released during the mechanical processes of the WWTW such as aeration and denitrification. VOCs are emitted from the waste water collection, treatment and storage systems through volatisation of organic compounds at the liquid surface. Bioaerosols, airborne particles that are organic in nature, are released from the processing units. Bioaerosols are of concern to the operators at the WWTW and do not impact beyond the immediate vicinity of the processing units.

Odour is however the most noticeable form of pollution from the public perspective. It occurs during specific processes such as cleaning of screens, emptying of sewage tanks and when the sewage sludge turns septic during stockpiling of waste. Compounds contributing to the smell of waste water arise from the original composition of the sewage, the biochemical changes which take place during treatment and the additions of chemical to the sewage as part of the treatment process.

The operating conditions and capacity of the WWTW are important determinants of the level or extent of air pollution. Overloading, operational failures and maintenance backlogs would result in substandard effluent that is released back into the environment, thereby increasing the exposure time and release of airborne pollutants.

3.7 Mining activities

Mining operations within the Western Cape Province are mainly restricted to open cast mining and heavy beach sand operations. The main air quality emissions from open cast mining and heavy beach sand operations are particulate matter and fugitive dust. Sources include material handlings activities, vehicle entrainment on unpaved roads, as well as wind erosion from open areas or discard and slimes dams where waste materials are stockpiled. Vehicle related emissions and handling facility-based combustion processes (e.g. burning coal in boilers) further contribute to gaseous emissions.

Although mining is not considered a dominant economic sector in the Western Cape, a number of open cast operations are found within the West Coast area. Sand mining takes place in the City of Cape Town, some further open cast operations occur in Eden District, and scattered hardrock and limestone quarrying is found throughout the province.

3.8 Landfill sites

The emissions associated with landfill sites are mostly gaseous emissions and fugitive dust. Fugitive dust emissions arise from vehicle movements on unpaved roads, the erosion of soil, earth moving activities and wind erosion from soil covered waste mounds. Landfill gases usually consist of between 40 to 60% methane and carbon dioxide. Both organic and inorganic compounds contribute to landfill gas emissions. Burning of waste material such as general household waste, plastics and tyres at landfills is a common occurrence, and the health implications associated with this informal and incomplete combustion is severe. Emissions such as particulate matter, VOC and carcinogenic compounds are released.

4 STATE

4.1 Atmospheric pollutants

Tracked indicators of the *status* of Air Quality:

- Types and quantities of atmospheric pollutants
- District specific air quality aspects

The air quality situation in the Western Cape is discussed in this chapter based on a differentiation between the Western Cape Districts, due to the differing nature of land-use sectors per area and the resultant variable air quality profile. Information on air quality is limited as monitoring sites are not uniformly distributed through the province and long terms records are scarce. Nevertheless, the monitoring stations are the primary sources of information on a provincial scale.

4.1.1 Particulate matter

Particulate matter is the collective name given for solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles. PM is classified as a criteria pollutant, thus national air quality standards under the auspices of NEM: AQA have been developed in order to protect the public from exposure to the inhalable fractions.

Annual trends in the PM_{10} concentration are depicted in Figure 3 below for the period from 2008 to 2011. All monitoring stations show recorded PM_{10} concentrations below the annual average limit of 50 µg/m^3 (shown in red), but steady year-on-year increases. Longer time series data is required to confirm this trend, but it warrants close attention.

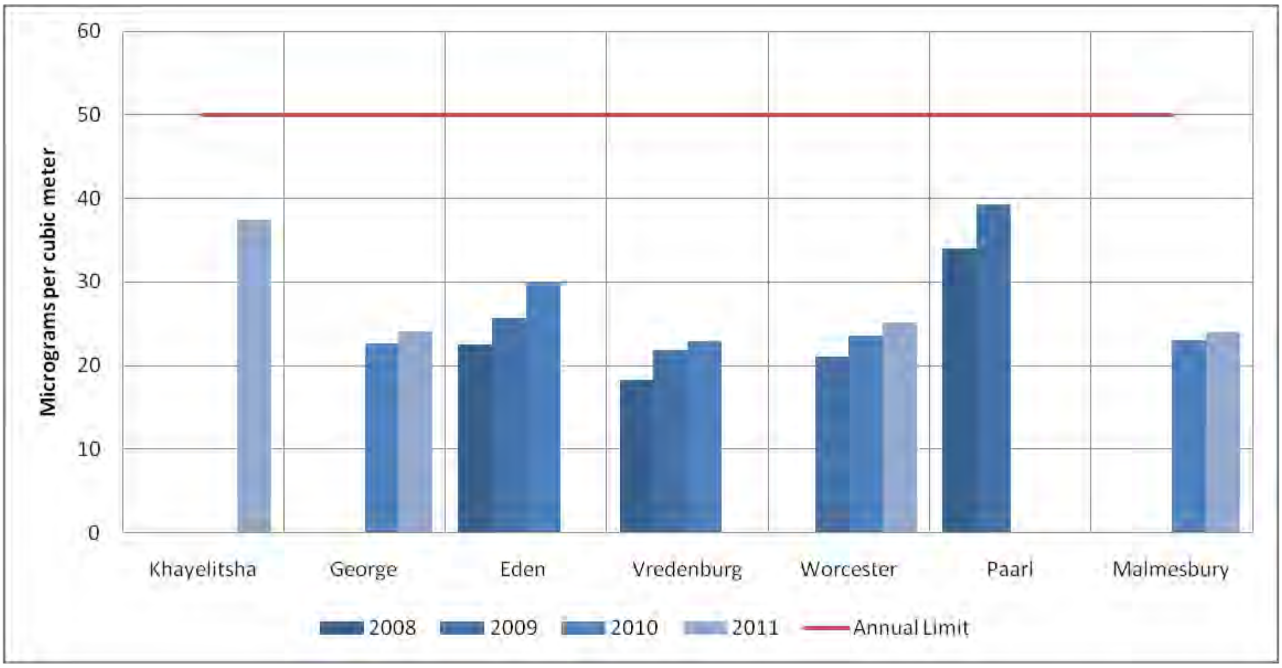

Figure 3: Annual trends in Particulate Matter (PM_{10}) concentration (µg/m³) for 2008 – 2011 (DEADP Monitoring Stations Data)

Monitoring undertaken at Vredenburg over the 10-year period from 1999 to 2010 (Figure 4) indicate that an apparent general decrease in PM_{10} concentrations in the area, with the highest recorded values being in 2002/2003. The results also show the inconsistency of the data series, and the need to improve on the reliability of measurements.

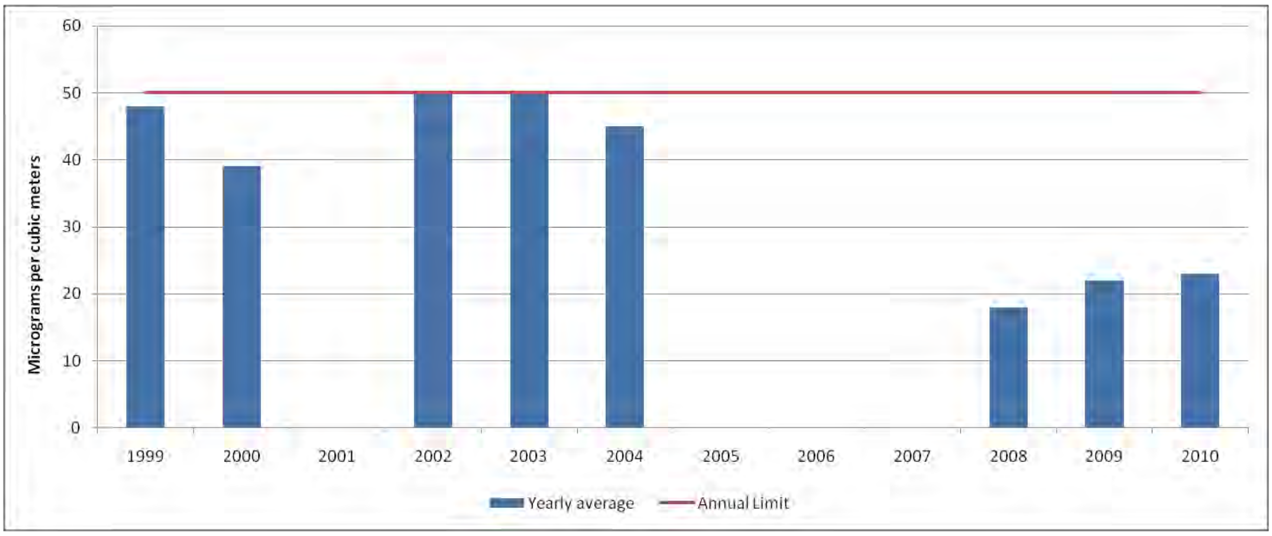

Figure 4: Annual trends in the Particulate Matter (PM_{10}) concentration (µg/m³) for 1999 – 2010 (DEADP Monitoring Stations Data)

4.1.2 Oxides of nitrogen

The air quality guidelines and standards which are issued in most countries and organisations tend to be given exclusively for Nitrogen dioxide (NO_2) concentrations, rather than for the full range of NO_x compounds. This is due to NO_2 being considered the most important compound from a human health point of view. NO_2 is formed through the oxidation of Nitric oxide (NO). NO is one of the primary pollutants which are emitted by aircraft and vehicle exhausts. NO_2 is easily absorbed into the mucous membrane of the respiratory tract and has been known to result in adverse human health effects.

The annual data for NO_2 concentrations show no clear trend in concentration from 2008 to 2011 (Figure 5). Elevated levels are characteristic of the Khayelitsha monitoring station. Khayelitsha is a highly urbanised township, situated within the Cape Flats area approximately 30 km from the Cape Town city centre. The release of NO_2 in the vicinity of the monitoring station can be attributed to industries and vehicles emissions due to the high level of urbanisation and high reliance on road transport.

Nitric oxide (NO) and Oxides of Nitrogen (NO_x) concentrations vary from location to location, but are generally quite low (Figure 6 and Figure 7).

The Khayelitsha monitoring station reported exceptionally high levels of NO_x in 2011, the only year for which monitoring results are available. This could imply that the densely populated localised area in the vicinity of the Khayelitsha Ambient Air Quality Monitoring station experiences chronic poor ambient standards.

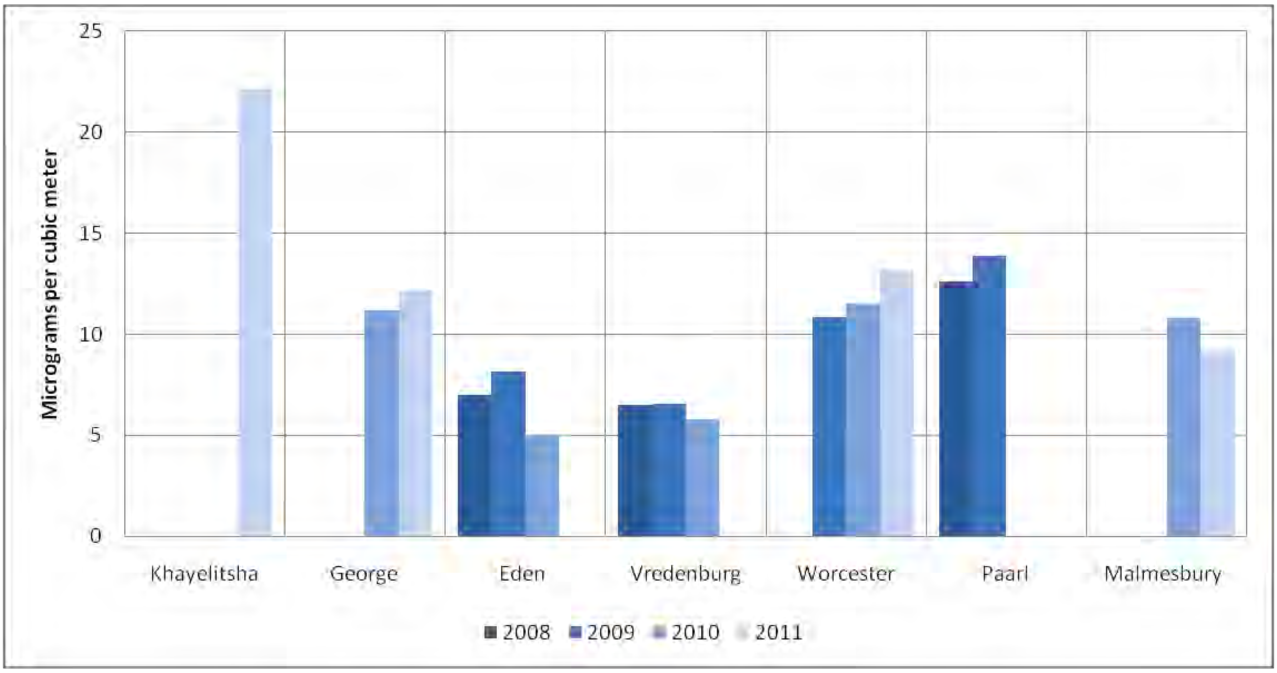

Figure 5: Annual trends in the Nitrogen dioxide (NO_2) concentration (µg/m^3) for 2008 – 2011 (DEADP Monitoring Stations Data)

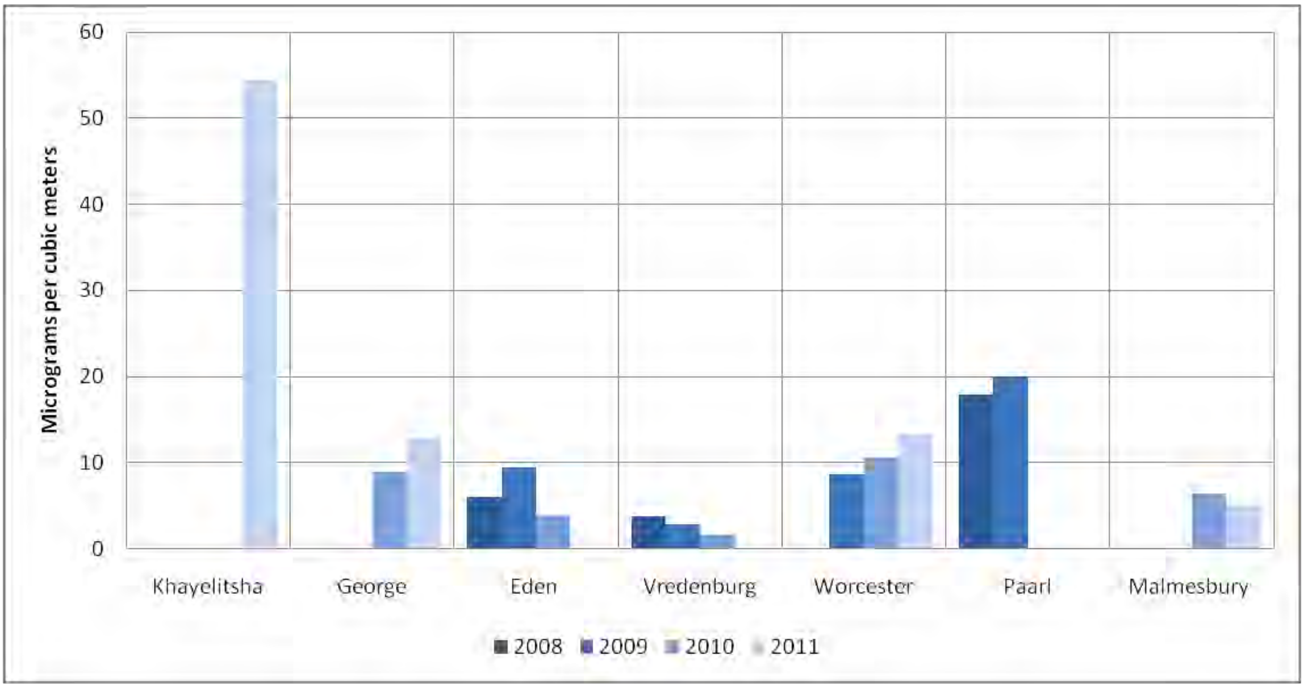

Figure 6: Annual trends in the Nitric oxide (NO) concentration (µg/m³) for 2008 – 2011 (DEADP Monitoring Stations Data)

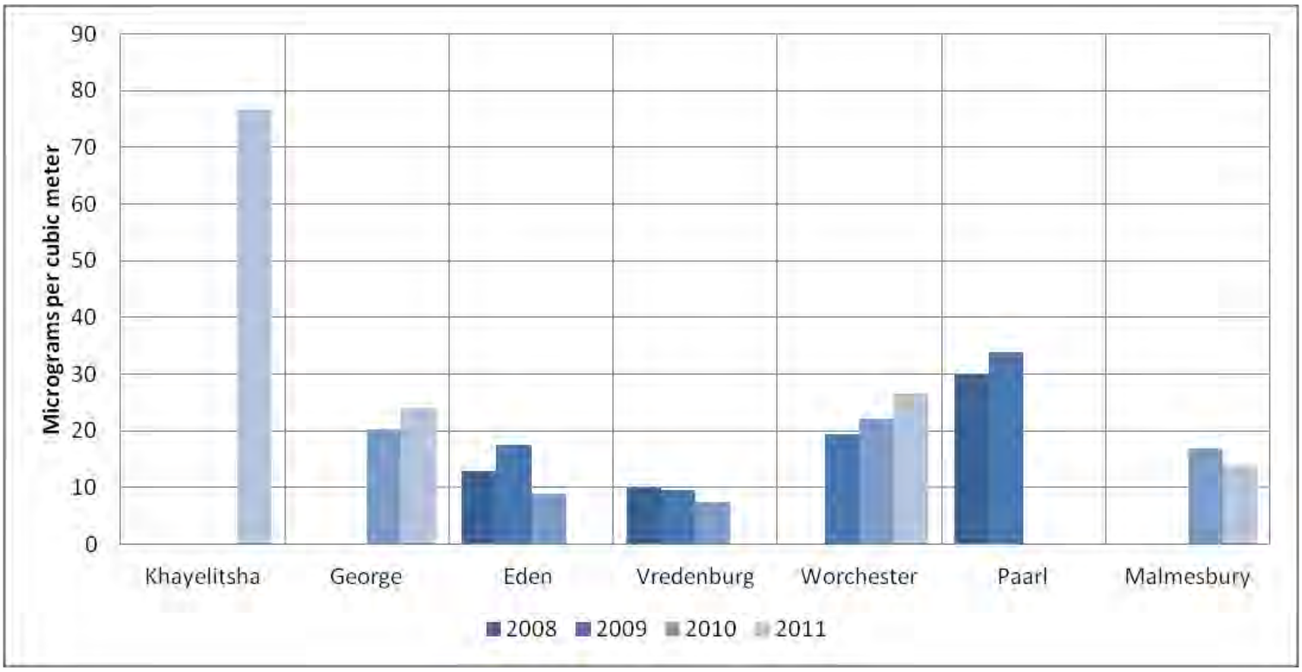

Figure 7: Annual trends in the Oxides of Nitrogen (NO_x) concentration (µg/m³) for 2008 – 2011 (DEADP Monitoring Stations Data)

4.1.3 Sulphur dioxide

Sulphur dioxide (SO_2) is an irritant which is readily absorbed in the mucous membranes of the nose and surfaces of the upper respiratory tract. It is associated with reduced lung function and thus leads to an increased risk of mortality and morbidity (WHO 2000). Adverse health effects of SO_2 exposure include coughing, phlegm, chest discomfort, bronchitis and pneumonia.

In the annual trend of SO_2 (Figure 8) over the 2008 – 2011 monitoring period was stable for all stations, and well under the annual threshold. The SO_2 emissions are highest within Vredenburg, although marginally so; this is attributed to the emissions released by industries.

4.1.4 Greenhouse gas emissions

Greenhouse gases (GHG) is the collective term for gases in the earth's atmosphere which adsorb and trap radiation within the thermal infrared range, a process also known as the Greenhouse Effect. Gases such as water vapour, carbon dioxide, methane, nitrous oxide and ozone (O_3) are considered the primary greenhouse gases either due to high volumes or effectiveness as a greenhouse gas. Anthropogenic sources such as the combustion of wood, coal, liquid fuels and natural gases are major contributors to the release of greenhouse gases.

The main greenhouse gas is carbon dioxide, and its accumulation in the atmosphere is closely observed as an indicator of the human forcing of climate change. Carbon emissions from human activities are therefore monitored in order to gauge relative contributions to the greenhouse effect. The contribution from other greenhouse gases is similarly tracked, and reported on in terms of their effect relative to carbon dioxide. This allows for reporting in terms of a single unit, namely carbon dioxide 'equivalent' or 'CO_2e', that gives an indication of the combined global warming effect. Typically, the total contribution is simply reported as 'carbon emissions' for the sake of brevity.

The highest contributing source of carbon emission in the Cape Metropolitan area is the use of electricity, which contributes 57% of the carbon emissions total (Figure 9). Marine transport and liquid fuel use contributes 15% and 11% of carbon emissions respectively (WCG 2013). The carbon emissions attributed to the use of electricity result from the use of coal to run power stations elsewhere in the country.

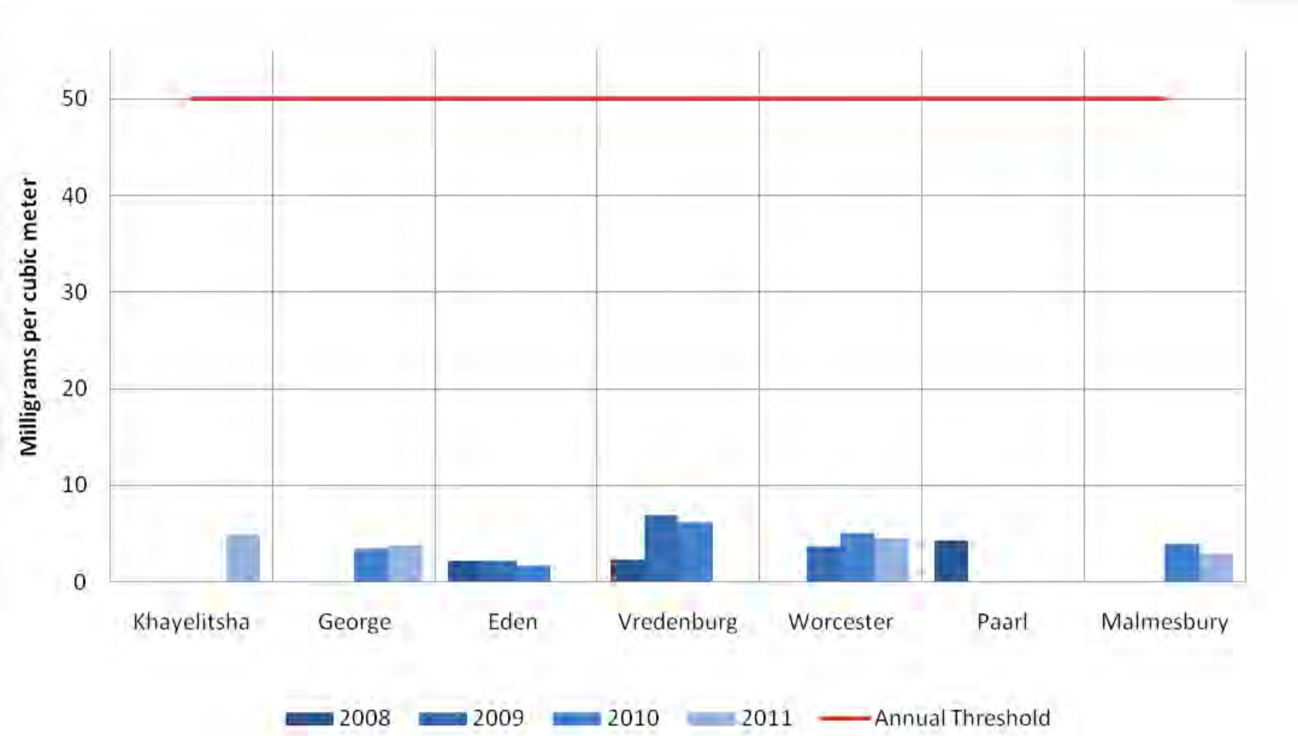

Figure 8: Annual trend in Sulphur dioxide (SO_2) concentration (µg/m³) for 2008 – 2011 (DEADP Monitoring Stations Data)

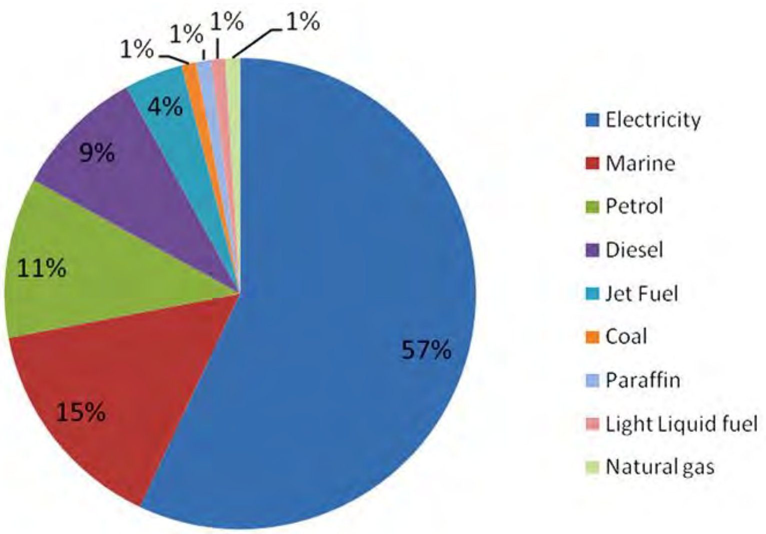

Figure 9: Sources of carbon emissions in the City of Cape Town (WCG 2013)

Most of the energy usage within the City of Cape Town is in the transport sector, followed by general industry and residential uses. Similarly, in terms of GHG emissions per sector, the transport sector accounts for 42% of the total emissions in the city, followed by the residential and industrial sectors that account for 22% and 24% respectively (WCG 2013). Refer to the Energy Chapter for more information in this regard.

Figure 11 and Figure 11 relate to greenhouse gas emissions in the inland Districts of the Western Cape. Two notable aspects are electricity use in the Cape Winelands and fuel use in the Central Karoo.

The highest contribution to greenhouse gas emissions in the Cape Winelands District is from electricity usage, which contributes 69% of carbon emissions. With the direct use of coal being the second highest contributor, it is clear that the district is highly reliant on the use of coal based energy (WCG 2013).

The Central Karoo, on the other hand, is split between the use of electricity and diesel fuels (WCG 2013). This is a consequence of the main overland route (the N1 highway) running through the district along which several popular refuelling stations are located.

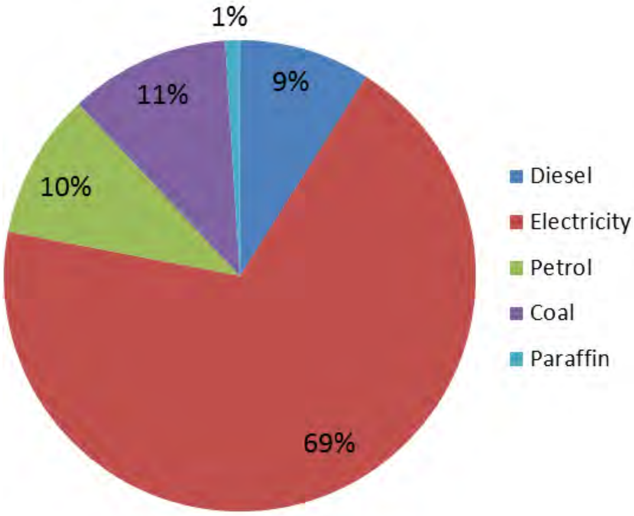

Figure 11: Sources of carbon emissions in the Cape Winelands (WCG 2013)

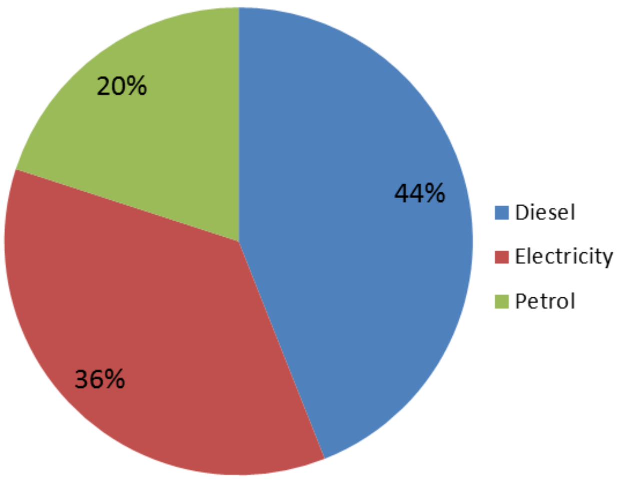

Figure 11: Sources of carbon emissions in the Central Karoo District (WCG 2013)

In the Eden district (Figure 14) the highest single source of carbon emissions is attributed to the use of electricity. However, the combined contribution from the use of different liquid fuels eclipses the emissions from electricity. In particular, the presence of industrial activities and high reliance on transport contributes to the use of liquid fuels within the District.

In Figure 14 below it is shown that the major contributing carbon emission sources within the Overberg District can be attributed to electricity generation, whereas the highest carbon emission source within the West Coast District (Figure 12) is attributed to the consumption of coal.

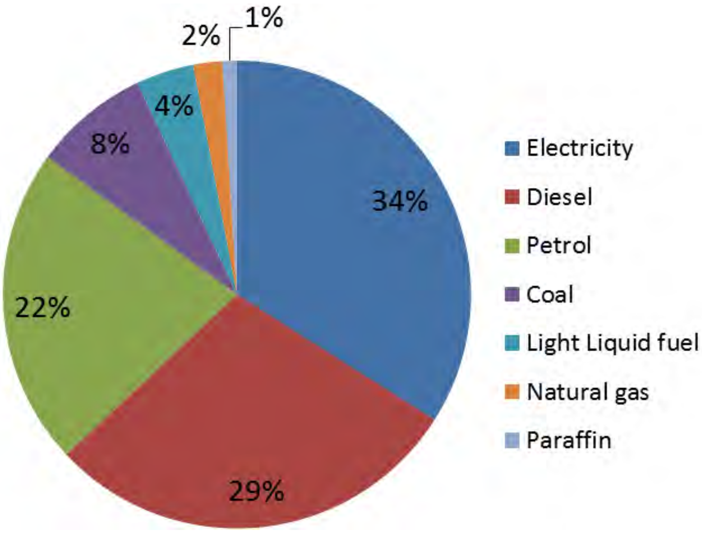

Figure 14: Sources of carbon emissions in the Eden District (WCG 2013)

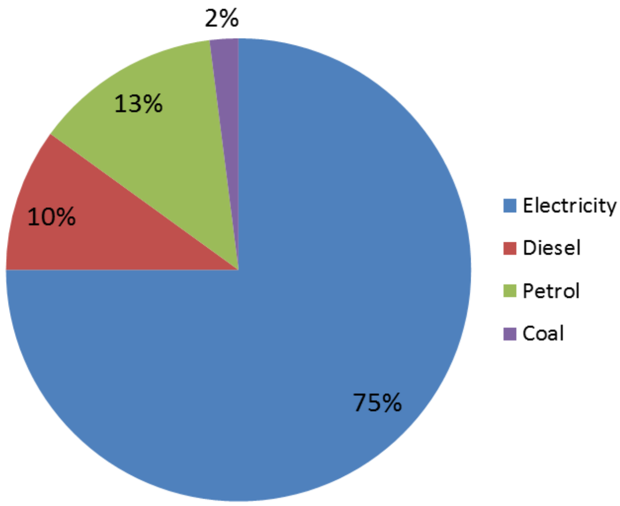

Figure 14: Sources of carbon emissions in the Overberg District (WCG 2013)

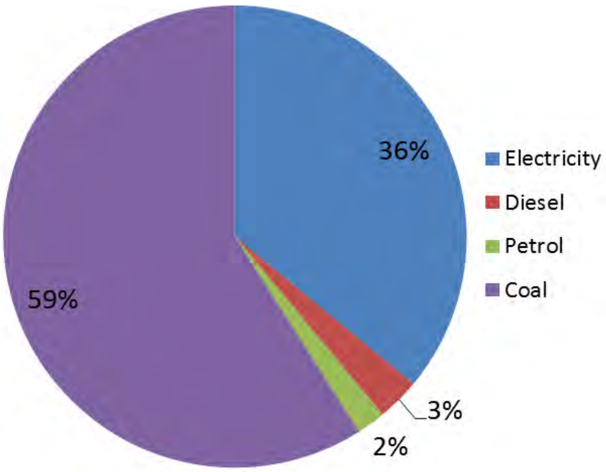

Figure 12: Sources of carbon emissions in the West Coast District (WCG 2013)

4.2 District specific air quality aspects

4.2.1 City of Cape Town

The majority of the Western Cape's population resides within Cape Town and surrounds. This means that most of the province's emissions are generated in the Metro, but also that this is where the highest level of individual exposure to poor air quality is likely.

The main sources of ambient (outdoor) air pollution in the Cape Metropolitan area is attributed to NO_2, PM and SO_2 which are released from Industrial operations and the transport sector. Indoor air pollution consisting of similar pollutants is also high despite the district being widely electrified, as a significant amount of households utilise domestic fuels such as gas, wood and paraffin for space heating and cooking (StatsSA 2013). This is likely due to electricity, although available, not necessarily being affordable. In areas where informal burning and the domestic fuel use are high, such as in low income township or informal areas, elevated levels of emissions such as PM, CO, NO_2 and SO_2 will be present. Wind-blown dust is another contributor to PM_{10} during summer months.

According to the 2011 Western Cape State of Air Quality (DEADP 2011), parts of Khayelitsha in the vicinity of the Provincial monitoring station have consistently shown high concentrations of PM_{10}. PM_{10} and VOC emissions attributable to sources such as domestic fuel burning, traffic and nearby industries. The provincial air quality monitoring station at Khayelitsha measures NO_2, O_3, PM_{10}, $PM_{2.5}$, SO_2, CO and BTEX. During the January to August 2011 monitoring period, there were no exceedances of the ambient air quality standards across all measured parameters. Trends in the concentration peaks were however noted. Specifically, particulate matter showed increased concentrations during the morning and evenings, which is indicative of domestic fuel burning, vehicular activity and stable atmospheric conditions that prevail during these periods.

NO_2 concentrations across the monitoring stations were higher during the morning hours of 03:00-10:00 am and during the evening hours of 17:00-23:00 pm. These peaks are representative of vehicle emissions. The CO concentration had a similar pattern to that of NO_2, with increased concentrations during the early hours of the morning (04:00-12:00 am) and during the evenings (18:00-23:00 pm).

The majority of the specific air quality complaints received during 2011 related to nuisance dust, closely followed by smoke pollution, burning on farmlands and nuisance odours (DEADP 2011).

4.2.2 Cape Winelands District

Areas such as Stellenbosch and Paarl within the Cape Winelands District host numerous industrial activities as well as extensive agricultural areas and agri-processing facilities that contribute to elevated levels of air pollution. Data representative of the air quality situation shows that the district has a high concentration of PM and NO_2 emissions. Industrial activities and vehicle emissions are commonly responsible for releases of PM and NO_2 into the air. Agricultural activities and fires further contribute to the PM emissions within this district, as does the use of fuels such as coal and paraffin in both low income households and by industrial boilers. The DEADP has a monitoring station located in Paarl which measures PM_{10}, NO_2, SO_2, O_3, VOC and Meteorological data.

Complaints received during 2011 related to poor air quality were mostly agricultural in origin (DEADP 2011). These specifically relate to conflicts between residential land uses and fugitive fallout from agricultural crop spraying, but also other activities such as biomass burning and dust.

4.2.3 Central Karoo District

There is not much industrialisation within the Cape Central Karoo district. The district is dominated by emissions emanating from the use of liquid fuels such as diesel and petrol for overland transportation. Domestic fuel burning such as coal, paraffin and wood for cooking and heating purposes is also present.

The district is rich in uranium and shale gas, and there is interest in mining these resources in future. Mining activities results in PM and fugitive dust emissions, which would therefore increase along with mining activities.

Very few complaints about air quality are received in the District. Of the three complaints lodged during 2011, two related to noise, and one to the burning of waste at the Beaufort West refuse site (DEADP 2011).

4.2.4 Eden District

There are various industries and petrochemical operations located within the Eden District, especially in Mossel Bay. Emissions released during refining operations at the Mossel Bay Refinery relate to combustion processes and to the separating out of volatile compounds. The combustion related substances generated include SO_2, CO, CO_2, NO_x and PM. Other pollutants released include various levels of volatile organic compounds (e.g. benzene) or heavy metals (e.g. lead).

Air pollution complaints in the District also highlight problems related to tanneries and abattoirs in the Oudshoorn area. During 2011, numerous complaints were received by authorities related to odours emanating from these businesses.

The district also has a very high consumption of petroleum fuels such as diesel and petrol, due to the presence of a key national road (N2 highway) that runs through the district. This route carries a large amount of passenger and freight traffic between the urban centres on the West and Southern Coasts, as well as between the harbours of Saldanha Bay, Cape Town, Mossel Bay, and the Eastern Cape.

Biomass burning and domestic fuel burning in low income households contribute to air pollution within the district in the form of PM (soot, dust), SO_x and NO_x. According to the State of Air Quality 2010, the Eden District has shown elevated levels of SO_2 particularly in the in Plettenberg Bay and Knysna when compared to other places such as Riverdale and George. This is likely attributed to the brickfields in Plettenberg Bay and vehicle emissions in Knysna (DEADP 2010a).

4.2.5 Overberg District

The dominant industries within the Overberg district include fishing, forestry and agriculture. Emissions associated with these industries are PM, odours, VOC, CO_2 and fugitive pesticides. The use of fuels for domestic fuel burning and biomass burning is also a key contributor to emissions released in air. The Overberg District has the highest percentage of per capita vehicle ownership, which likely results in local scale elevated levels of vehicle emissions within the district (WCG 2013).

Air quality complaints during 2011 were mostly related to odours (DEADP 2011).

4.2.6 West Coast District

The West Coast district has a very high consumption of coal. The use of coal is attributed to the energy demanding industries within the district specifically in the vicinity of Saldanha Bay. The main share (57%) of greenhouse gases emissions in the district can be attributed to the use of coal. The district is further heavily dependent upon fossil fuels (WCG 2013).

Air quality issues in the area are linked to the local industrial activities, specifically red dust from iron ore handling in Saldanha Bay, dust associated with lime production in Matzikama and the malodorous fish meal production at St. Helena Bay (DEADP 2011).

5 IMPACTS

5.1 Climate change

One of the most concerning impacts of atmospheric emissions is climate change. Climate change results from the emission of greenhouse gases which trap heat in the atmosphere and alter the earth's climate systems. Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, ozone and particulate matter.

Scientific projections of climate change have confirmed rising global temperatures and shifting rainfall patterns. It is also likely that more regular extreme weather such as heat waves or high intensity rainfall may occur. Extreme weather events and changing weather patterns will result in ecosystem degradation and biodiversity challenges, a shift in agricultural resources, changes in the distribution ranges of disease vectors such as malaria mosquitoes and negative impacts on social welfare and development.

5.2 Brown haze

The 'Cape Town brown haze' is a dense brown coloured smog which is present over Cape Town, especially during the winter months. It is the result of the accumulation of gaseous and particulate pollution when there is strong temperature inversion and limited wind dispersion. The brown haze extends throughout most of the Cape Town Metropolitan area and is most intense during the morning hours with highly visible levels of pollution. A study of the brown haze was conducted in 1997, and it attributed 67% of the total visible pollution to vehicular emissions, and specifically particulates (Wicking-Baird *et al*. 1997). Diesel driven vehicles were most to blame, representing 49% of all the vehicular emissions. The balance of the haze is attributed to industrial emissions and residential biomass burning. In response to the rising concerns, the City of Cape Town devised an action plan in order to reduce the impacts. The Air Quality Management Plan was divided into objectives to be implemented at the local level and structures the ongoing air quality monitoring in the city (City of Cape Town 2005). National input is required, however, to influence fuel use preferences for long-distance overland transportation.

Despite its high propensity for air pollution, Cape Town's pollution levels are regarded as generally acceptable to good because of the cleansing effect of the South Easterly winds. The South Easter is the predominant wind from spring to late summer, and is known as the 'Cape Doctor'. It mixes the air and blows atmospheric pollution away from the city. However, under extremely windy conditions it can elevate PM levels due to dust, sea salt crystals and mineral sand entrainment.

Climate change projections indicate an intensification of the South Atlantic High Pressure cell that drives the south easterly winds. Although this bodes well for the continued functioning of the 'Cape doctor' it should be noted that the temperature inversions that are a large causative factor of the 'brown haze' occur mostly in winter, whilst the South Easter is largely a function of the summer months.

5.3 Health effects

Air pollution, as with other types of pollution and nuisance factors, either leads to immediate health problems or contribute to general deterioration in health. Apart from specifically hazardous substances, pollutants such as PM_{10} particulate matter, SO_2, NO_2, Pb, O_3 and CO are to blame for such adverse effects. Typically, low levels of ambient (background) pollution leads to slow deterioration in health, whilst higher intensity pollution typically from industrial sources or from indoor air pollution will cause direct health problems.

The impacts of poor air quality on the environment and people have severe health implications.

- A study on outdoor air pollution in South Africa estimated that in 2000, outdoor urban air pollution was directly linked to nearly 1% of all deaths (Norman *et al*. 2007)
- Exposure to indoor air pollution has been implicated, with varying degrees of evidence, as a causal agent of several diseases in developing countries including acute respiratory infections, middle ear infection, chronic obstructive pulmonary disease, lung cancer (from coal smoke), asthma, cancer, tuberculosis, perinatal conditions and linked low birth weight and diseases of the eye such as cataracts and blindness.
- Increased ozone has adverse effects upon human respiratory functions as it triggers asthma and causes lung cancer.
- Anthropogenic sources of air pollution such as the release of Nitrogen dioxide and Sulphur dioxide from industrial processes decreases lung function, increases mucus secretion and aggravates asthma.

Exposure to indoor air pollution from the combustion of solid fuels is an important cause of morbidity and mortality in low income communities. Indoor air pollution results mainly from domestic fires and fuel burning, fires from informal trading and refuse burning. For instance, the latest international standard for daily average concentration of PM_{10} is $<180\ \mu g/m^3$ with an annual average of $<60\ \mu g/m^3$. In contrast, a typical 24-hr average concentration of PM_{10} in homes using biomass fuels may range from 300 to 3,000 $\mu g/m^3$ or more throughout the year, depending on the type of fuel and stove used and housing design (Torres-Duque 2008).

Relatively high population densities in poorer communities, together with the low release height of the pollutants, imply that the health risk is greater in these areas. It is estimated that 80% of fuel-combustion related respiratory ailments in Cape Town can be attributed to residential wood burning (Scorgie 2012). Costs resulting from the inhalation of pollutants include direct health spend, lost productivity, and reduced life expectancy.

5.4 Impacts on biodiversity

Air pollution directly affects the health of fauna and flora, but also impacts them indirectly by contaminating the soil and water that they depend on. The effects are highly dependent on the levels of exposure and type of contaminant, which naturally make location-specific conditions and sources of pollution important in terms of the specific effects on biodiversity at different locations.

The most common pollutants that have adverse effects on plants include SO_2, fluoride, chlorine, ozone and ethylene. These result in "burning" at leaf tips or margins, stunted growth, premature leaf growth, delayed maturity, early drop of blossoms and reduced yield or quality. Typically, these effects would occur close to large urban areas and industrial areas, and specifically around point sources of pollution such as power generation plants, smelters, incinerators, landfill sites, pulp and paper mills, and other fossil fuel burning activities.

Animals inhale pollutants or absorb them through their skin. Pollutants such as O_3, SO_2 and NO_2 primarily affect the respiratory system. Heavy metals (e.g. lead, arsenic, and cadmium) and various hazardous chemicals are released from industrial activities and these will affect the circulatory, respiratory, gastrointestinal, and central nervous systems of animals.

The release of high concentrations of sulphur dioxide in the earth's atmosphere can also combine with water vapour to form sulphuric acid, which precipitates as acid rain. Acid rain has adverse effects on natural habitats and can kill small insect and freshwater life forms.

5.5 Economic effects

The effects that poor air quality can have on environmental health, human health and economic activities can translate into significant economic impacts. The impacts manifest both as direct expenditure and as a diffuse lowering of the economic value of land. Direct costs relate to the abatement of air pollution, infrastructure or technology required to reduce emissions, and expenditure on addressing health problems. Poor air quality further reduces the value of particular properties, or can result in an overall deterioration of environmental standards that are necessary foundations of economic sectors such as tourism or commerce.

A particular example of the negative impacts of poor air quality is found in St. Helena Bay, where the odorous fallout from the fish meal processing facilities are detracting from the value of residential properties. Similar cases are found in the Cape Winelands where conflicts arise between residential developments and agricultural activities.

5.6 Transboundary pollution

Airborne pollutants are easily distributed by the local or regional atmospheric circulation patterns. This means that the longer the pollutants can remain airborne, the further they can travel. Atmospheric circulation over the Western Cape could therefore transfer the impact of air pollution to areas further north along the West Coast and the Atlantic Ocean and inland or along the East Coast, or receive it from adjacent areas. Greenhouse gas emissions, however, contribute to a global problem due to the mixing taking place in the atmosphere as a whole and consequential global accumulation.

Transboundary air pollution is particularly difficult to address as it is often subject to scientific uncertainty and economic and political relations between regions or countries. Current knowledge of the extent of transboundary pollution is also limited (DEADP 2010a).

5.7 Stratospheric ozone depletion

Several substances, including Chlorofluorocarbons (CFCs), have the ability to rise through the atmospheric layers to interact and break down stratospheric ozone molecules. The so-called 'ozone layer' plays a significant role in filtering ultraviolet radiation from the sun and its reduction due to human industrial activities has impacts on health and the natural environment. This includes sunburn, skin cancer and eye damage. South Africa is located at the southern tip of Africa, and is therefore the African country closest to the region of high ozone depletion over the Antarctic (the 'ozone hole') and most at risk from the increased levels of radiation. Interestingly though, the Western Cape has a lower exposure level than other monitoring locations such as the Northern Cape and Gauteng (Wright et al. 2011). This is likely due to the prevailing weather conditions.

6 RESPONSES

6.1 South African Air Quality Standards

Air quality guidelines and standards are fundamental to effective air quality management, as they define an acceptable relationship between the source of atmospheric emissions and receivers at downstream receptor sites. The National Department of Environmental Affairs has issued national ambient air quality guidelines for common pollutants such as SO_2, Pb, NO_2, benzene, PM_{10}, $PM_{2.5}$ and CO, in order to support management practices. These ambient air quality guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly.

A particular omission from a Western Cape perspective is the lack of a standard for Hydrogen sulfide (H_2S) emissions. Hydrogen sulphide is a major constituent of odorous gases, and an appropriate standard would therefore take a measure of subjectivity out of the measurement of odours.

6.2 Air Quality Management Plans

The development of the Air Quality Management Plan for the Western Cape (DEADP 2010a) was undertaken in response to the introduction of the idea of active air quality management in the National Environmental Management: Air Quality Act (Act 39 of 2004). The plan was developed in phases, and included a status quo assessment of air quality management, public engagement and ultimately the compilation of a plan that includes the Vision, Mission and Goals for air quality management in the province, and that identifies activities that are required in order to meet the objectives of the plan. A Steering Committee and three Working Groups were established to ensure the successful implementation of the Air Quality Management Plan.

The vision for air quality management is defined as "*clean and healthy air for all in the Western Cape*", and goes hand-in-hand with a mission defined as:

"*...to ensure the effective and consistent implementation of sustainable air quality management practices, by all spheres of government, relevant stakeholders and civil society to progressively achieve and efficiently maintain clean and healthy air in the Western Cape*".

In terms of air quality management plan development on local authority level, all the Districts as well as the City of Cape Town have complete plans that are being implemented (Figure 15). The City of Cape Town, Cape Winelands District and Eden District have included their Air Quality Management Plans as integral parts of their Integrated Development Plans. The Eden District Municipality's Air Quality Management Plan is due for review in 2013, and the Cape Winelands District in 2015 (DEADP 2011).

Currently eight Local Municipalities have fully developed management plans. Nine more are in development, and seven municipalities have not commenced with the development of management plans.

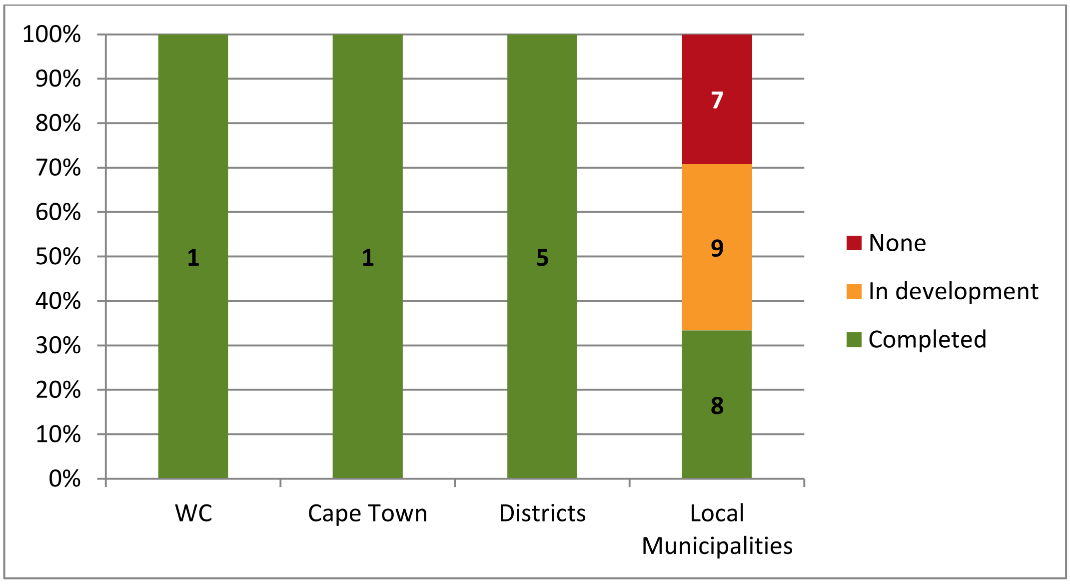

Figure 15: Status of air quality management plans in the Western Cape

An additional outcome of the Provincial efforts at a coordinated response to air quality management issues is the commencement of a long term health impact study led by the Department of Environmental Affairs and Development Planning.

6.3 Ambient air quality monitoring

The Department of Environmental Affairs and Development Planning operated nine monitoring stations across the province in 2011, as compared to three during 2008 (DEADP 2011). The plan is to expand this network to at least 12 stations during 2013. Concern is expressed in the State of Air Quality Report (DEADP 2011) over the challenges in maintaining the air quality monitoring stations. Monitoring data losses due to electrical and instrumentation challenges are described in some instances as 'significant'.

Of the list of monitoring stations in use in 2011, three were located in Eden District, namely at Dana Bay, Oudtshoorn (Bongolethu Clinic) and George. Two stations were located in the West Coast (Malmesbury and St. Helena Bay), two in the Cape Winelands (Worcester and Stellenbosch) and two in the City of Cape Town (Khayelitsha and Vissershok).

Table 1 below provides a list of the monitoring stations operated by DEADP in the Western Cape between 2008 and 2013. Discontinuance at certain stations is indicative of the monitoring stations being relocated to more appropriate positions.

Table 1: DEADP monitoring stations and measured parameters (DEADP 2011)

<table>
<tr><th rowspan="2">Station Name</th><th colspan="5">Year Operational</th><th rowspan="2">Measured parameters</th></tr>
<tr><th>2008-2009</th><th>2009-2010</th><th>2010-2011</th><th>2011-2012</th><th>2012-2013</th></tr>
<tr><td>Paarl</td><td>M</td><td></td><td></td><td></td><td></td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Worcester Electrical Sub-station</td><td></td><td colspan="4">Monitoring</td><td>PM_{10}, NO_2, SO_2,O_3,VOC, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Stellenbosch</td><td></td><td></td><td></td><td colspan="2">Monitoring</td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Mossel Bay</td><td colspan="2">Monitoring</td><td></td><td></td><td></td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>George Municipal Swimming Pool</td><td></td><td></td><td colspan="3">Monitoring</td><td>PM_{10}, NO_2, SO_2,O_3,VOC, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Dana Bay (Residential Area)</td><td></td><td></td><td></td><td colspan="2">Monitoring</td><td>VOC, CO_2 and H_2S</td></tr>
<tr><td>Oudtshoorn (Bongolethu Clinic)</td><td></td><td></td><td colspan="3">Monitoring</td><td>VOC, CO_2 and H_2S</td></tr>
<tr><td>Vredenburg / Saldanha</td><td colspan="2">Monitoring</td><td></td><td></td><td></td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Malmesbury</td><td></td><td></td><td colspan="3">Monitoring</td><td>PM_{10}, NO_2, SO_2,O_3,VOC, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>St. Helena Bay</td><td></td><td></td><td colspan="3">Monitoring</td><td>VOC, CO_2 and H_2S</td></tr>
<tr><td>Hermanus</td><td></td><td></td><td></td><td></td><td>M</td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Caledon</td><td></td><td></td><td></td><td></td><td>M</td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Maitland</td><td></td><td></td><td>M</td><td></td><td></td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Vissershok (Residential Area)</td><td></td><td></td><td></td><td colspan="2">Monitoring</td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Hout Bay</td><td></td><td></td><td></td><td></td><td>M</td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
<tr><td>Khayelitsha Training Centre</td><td></td><td></td><td></td><td colspan="2">Monitoring</td><td>PM_{10}, NO_2, SO_2,O_3, CO, CO_2, H_2S, BTEX and meteorological</td></tr>
</table>

M = monitoring

Routine passive sampling also takes place at various industries or activities throughout the province where air pollution can become a threat, and in addition, the Cape Metropolitan area also has thirteen additional air quality monitoring stations operated by the City of Cape Town Scientific Services. These stations monitor CO, CO_2, SO_2, NO_2 and

PM in order to inform planning and management, and respond to specific pollution incidences.

The municipal and private monitoring stations are listed in Table 2.

Table 2: Other air quality monitoring stations

Organisation	Station Name	Measured parameters
City of Cape Town Metropolitan Municipality	Athlone	SO_2
	Atlantis	NO_x
	Belville South	PM_{10}, SO_2
	Bothasig	NO, NO_2, NO_x, SO_2, H_2S and Meteorological
	Central Cape Town City Hall	NO, NO_2, NO_x, SO_2, CO
	Central Cape Town – Molteno Reservoir	O_3
	Foreshore	PM_{10}, VOC
	Goodwood	PM_{10}, NO, NO_2, NO_x, SO_2, CO, O_3 and Meteorological
	Khayelitsha	VOC, PM_{10}, NO, NO_2, NO_x, SO_2
	Killarney	PM_{10}, NO, NO_2, NO_x, SO_2, H_2S, VOC
	Potsdam	H_2S, TRS
	Somerset West	NO, NO_2, NO_x, SO_2, PM_{10},
	Table View	NO, NO_2, NO_x, SO_2, H_2S, PM_{10} and Meteorological
	Wallacedene	NO, NO_2, NO_x, SO_2, PM_{10},CO, O_3
Chevron	Milnerton	BTEX (passive samplers)
Cape Town International Airport	Northern edge of the airport property	PM_{10}, NO_x, SO_2, O_3,BTEX
SAWS	Cape point global atmospheric watch station	CO_2, CO,O_3 and Meteorological
PetroSA	Mossel Bay: Passive sampling at PetroSA GTL refinery	NO_2, SO_2 and Benzene
Mittal Steel	Saldanha Bay	PM_{10}, SO_2, H_2S and Meteorological
Portnet	Saldanha Bay: Blue water bay, port of Saldanha and surrounding area	PM_{10}, Meteorological, Dust fallout monitoring
	Vredenburg	PM_{10}, Dust fallout monitoring

6.4 Authority structures and mandates

Air quality management in the Western Cape is administered through a dedicated Air Quality Management unit set up in the DEADP Directorate: Pollution Management, along with a Provincial Air Quality Officer as well as District Air Quality Officers in the various District and Local Municipalities. The Central Karoo is the only District without an Air Quality Officer, whilst 12 of the 24 Local Municipalities lack officers.

Significant efforts are being made to capacitate the various local authorities sufficiently to take over the role as licensing authorities (DEADP 2011). Unfortunately, significant capacity constraints remain at local level, both in terms of financial and human resources. This results in often poor levels of implementation of the constitutional obligation to ensure a healthy living environment for citizens. Capacity constraints, in conjunction with the lack of real-time air pollution information, also prevent rapid response to pollution incidents.

An important aspect of air quality management that is often overlooked is the role of implementing agents – e.g. transport planning, the energy sector or human settlements planning. Air quality management is not about mere monitoring of pollution levels and redress of non-compliance, but should include pro-active design and planning that will integrate positive emissions profiles into day-to-day social and economic functioning.

6.5 Policy, tools and legislation

The Bill of Rights enshrined in the Constitution states that South Africans have the right to an environment that is not harmful to their health and well-being. To enable and support this right the National Environmental Management Act (NEMA) (Act No. 107 of 1998) and National Environmental Management: Air Quality Act (NEM:AQA) (Act No. 39 of 2004) were promulgated to create the various mechanisms through which control over air quality in South Africa can be exercised. The main objective of the National Environmental Management: Air Quality Act (NEM:AQA) (Act No. 39 of 2004) may be summarised as the protection of the environment and human health, in a sustainable development framework, through reasonable measures of air pollution control.

To further give effect to the public right to a healthy living environment, municipalities were recently granted executive authority over air pollution control within their areas of jurisdiction. An appropriate contribution from each municipality within the province, in conjunction with oversight from the provincial government, is required to ensure the implementation of the NEM: AQA across the province.

In terms of local authority air quality management by-laws, by 2011 the City of Cape Town's by-law was approved by its Council; the West Coast District's by-law was submitted for vetting to their legal services; the Eden District's by-laws have gone through a public participation process and was to be reviewed by its Council; and the Cape Winelands District Municipality's by-law was in draft form (DEADP 2011).

Responses in the form of policies, tools and legislation across all scales applicable to this theme are listed in the summary table below:

Table 3: Summary of policy, tools and legislation

International Responses	1998	Clean Air Initiative Africa
	1998	Air Pollution Information Network Africa
	2002	Kyoto Protocol (Ratified by South Africa in March 2002)
National Responses	2004	National Environmental Management: Air Quality Act No 39 of 2004
	2007	National Framework for Air Quality Management
	2011	National Climate Change Response White Paper
Provincial Responses	2010	Western Cape Air Quality Management Plan
Local Authority Responses	1997 & 2004	Brown Haze studies 1 and 2
	2005	City of Cape Town Air Quality Management Plan
	2010	City of Cape Town Air Quality Management By-Law (sets limits for light obscuration from tailpipe emissions for compression ignition engines i.e. diesel vehicles)
	various	Air Quality Management Plans of Drakenstein, Eden, West Coast, Cape Winelands

	2005	The Cape Town Energy and Climate Change Strategy
	2009	City of Cape Town Fleet Greening Framework

7 CONCLUSION

OUTLOOK: STABLE

Air Pollution knows no boundaries, as pollutants can easily travel from one locality to another. By reducing air pollution we can assist in reducing respiratory illness and the adverse effects on the environment. The major drivers of air pollution differ between the districts, but include mostly industrialisation, the transport sector and the use of domestic fuels for cooking and heating purposes.

The number of air quality monitoring stations within the province has increased steadily which assists authorities in gaining a better understanding of the state of air quality. As reported in the Air Quality Management Plan in 2011 (DEADP 2011), the overall air quality situation within the Western Cape Province is positive, with a gradual improvement evident. Ambient levels for most pollutants are below the minimum standards set on a national basis, although various hotspots of poor air quality remain. Ongoing management is required in order to maintain acceptable levels of air quality.

The City of Cape Town Metropolitan area remains the biggest contributor to atmospheric pollution as it is the area of highest economic activity and population density. Specific concerns are present in Khayelitsha, as the local pollution monitoring shows pollutant concentrations at or above acceptable standards. Additional monitoring undertaken in this area would help in determining the spatial and temporal extent of pollution sources and concentrations, and hopefully allow for an improvement in air quality in this and similar sensitive areas.

The absence of consistent long term air quality monitoring records is a limiting factor for air quality management. It is therefore imperative that more consistent monitoring be undertaken, a better spatial coverage be achieved and that operational procedures and processes for instrument repair and maintenance be reviewed to allow for more rapid replacement of instruments at air quality monitoring stations in order to reduce data losses (DEADP 2011).

Effective air quality management will also need effective engagement and cooperation between spheres of government, as well as between different planning processes. An integrated approach that will result in mutually reinforcing responsible planning and system design will be the most effective means of limiting the extent to which reactive abatement actions will be required. For example, if spatial planning can effect an efficient city form, it will improve the efficiency of transportation and, in turn, improve the overall air quality.

The findings of the Air Quality chapter can be summarised as an overall stable outlook. Table 4 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action. Table 5 contains the anticipated changes or outlook for the future of Air Quality, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding.

Table 4: Summary of key aspects identified in the chapter

Aspect	Summary of key points
Pressures	• Transportation (especially diesel) • Domestic fuel burning • Urbanisation
Impacts	• Brown haze • Indoor air pollution • Carbon footprint
Challenges	• Future shale gas exploration • Transportation • Obstacles to implementation of renewable and micro-generation solutions
Progress	• Roll-out of monitoring stations • Generally good air quality
Critical areas for action	• Improve coverage of monitoring network • Remove obstacles to innovative (green) urban development • Revolutionize transportation systems

Table 5: Summary of the outlook for air quality based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend
Atmospheric pollutants	• Particulate matter (PM_{10}) – below threshold but shows steady increase • Nitrogen oxides (NO, NO_x) – acceptable but problems at certain locations • Sulphur dioxide (SO_2) – below threshold • Green House Gases (GHG) – levels increasing	Insufficient data

District breakdown	• City of Cape Town – higher concentrations of all parameters
	  ○ General problem in the form of smog ('brown haze') – linked to vehicle emissions
	  ○ Cape Flats – high PM_{10} and volatile organic compounds (VOC) – due to domestic fuel burning, traffic and industry
	• Cape Winelands – high particulate matter (PM) and NO_2, linked to fugitive agricultural spraying
	• Central Karoo – transportation related emissions
	• Eden emissions – concentrations at PetroSA, Oudtshoorn (tanneries and abattoirs)
	• Overberg – has highest per capita vehicle ownership, indicating potential issues over time
	• West Coast – concentrated emissions from industries using coal, red oxide dust from iron ore handling at the Saldanha port, mines (e.g. dust from lime production, Matzikama), and aqua/mariculture industries (e.g. St. Helena Bay fishmeal production)
		No change

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BETTER TOGETHER.

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Climate Change Chapter

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1 INTRODUCTION

The earth's climate systems have demonstrably changed on both global and regional scales since the pre-industrial era. The 1990s were the warmest decade in the instrumental record since 1861.The years 2010 and 2005 were noted as the two warmest years for the planet (NOAA 2012) on record. Increasing evidence and scientific consensus have now shown beyond any doubt that the warming trend of the past five decades is attributable to human transformation of the earth's surface and atmosphere. Human activities lead to the emission of gases which accumulate in the atmosphere and trap radiation in a way similar to a horticultural greenhouse. This progressively heats up the earth's atmosphere and surface and disrupts the normal functioning of the climate system. The end result is shifting weather patterns, increased severity of climatic events and a universal rise in global surface temperature and sea levels. Cascading effects then affect biological life and the steady state of many of earth's surface features.

There is a growing understanding that the climate system exhibits a significant 'lag' period between the time when artificial forcing is taking place and the eventual responses from the climate system. This means that the human activities will only translate into climatic effects several decades after the initial events. It also means that because of activities that took place during the previous century, we are already locked into global temperature increases of at least 2°C, irrespective of how drastic our current and future mitigation efforts will be (Peters *et al*. 2013).

According to projections, climate change will bring about an increase in average temperatures and possibly lower rainfall to the Western Cape (Midgley *et al*. 2005), although there is a significant range of uncertainty related to the precipitation projections. The draft Western Cape Climate Change Response Strategy (WCG 2012) summarises the expected changes to include:

- Higher mean annual temperature;
- Higher maximum temperatures, more hot days and more heat waves;
- Higher minimum temperatures, as well as fewer cold days and frost days;
- General decrease in precipitation;
- Increased severity of drought;
- Increased intensity of extreme events; and
- Increased mean sea level.

The purpose of this chapter of the Western Cape State of Environment Outlook Report is to profile the expected changes in climate, and evaluate both the causes of the changes and the impacts that the changes will have for both the biophysical and human environments. In profiling climate change, two indicators are used – Projected changes to the climate system, and Carbon Footprint. Respectively, these indicators show what is happening in terms of the natural and human dimensions of climate change.

Importantly though, the chapter also considers how the Western Cape Province is responding to the projected changes, whether through mitigation of the contribution to climate change or as adaptation to the expected impacts.

Understanding Climate Change

The process of 'climate change', as understood in terms of human (anthropogenic) disturbances of the climate system, relates to the intensification of the earth's natural greenhouse effect. Because of the composition of the earth's atmosphere, the atmosphere serves as a 'blanket' that allows radiation coming in from the sun through but traps a large component of the radiation from the earth's surface. This effect allows the earth's surface and atmospheric layers immediately above it, the so-called 'troposphere', to remain at temperatures that can sustain life as we know it. However, human activities during the last fifty years or so have altered the composition of the atmosphere enough to increase the amount of heat that is trapped in the troposphere, which leads to a gradual alteration of the climate.

The gases or substances responsible for the alteration of the radiation balance are collectively known as greenhouse gases (GHG), and include water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3) and particulate matter (especially $PM_{2.5}$ and PM_{10}, which refers to particulate matter smaller than 2.5 or 10 microns (µm) in size). Most human activities increase or decrease the amount of these substances found in the atmosphere, thereby causing climate change. Activities that result in especially high emissions of greenhouse gases include the burning of fossil fuels such as coal, oil or natural gas.

2 PRESSURES AND DRIVERS OF CHANGE

Human activities can be seen as the drivers and pressures determining the scope and extent of climate change, due to their inherent or embodied contribution to the intensification of the greenhouse effect. Typically, the sectors acting as main drivers of climate change include transportation, industry, residential and commerce. They influence the climate primarily through the consumption of non-renewable forms of energy, inefficient energy use and the release of greenhouse gases (GHG) as by-products (WCG 2013). In addition, various forms of agriculture contribute to climate change through the use of agricultural chemicals and land transformation.

2.1 Drivers

2.1.1 Energy

Fossil fuel related carbon dioxide (CO_2) and solid waste related methane (CH_4) releases comprise the vast majority of the country's climate change inducing emissions, with the other greenhouse gases contributing marginally to the overall inventory (WCG 2013). It is therefore worthwhile to consider the use of energy in the Western Cape as a driver of climate change, and in order to profile the province in terms of its main greenhouse gas emissions.

Whilst some information on the relationship between energy, emissions and climate change is provided in this chapter, the reader is encouraged to access more comprehensive information on the energy sector in the Western Cape in the chapter on Energy.

Large scale generation and use of energy emit air pollutants and greenhouse gases such as carbon dioxide, methane and nitrous oxide (N_2O). According to the Intergovernmental Panel on Climate Change (IPCC), the supply of energy alone contributes about 25% of the world's greenhouse gases, with significant further emissions generated through the use of energy (IPCC 2007). The amount of energy consumed and the efficiency with which it is applied are therefore significant determinants of the rate and scale of climate change.

2.1.2 Land use change

Next to the generation and use of energy, land use change ranks as one of the most important drivers of climate change. Changes to the earth's surface take many forms, but where they affect natural climatic processes they do influence climatic change. Three primary mechanisms are at play – changes to the reflectivity (albedo) of the earth's surface, the release of greenhouse gases into the atmosphere, and the withdrawal of carbon dioxide from the atmosphere.

Activities such as agriculture, deforestation and afforestation, urbanisation, degradation of wetlands and degradation of soils all affect the amount of carbon dioxide that is removed from the atmosphere and stored in biomass or trapped in soils through biochemical processes. These activities typically also go hand-in-hand with the actual release of greenhouse gases through the burning of biomass, application of chemicals, or consumption of energy. This serves to skew the carbon balance towards a nett accumulation of carbon dioxide and other greenhouse gases in the atmosphere.

Additionally, extensive changes to the surface of the planet, such as large scale deforestation or urbanisation, also changes its reflectivity which affects the radiation balance in the atmosphere. The same is true for activities that generate significant amounts of dust, particulate matter, water vapour and general air pollution.

2.2 Pressures

Comparisons of energy use for different economic sectors in the Western Cape for 2009 indicate that transportation accounted for 52% of energy use, industrial uses for 34% and the residential/household sector for some 9% of energy consumption (WCG 2013). With their transportation needs omitted, the local government and agriculture spheres combined contribute less than 2%. This sectoral breakdown for 2009 is shown in Figure 1.

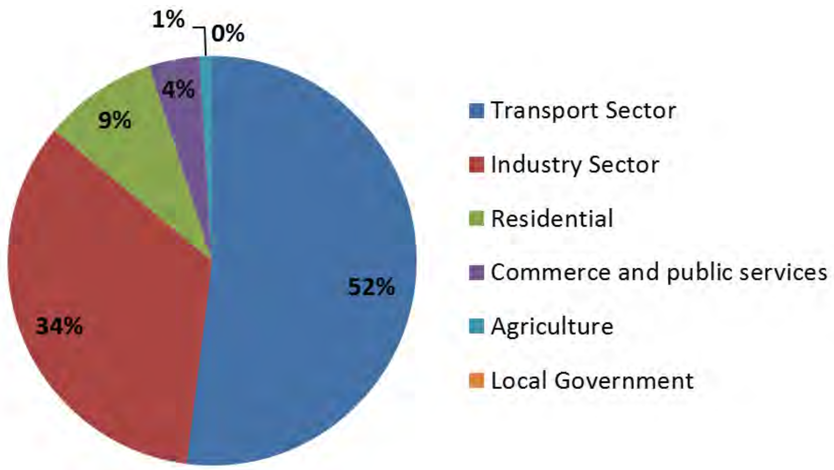


Figure 1: Western Cape energy use by sector in 2009 (WCG 2013)

2.2.1 Transportation

Transportation is shown to be the highest single consumer of energy in the Western Cape. This also translates into making the sector the second highest emitter of greenhouse gases (WCG 2013). However, transportation is one of the core foundations on which all economic activities are based, and a primary constituent of urban systems. It is therefore a pressure on the climate system that cannot be avoided.

What should however be recognised is that transportation contributes to climate change in several different ways, which includes greenhouse gas emissions from powers stations in addition to direct emissions from vehicles. The different levels of access to, as well as the types of transport, also determine user behaviour and resulting impacts on the energy intensity of human activities. Furthermore, transportation networks often require large tracks of land for infrastructure development, which contributes to the overall effect that land use change has on climate change.

2.2.2 Built environment

Between the residential, public service and commerce sectors, the built environment consumes some 13% of total energy in the province (WCG 2013). This energy use, and the consequent impact on climate change, is determined by the characteristics of buildings. Thermal inefficiency and unnecessary reliance on non-renewable energy sources are the prime reasons why buildings have high energy consumption and GHG footprints.

In terms of industrial hubs in the Western Cape, the major clusters are located in the Cape Town, Stellenbosch, Saldanha Bay and Mossel Bay areas. These rely heavily on electricity and coal, and therefore also emit high amounts of greenhouse gases.

2.2.3 Solid waste

Apart from fossil fuel related carbon dioxide emissions associated with energy consumption, solid waste related methane releases comprise the majority of the country's climate change inducing emissions; other greenhouse gases contribute only marginally to the overall inventory (WCG 2013). When considered as a sector, solid waste decomposition accounts for 5% of the total provincial GHG emissions. This is in line with international trends of 3-5% (UNEP 2010).

Solid waste generates greenhouse gases through the process of decomposition and subsequent release of the embedded carbon. Typically, compacted and covered landfills create optimum conditions for anaerobic decomposition and a subsequent build-up and slow release of methane and carbon dioxide. However, incineration of waste using, for example, cement kilns can also release GHG emissions to the atmosphere, as can the vehicles used to collect the municipal waste from various sources such as households, commercial businesses and hospitals.

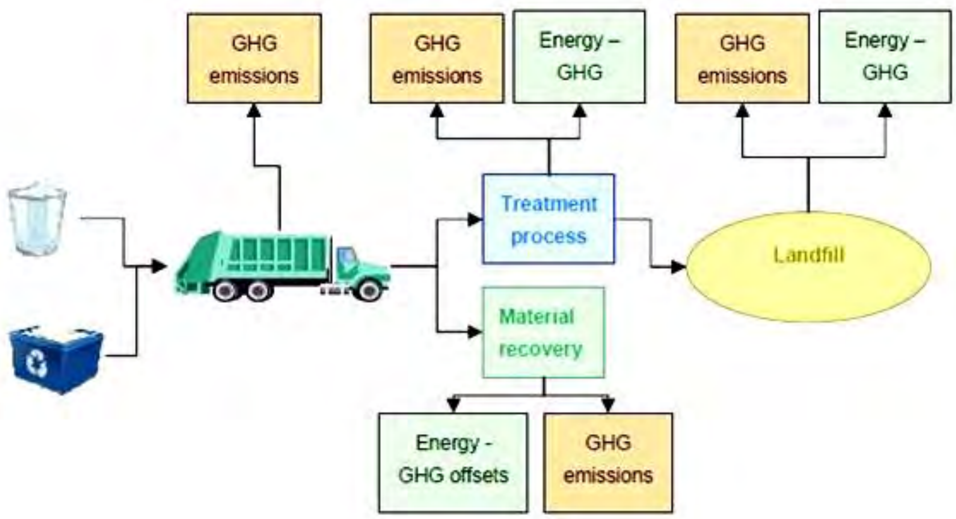


Figure 2: Schematic diagram of waste management related GHG emissions (UNEP 2010)

2.2.4 Agriculture

The agricultural sector has notable effects on climate change, primarily through the production and release of greenhouse gases such as carbon dioxide, methane, and nitrous oxide, but also through transformation of land cover. Conversion of land cover releases carbon stored in biomass and soils, and changes the reflectivity of the land surface.

According to the Intergovernmental Panel on Climate Change (IPCC), agriculture is responsible for methane and nitrous oxide emissions related to human activities, which are approximately 13.5% of all GHG emissions (IPCC 2007). Unfortunately, an accurate inventory for emissions from agricultural sources does not exist for either the Western Cape or the country as a whole, with the most recent full GHG inventory dating from 2000 (WCG 2013; DEAT 2009). This problem is currently being addressed, with the National Department of Environmental Affairs updating the GHG emissions inventory for the country. An updated inventory is expected to be released during 2013. According to the IPCC guidelines that are used for national reporting in terms of the United Nations Framework Convention for Climate Change (UNFCCC), agricultural, land use, land use change and forestry contributions need to be reported on.

3 STATE

The climate projections for the region indicate not only a warming trend as with the rest of the country, but also a projected drying trend, with longer time periods between increasingly intense rainfall events. In addition, sea level rise and other biological changes due to a rise in ocean temperatures can be expected.

Tracked indicators of *status* of Climate Change:

- Carbon footprint
- Climate change induced stress (anticipated changes)

The Western Cape climate system

The Western Cape is typified by a Mediterranean climate, comprising of cool wet winters and hot dry summers. The climate is primarily determined by a band of low pressure systems that move from west to east in the mid-latitudes, between about 23 and 60 degrees South. These systems shift northwards in winter and back south in summer. Rainfall and cold fronts are associated with the low pressure systems, and with more of the systems passing over the Western Cape during the winter, they bring about cold temperatures and rainfall in the form of prolonged light showers. Droughts result when the systems do not shift northwards for long enough to bring about sufficient rain.

The influence of the warm Agulhas ocean current running up the East coast mitigates the effects of the cold fronts, leaving the eastern parts of the province with a very mild climate. Mountain ranges stretching north-south along the west coast and east-west in the south augment the coastal rainfall through orographic rain but act as barriers that create a dry interior.

On a more local scale, the presence of mountain ranges close to the coastline influences the amount of rain received by inland areas in the rain shadow. Coastal low pressure systems can also give rise to reversed air flow over the mountains and resultant hot dry "berg" winds and extreme warm conditions on the coastal side of the mountains, generally during late winter and early spring.

Frontal systems sometimes result in cut-off low pressure conditions during spring and autumn that may cause extreme rainfall events and flooding over South Africa as a whole.

3.1 Projected changes to climate patterns

The Western Cape is projected to experience a range of changes to the local climate as a result of global warming. Broadly speaking, it is expected that minimum temperatures in late summer and late winter will be warmer, very hot days will become more frequent, and rainfall could decline (Midgley *et al*. 2005).

3.1.1 Temperature

Global average temperature is indisputably on the rise (NOAA 2012). Records indicate that the Western Cape is no exception, with a warming trend for nearly the whole province, increasing with distance from the coast (DEADP 2007).

Expected changes for the future maintain this trend:

- A minimum of 1°C warming by the late 2030s as compared to the second half of the 20th century, and warmer minimum temperatures.
- The warming trend increases from the south-west to the north-east.
- Warming is most pronounced in the spring and summer months.

3.1.2 Precipitation

Modelling of future changes to patterns of precipitation (e.g. rain, snow, drizzle, hail, etc.) is still an uncertain science, especially in areas such as the Western Cape where the complex arrangement of mountains and oceans make fine detail projections difficult. Fine scale trends are therefore still uncertain, although mostly in terms of magnitude rather than overall pattern of change. It can therefore only be said that there will be a general drying trend towards the west away from the mountains, with less certain projections for other seasonal and spatial effects (DEADP 2007).

Current modelling and analysis (DEADP 2007) suggests that:

- In the far south-west of the province there is a general decrease in precipitation in all seasons. The decrease is strongest in early and mid-winter. These changes are likely to lead to an associated decrease in water availability.
- In the eastern coastal regions there are likely to be moderate increases in the early winter, with moderate decreases in late winter.
- In the interior arid zones to the north-east there are likely to be small increases in rainfall.
- The different projections show general agreement for a shorter winter rainfall season.
- The specific location of the boundaries between regions of stronger increases or decreases is a point of uncertainty. The western coastal mountains are one important feature that delineates a boundary.
- For the most part the spatial pattern of change in the number of rain days and the amount of rain per rainfall event mirrors that of the change in monthly totals, although the finer regional details show some exceptions.

As is evident in a number of the listed projections, large scale drying is expected across the province. In contrast, however, there are also areas where local scale increased precipitation is projected, for example in the mountains stretching from Cape Town through to the southern Cape.

3.1.3 Wind

Average wind velocity will increase, which is likely to be the result of a stronger and more dominant South Atlantic high pressure system (DEADP 2007). Specific changes to be expected are:

- Mild to moderate increases in wind velocity in summer, autumn and spring.
- Moderate to strong increases in winter (associated with stronger storm systems).
- Increased wind velocity when accompanied by corresponding drying will increase fire risk and evaporation potential.

3.1.4 Sea level

The Western Cape can expect a slow but inevitable rise in sea levels. Regional sea level rise rates of respectively ~1.97mm/yr and ~2.00mm/yr for Simon's Town and Knysna have been observed in recent years (Mather *et al*. 2009). This implies ~5cm over 25 years if rates remain constant. However, recent indications are that global projections might be too low (Rahmstorf *et al*. 2012).

3.2 Carbon footprint

3.2.1 Calculation of the carbon footprint

A carbon footprint 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 combines the amount of pure carbon dioxide emitted with 'effective' carbon dioxide emissions due to other greenhouse gases. The 'effective' emissions are calculated based on the global warming effect of other gases relative to that of carbon dioxide.

The amount of carbon dioxide equivalent generated by direct emissions (emissions which occur at the point of consumption e.g. transportation, heating and cooling of homes and the burning of gas, oil or other fossil fuels) is calculated through the use of emission factors associated to specific energy carriers (fuels). An emission factor is the ratio of carbon dioxide equivalent generated for a given quantity of fuel. Indirect emissions (secondary emissions that are not occurring from the point of consumption e.g. electricity generated from the power station) is estimated through the use of electrical emission coefficients. For example, areas that depend on coal for power generation have higher coefficients than areas using oil. Hydroelectric power has the lowest coefficient since it does not rely on combustion for power generation.

Under the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto protocol, greenhouse gas inventories compiled by Annex I countries must include information on the following elements (UNFCCC 2004):

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Family of Hydrofluorocarbon gases (HFC)
- Family of Perfluorocarbon gases (PFC)
- Sulphur hexafluoride (SF_6)
- as well as for the indrect greenhouse gases such as SO_2, NO_x, CO and NMVOC.

3.2.2 Western Cape carbon footprint

The Carbon Footprint for the Western Cape refers not only to the carbon dioxide that is produced locally through activities such as vehicle emissions and industry, but also emissions of other greenhouse gases and the emissions produced elsewhere in South Africa such as coal fired power stations within the Mpumalanga Province that support the energy supply of the Western Cape Province. A rough calculation of the provincial carbon footprint based on 2009 data is found in the Energy Consumption and CO_2 Emissions Database for the Western Cape (WCG 2013). The inventory calculated the footprint based on carbon dioxide, methane and nitrous oxide emitted through the consumption of energy and disposal of solid waste. Further refinements of the footprint are possible, but due to the lack of readily available information and the significant dominance of energy and solid waste in terms of GHG emissions, only these two sectors were included. Refinements in future can include adding the carbon cost of land transformation, HFC, SF_6 and PFC emissions, as well as embedded emissions related to the production of most goods bought or consumed in the province. This information is, however, difficult and time consuming to access and collate and does not necessarily add substantial value.

According to the Database, the province emitted 41 303 482 tonnes of CO_2e during 2009, which translates into approximately 8 tonnes per capita and 178 tonnes per million Rand contribution to Gross Domestic Product (GDP) based on 2009 population and GDP figures (WCG 2013).

For reference - in 2004, the calculation for the Western Cape, based solely on energy use, was 30 257 000 tonnes of CO_2e (DEADP 2007), compared to 17 000 000 tonnes of CO_2 in total and 5.8 tonnes per capita in 2000/2001 (DEADP 2005). The comparison is shown in Figure 3.

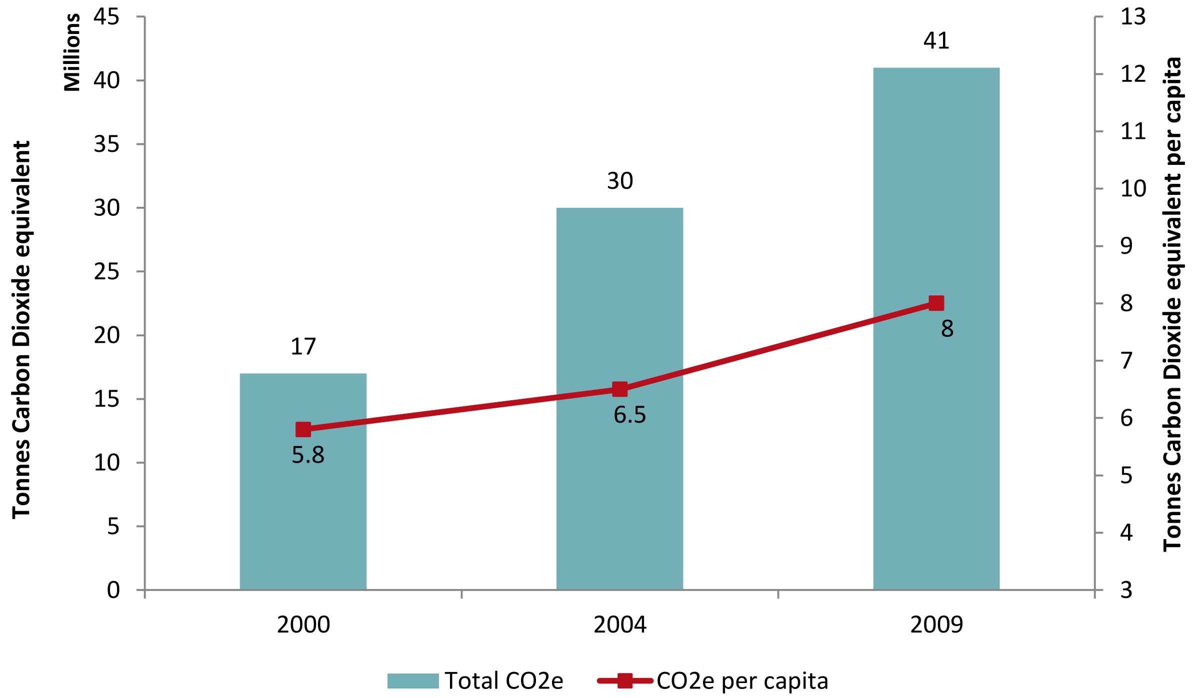


Figure 3: Western Cape emissions as total and per capita Carbon Dioxide Equivalent (DEADP 2005; DEADP 2007; WCG 2013)

Electricity is by far the largest source of GHG emissions in the province, accounting for 53% of total emissions (21 891 661 metric tonnes CO_2e). This is virtually the same as in 2004 when electricity was calculated at 52%, although the figures are only indicative due to differing data collection and analysis methods.

28% of the total GHG emissions originate from the transport sector, with industries contributing 36% and the residential sector 17% (Figure 4)(WCG 2013).

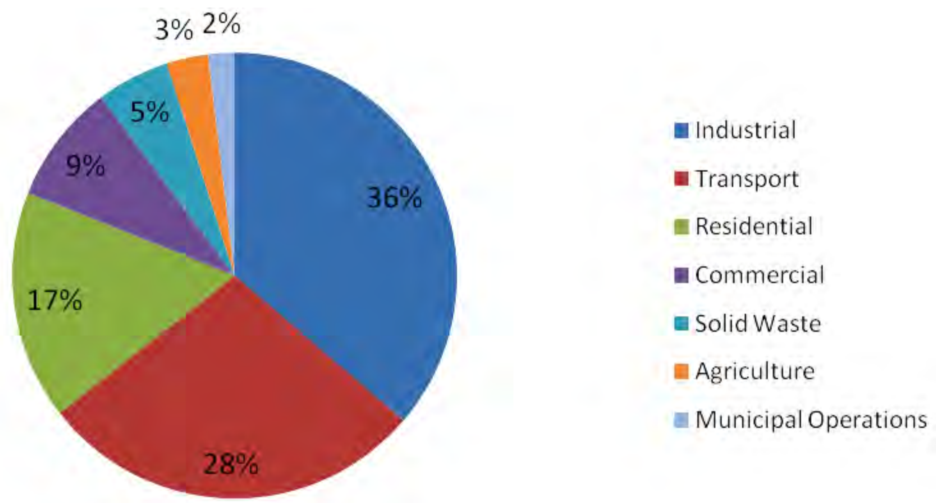


Figure 4: Western Cape energy and waste-related GHG emissions by sector for 2009 (WCG 2013)

Energy emissions from all sources of combustion were estimated using the IPCC Good Practice Guideline Tier 1 Method (simple methods with default values) where carbon dioxide emissions from fuel combustions are estimated by multiplying the amount of fuel used (taken from national/municipal statistics) with a fuel-specific default carbon dioxide emission factor. It is important to note that South Africa hasn't developed its own country-specific emission factors for a number of emission sources. This method, although accurate for carbon dioxide emissions, is less accurate for non-carbon dioxide gases because emission factors for these gases may depend considerably on the combustion technology and operating conditions (WCG 2013).

3.2.3 Municipal profiles

As the implementing agents of economic growth, development and innovation, municipalities need to recognise the challenges posed by climate change impacts, but importantly also their respective contributions to climatic change. This requires watchful management and care in protecting our natural resources to ensure sufficient availability of resources for both the current and future populations.

The Energy Consumption and CO_2 Emissions Database for the Western Cape (WCG 2013), profiled municipalities in terms of the overall GHG emissions in the municipal area, the GHG emissions directly attributable to fuel use and solid waste management ("Scope 1"), emissions from electricity use ("Scope 2") as well as the marine and air travel emissions ("Scope 3"). The results are presented in Table 1.

As can be expected, the highest emissions are recorded against the City of Cape Town (57%), with the West Coast a distant second (22%). The Central Karoo district municipality produces the least (1%) of the province's total emissions. This is likely due to the low industrial activity taking place in this district as well as the relatively small population.

Table 1: District energy- and waste-related emissions by scope (WCG 2013)

	Scope 1 - Total direct GHG emissions (tCO_2e)	Scope 2 - Total indirect GHG emissions (tCO_2e)	Scope 3 - Total indirect (air & marine travel) (tCO_2e)	TOTAL GHG Emissions (tCO_2e)
Central Karoo	210,178	157,985	82	**368,245**
Overberg	331,309	807,745	5,207	**1,144,261**
Eden	1,105,927	2,500,068	28,805	**3,634,800**
Cape Winelands	1,793,589	2,702,291	1,105	**4,496,985**
West Coast	6,298,587	3,294,488	2,958	**9,596,033**
City of Cape Town	7,286,060	12,957,497	4,777,317	**25,020,874**
Provincial Total per Score	17,025,650	22,420,074	4,815,474	**44,261,198**

Analysis of the specific emissions per District shows that emissions associated with electricity consumption are the dominant source of emissions in each district municipality ("Scope 2" emissions in Figure 5). The West Coast and Central Karoo Districts are the only exceptions to the rule, with "Scope 1" emissions (fuel use and waste disposal) that exceed Scope 2 emissions. In the West Coast District it can be attributed to the energy intensive industries e.g. the Arcelor Mittal-owned Saldanha iron & steel plant, PPC cement production and Namakwa Sands which undertake the mining and beneficiation of heavy minerals. Most of these operations consume coal directly. The emissions in the Central Karoo would be related to the use of liquid fuels for road transport.

"Scope 3" emissions associated with the aviation industry and the marine sectors are higher in the Cape Town metro than in any of the other district municipalities. This is due to the fact that this city hosts a major international airport as well as some important national harbours and ports. Eden's George airport has a much smaller contribution (WCG 2013).

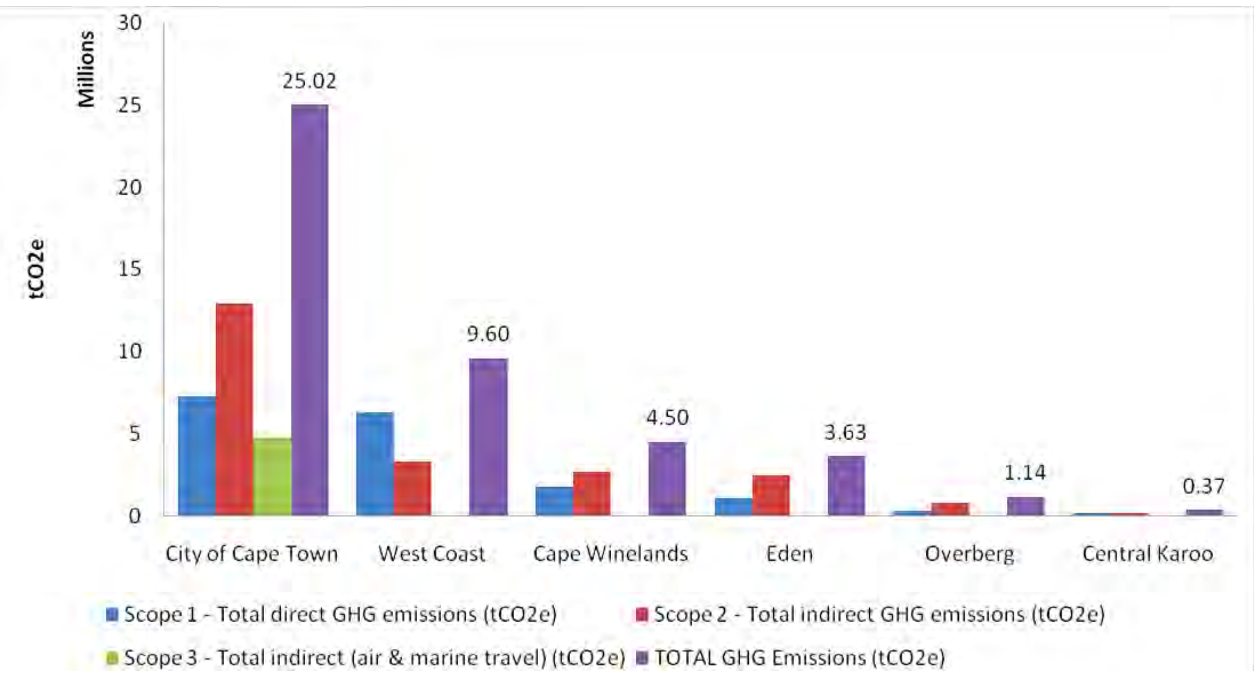


Figure 5: Energy- and waste-related GHG emissions by scope per district municipality in the Western Cape (WCG 2013)

Applying a per capita analysis of the GHG emissions across the district municipalities in the province provides a rather different picture since a large absolute GHG emissions figure does not necessarily translate to a high per capita emissions figure (Figure 6).

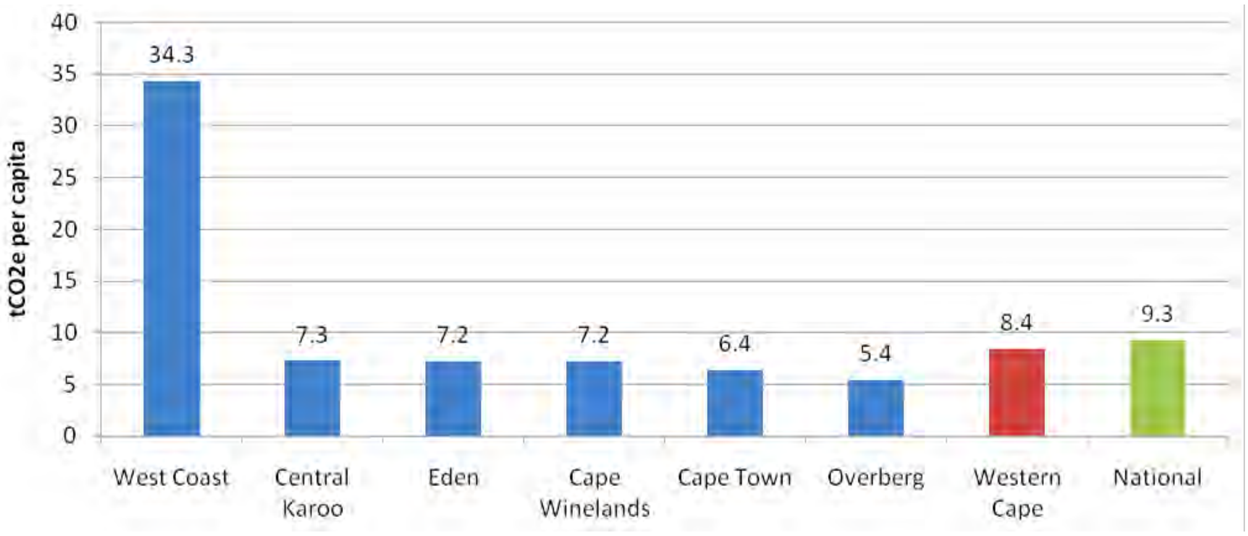


Figure 6: Per capita energy- and waste-related emissions comparison across district municipalities in the Western Cape (WCG 2013)

On a per capita basis, the West Coast appears as an outlier. It has a per capita emissions figure nearly five times as high as the next highest, the Central Karoo. Despite the City of Cape Town being the largest source of absolute emissions (57%) in the province, it lies jointly with Eden District in third position.

This lack of correlation between per capita and total emissions is as a result of the low population levels in the West Coast and Central Karoo combined with, respectively, GHG-intensive industries and a high amount of liquid fuel use by refuelling traffic that pass through the area on national highways.

4 IMPACTS OF CLIMATE CHANGE

The Western Cape is well acquainted with the effects of climate-related hazards. Between 2003 and 2008 alone, direct damage costs associated with climate related extreme events in the Western Cape amounted to approximately R 3161 million (UCT 2010). These events were mostly storm related flooding, but also included severe hailstorms, strong winds and even a mid-latitude cyclone. The effects of climate change will however be felt on many different levels and relative to different environmental components.

The range of possible impacts is shown in Table 2. The table matches locally relevant impacts to climate change projections, as modelled for the province by the Climate System Analysis Group (CSAG) at the University of Cape Town as part of the Western Cape Climate Change Strategy and Action Plan (DEADP 2007).

Table 2: Climate Change Projections and Potential Impacts

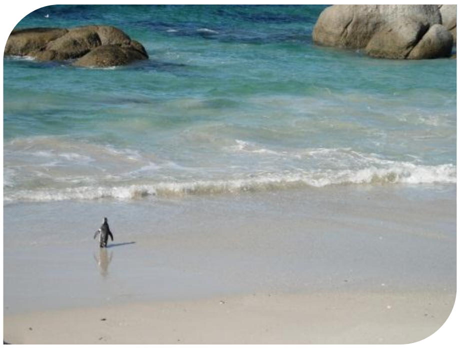
PROJECTION	EXAMPLES OF IMPACTS
Higher mean temperature	• Increased evaporation and decreased water balance • Increased severity of droughts • Increased incidence of pests such as fruit fly
Higher maximum temperatures, more hot days and more heat waves	• Increased incidence of death and serious illness, particularly in older age groups; • Increased heat stress in livestock and wildlife • Increased risk of damage to some crops • Increase susceptibility to crop burning • Increased wild fire danger (frequency and intensity) • Increased threat to infrastructure such as Telkom • Increased electric cooling demand and reduced energy supply reliability
High minimum temperatures, fewer cold days and frost days	• Decreased risk of damage to some crops and increased risk to others • Extended range and activity of some pests and disease vectors • Reduced heating energy demand • Increased risk to crops such as deciduous fruits that rely on cooling period in autumn
Decrease in precipitation	• Decreased average runoff, stream flow • Decreased water quality • Decreased water resources and potential increase in cost of water resources • Decrease in shoulder seasons threatens the Western Cape fruit crops • Increased fire danger (drying factor) • Impacts on rivers and wetland ecosystems
Increased severity of drought	• Decreased crop yields and rangeland productivity • Increased damage to foundations caused by ground shrinkage • Increased fire damage • Reduced economic activity including industry
Increased intensity of extreme events	• Increased risk to human lives and health • Increased storm surge leading to coastal flooding, coastal erosion and damage to coastal infrastructure • Increased damage to coastal ecosystems • Increased soil erosion • Increased pressure of disaster relief systems
Increased mean sea level	• Salt water intrusion into ground water and coastal wetlands • Increased coastal flooding (particularly when combined with storm surges)

4.1 Impacts on biodiversity

Climate change is likely to impact on biodiversity, with changes expected in the distribution of biomes in the Province, possibly more frequent and hotter fires and increased spread of alien invasive plants (DEADP 2007). A warmer and drier climate is likely to lead to a progressive decline in the diversity and distribution of species richness within the Western Cape – specifically the species rich and endemic Fynbos and Succulent Karoo Biomes. Much uncertainty remains, however, with regards to the tolerance levels for different species and biodiversity assemblages. Estimations of species loss point to a 30% loss in diversity (DEADP 2007).

Complex environmental climatic interactions determine the overall and specific effects on biodiversity. For instance, increased summer rain will lead to increases in the amount of grass and fuel for fires in general, which will make fires more intense or shorten the interval between fires. This may have a negative effect on both fauna and flora. For example, while fynbos needs fire as part of its life cycle, too frequent fires may mean that plants do not have time to set seed and therefore they could be eliminated over time. If the projected effects of climate change are considered in conjunction with expected land-use changes, the threats are likely to be exacerbated.

Both slow onset changes and a higher likelihood of extreme events can detrimentally affect biodiversity. For extreme events, any species with a small spatial footprint, low population numbers or other restrictive factors (typically all endangered species) will



struggle to cope with, or recover from, losses experienced during extreme events. The African Penguin (*Spheniscus demersus*), for example, could lose an entire breeding season due to extreme heat stress. A slow onset change in climate that is nevertheless still faster than the time needed for a species to adapt or evolve would result in fauna and flora species failing to find suitable microclimates for survival. This will result in local extinctions. Fauna like reptiles and amphibians can be expected to be quite sensitive to changes in local climate, since they are often dependent on particular microclimates or habitat niches.

Our understanding of how alien invasive species will respond to climate change is currently limited. Some climatic changes such as increased rainfall could enhance their growth or spread, but other changes such as higher temperature could reverse the effect. In most cases, local conditions, species characteristics and contextual biodiversity factors will determine the effect.

4.2 Impacts on water resources

Water resources in South Africa in general, and specifically in the Western Cape, are considered to be under stress. Although the Western Cape is characterised by great variability and relative abundance of water resources, the availability is strongly seasonal and most surface water sources are already fully utilised (Midgley *et al*. 2005; DEADP 2012). Primary users include the farming sector for irrigation purposes, urban areas and industrial applications. Because water is already a limiting factor in most of the province, a general drying of the Western Cape will impact on socio-economic development as well as the integrity of the wetlands, rivers and estuaries (Midgley *et al*. 2005).

As shown in climate change forecasting, a progressive drying of the province towards the south-west is expected. This will reduce surface runoff and slow down the recharge rate of groundwater aquifers. Ultimately, this implies a reduced water yield from both surface and groundwater sources. It is also likely to be exacerbated by the expected increase in temperature and resultant increased evaporation rates (DEADP 2012). Changes to coastal rainfall patterns could also lead to increased salt water intrusion into estuaries and coastal aquifers or raised groundwater tables near the coast.

Everyday demands for water (such as for irrigation and urban uses) will probably increase as rainfall decreases and temperatures rise. A corresponding increase in the frequency of droughts will, however, reduce the availability of water (DEADP 2012). Importantly, and despite growing demands for water supply to the expanding urban areas, sufficient water must legally be left in natural watercourses to maintain their ecological integrity – this is known as the 'ecological reserve'. The resultant pressure on water resources will therefore require more investment in water recovery, transfer schemes to balance water availability between catchments, the intensification of irrigation schemes, as well as water conservation and demand management. Further utilisation of currently underutilised groundwater reserves and water reuse will also become necessary.

4.3 Impacts on agriculture

Agriculture, being inherently dependent on the natural resource base, will be vulnerable to any change in climatic patterns. Changes that will impact on the agricultural sector include decreased rainfall, increased temperatures, increased evaporation rates, absence of required specific low temperatures for certain crops, as well as increases in extreme events such as droughts, floods, hail and frost. The climatic changes can result in reduced soil and water quality and increases in weeds, pests and diseases, with an overall reduction in animal and crop yield and quality. A reduction in output from agriculture will have serious negative impacts on the economy, including a loss of local and national income, reduced employment in the sector and higher food prices. This is likely to impact particularly the rural areas which rely heavily on agriculture as an economic base (DEADP 2012).

The agricultural sector as a whole, but specifically the wine sector, deciduous fruit industries and dryland agriculture, are particularly at risk from climate change. Wine is produced using cultivars of grapes that are appropriate to specific climatic regions and geographic locations. Changes in climate will necessitate adaptation to new microclimatic and location specific conditions, as well as the development of new cultivars and wines which may impact on existing reputations and markets. The fruit industry will be similarly impacted by changing temperatures, since a cooling period is required in autumn to produce export-quality fruit. The change in temperatures might therefore restrict the ranges in which fruit can be produced to high lying areas only (DEADP 2012).

In general though, the fruit industry is expected to be impacted upon more severely by extreme events (predicted to increase with climate change) than by changes in averages. Heat waves normally contribute to 10% of all losses during an average year, but can rise to 50% should temperatures of higher than 35˚ Celsius occur during summer. Farmers in geographically marginal areas (in terms of suitable climate conditions), such as Grabouw, and specifically those with substandard farming practices are expected to be affected most by an increase in temperature and changes in rainfall (DEADP 2012).

The dryland agriculture sector, with extensive presence in the West Coast and Overberg Districts, will be placed under pressure due to lower than expected rainfall, long hot summers, and increasing water scarcity. Irrigation needs will increase, which will place additional stress on the available supply of water.

The intensification of stressors will necessitate adaptation strategies in the agricultural sector, but the level of adaptive capacity will be limited where agricultural practices are already operating at (or close to) thresholds (DEADP 2012). Included in this category of 'at risk' farming are:

- Those that are already under stress economically and/or biophysically as a result of land degradation, salinisation, and loss of biodiversity;
- Those at (or close to) the threshold of their climate tolerance;
- Emerging farmers who may have limited capacity, resources, and skills to adapt to and withstand economic pressures;
- Rural livelihoods that depend on agri-business-based economic activity for jobs;
- Commercial farmers who have made significant long term investments, for example in irrigation systems, processing facilities, and some cultivars; and
- Agri-business activity that is dependent on the export market, which is itself adapting to climate change.

4.4 Impacts on tourism

The Western Cape is greatly dependent on income from tourism. As a well-known destination for natural resource-based tourism activities, such as going to the beach, whale watching, kayaking, mountain hiking, bird watching, wine tasting etc., the province has to ensure that its tourism products are not compromised. Tourism contributes around 10% of the provincial GDP and the industry is recognised as a major employment generator due to its inherent nature as a labour intensive service industry.

Climatic effects that could impact on tourism include increasing sea surface temperatures and the effect on marine ecologies, rising sea levels and the related impacts on beaches and estuaries, as well as increasing adverse weather events such as floods that will cause damage to tourism-related infrastructure (e.g. promenades and waterfront developments, beach resorts and facilities, coastal routes and attractions) (DEADP 2007). The altered climatic conditions will influence biodiversity distributions and migratory patterns, the frequency and intensity of wildfires, availability of water, and the attractiveness of key tourism drawcards such as wildflowers or seafood.

Changes to the climatic conditions that sustain the high quality natural resources could therefore affect the overall sense of place on which the tourism sector is based. Deterioration in the quality of resources or the generally mild climatic patterns, or increase in frequency of destructive natural events, could mean that the attractiveness of the region, especially Cape Town and the Garden Route, fades. This will have knock-on effects on employment in the sector, and the resilience of the local economy in general.

Climate change can also have indirect effects that place pressure on tourism. The international drive towards climate change mitigation, for example, could result in international tourists seeking closer holiday destinations due to increasing costs of long haul flights or the inherent carbon emissions costs associated with such flights (DEADP 2007).

4.5 Impacts on fisheries

Climatic changes that will affect fisheries are related to changes in sea surface temperatures (DEADP 2007) and ocean acidity. The changes may lead to stock decline, an alteration of species distributions, adverse weather, changes to ocean circulation patterns, and reduced larval recruitment. A reduction in catch per unit of effort is likely, with potentially lower incomes flowing to fishing communities.

Shifts in stocks and species will be the cardinal driver of impacts on economies of fisheries. High levels of uncertainty surround observed or projected thermal changes in both the Agulhas and Benguela Currents. Although increased upwelling in the Benguela system due to increased winds associated with the South Atlantic High semi-permanent pressure cell is possible, changing temperature patterns will result in shifting 'nodes of productivity'. Although larger fishing outfits will be able to respond to range shifts, less flexibility is possible for fishermen with smaller boats and specific harbour-based locations along the coast. It is also an open question whether regulatory controls will be able to respond quickly enough to ensure sustainable harvesting, given current uncertainties with regards to the science of estimating the productive capacity and understanding the complexities of marine ecosystems. It also complicates the demarcation and management of Marine Protected Areas as they may not achieve their conservation objectives due to shifting conditions.

Major concerns relate to the overall effect on estuaries, which function as critical fish breeding habitats yet sit at the interface between climate change related alterations of both terrestrial and marine systems. Freshwater requirements of estuarine environments could be compromised through both decreases in rainfall or higher water demands, whilst the marine component of estuary ecologies could be disrupted through changes in ecosystem assemblages. It is therefore important to understand the complexities of estuaries and protect sufficient spatial and ecological buffers.

4.6 Social impacts

According to the Western Cape Climate Change Strategy and Action Plan those most vulnerable to climate change impacts are the elderly and the poor with a low adaptive capacity living in marginalized areas or compromised social contexts (DEADP 2007). These vulnerable individuals are likely to experience severe impacts from climate change, either directly or indirectly. Direct impacts include extreme temperatures, flooding or droughts, lower agricultural productivity, as well as changes to the ranges for diseases and disease vectors. Indirect impacts can manifest as decreased food security, loss of livelihoods and deterioration in social welfare systems, translating into or exacerbating escalating levels of social dissatisfaction and unrest. One outcome would be the emergence of 'climate refugees' - when those whose livelihoods are impacted upon seek refuge in urbanised / climate resilient areas where better economic opportunities exist.

Society in general will feel the pressures from climate change. As risks from climate change increase and people migrate to climate resilient centres, so too will the need to create climate resistant infrastructure (sea defences, flood control), more extensive insurance coverage, and greater public spending on social welfare infrastructure and services (hospitals, fire services, disaster risk management and response services).

Negative climate change impacts on sectors such as agriculture and tourism are likely to have an adverse effect on rural and semi-rural employment, which could translate into an increase in migration to urban areas, typically to peri-urban informal settlements. These so-called climate-migrants would result in an even larger pressure on infrastructure and resources, such as the provision of sanitation services and access to clean water for domestic use.

5 RESPONSES

5.1 Mitigation and adaptation

The Western Cape Government is in the process of updating the provincial mitigation and adaptation response strategies (WCG 2012). The provincial position is to develop inclusive approaches to both mitigation and adaptation, which acknowledge the contributions made by government and the private sector alike.

One of the key responses that the DEADP Climate Change unit and its stakeholders are undertaking is the Municipal Support Programme which assists municipalities in the development of Climate Adaptation Plans and Sustainable Energy Plans. The primary aim is to guide the direction of local climate change responses, thereby ensuring local relevance, provincial alignment and thematic comprehensiveness.

5.1.1 Mitigation targets, projects and progress

The vision for mitigation in the Western Cape is aligned with the National Climate Change Response White Paper, with specific focus on sustainable energy systems and a low carbon economy. A foundation for the transformation of the energy economy has been laid in the form of an Energy and Emission Profile (WCG 2013); strategic interventions can be identified and tracked from this benchmark.

In order to support the envisaged national greenhouse gas emissions trajectory of peak-plateau-decline (peak in the period from 2020 to 2025, remain stable for around a decade, and decline thereafter in absolute terms), the Western Cape recognises that it is necessary to undertake an exercise to quantify project impacts in order to determine how best to support the achievement of emission reduction targets in the Western Cape context. This project is envisaged for 2013/2014 and will involve energy scenario modelling in order to determine what interventions are most appropriate (WCG 2012). Provincial targets for emission reductions were specified in the Climate Change Strategy and Action Plan for the Western Cape (DEADP 2007), although these are reviewed and renewed on an ongoing basis by the Provincial Energy Work Group. Targets set by the Work Group include:

- A 15% reduction in electricity use by provincial buildings in the Cape Town city centre and three hospitals by 2014
- 10% reduction in energy intensity (e.g. consumption per unit of GDP) in the Western Cape by 2014 off a 2009 baseline
- All new Provincial buildings to achieve at least a 4 star Green Buildings certification
- Achieving a rollout of at least 150 000 solar water heaters through the City of Cape Town facilitated strategy
- 132 MW of energy supplied from renewable sources in the Western Cape by 2014
- Transitioning society and the economy to more sustainable consumption and production patterns.

Mitigation options with the biggest mitigation potential in the short to medium term as identified for the Western Cape are (WCG 2012):

- Shifting to lower-carbon electricity generation options;
- Significant upscaling of energy efficiency application, especially industrial energy efficiency and energy efficiency in public, commercial and residential buildings and in transport;
- Promoting transport-related interventions including transport modal shifts (road to rail, private to public transport, non-motorised transport / active mobility), switches to alternative vehicles (electric and hybrid vehicles) and lower-carbon fuels;

Existing projects contributing to mitigation in the province include:

- Energy efficiency programmes, looking at lighting and other interventions, being implemented by municipalities with Eskom support
- Wind farm pilot projects at Klipheuwel and Darling, as well as the Sere commercial scale wind farm and a private wind energy facility at ArcelorMittal Saldanha

- A strategic environmental assessment on opportunities for wind energy facilities in the Western Cape
- Mass roll-out of solar water heaters for the City of Cape Town (also counts towards achievement of adaptation targets)
- Development of sustainable transportation strategies and project implementation for Eden District and the City of Cape Town
- Municipal coordination of an at-source domestic recycling programme
- Cape Town's TravelSMART campaign, which includes five other large employers in the Cape Town CDB, including the Western Cape Government
- Cape Town's "Greening the Fleet" strategy
- Development of a green technology hub along the West Coast north of Cape Town
- A biomass-based power plant near George
- Investment in public transport infrastructure (City of Cape Town and other municipalities)

An example of what can be done: Drakenstein Municipality (2012 Greenest Municipality winner)

Demand side management

- Residential load management scheme – appliance control devices to disconnect specific domestic loads during peak use periods
- Energy efficiency requirements for new electricity connections
- 1 641 new low cost housing units are fitted with solar water geysers
- Lower electricity tariffs for households with a reduced ampere capacity

Policy and regulatory measures:

- A Green Building Manual adopted by Council
- Draft Energy Master Plan in preparation
- Energy efficiency by-law in development

Renewable energy

- Methane gas from the Paarl waste water treatment works is captured and used for the on-site incinerator and boiler
- Waste to Energy Project at the Wellington landfill site will convert solid waste into energy

In-house measures:

- New traffic lights are fitted with energy efficient bulbs with an ongoing programme of retrofitting old traffic lights
- Mercury vapour street lamps are being replaced by more energy efficient high pressure sodium lamps
- Municipal buildings are being retrofitted with more energy efficient bulbs and lighting tubes
- Articles about energy efficiency are regularly placed in the municipal staff newsletter
- Energy efficiency is discussed at weekly management meetings and it is filtered down to workers.
- Staff are reminded via e-mail to switch off air conditioners, lights, etc. at the end of the working day
- The recycling of office waste.

5.1.2 Adaptation projects

Maintaining the viability of many economic sectors and protecting social welfare will require adaptation to unavoidable climatic shifts. Different focus areas for adaptation include energy efficiency and demand side management, renewable energy, sustainable transport, water conservation and demand management, the built environment, ecosystem-based adaptation, food security and social resilience.

The draft provincial Climate Change Response Strategy (WCG 2012) envisages the following outcomes for structural adaptation management in the province:

- Natural systems that improve resilience to climate impacts or that reduce climate impacts
- Reduced climate vulnerability and increased coping capacity within communities across the province
- An adaptive economy ready to take advantage of opportunities arising out climate change, as well as reducing losses

A database of projects addressing climate vulnerability and building climate resilience across the province, consisting of an initial status quo analysis, gap analysis and prioritisation process, and secondly the development of a multi-criteria assessment tool, is currently under development. This database will support the coordination of climate adaptation across the province (WCG 2012).

In order to build climate resilience across the province the Western Cape Government has adopted a multi-sectoral approach focussed on partnerships with multiple stakeholders. This is co-ordinated through the "PSO7" work group. Key sectors and adaptation activity areas include:

Sector	Activity
Agriculture	• Biogas related research being conducted on research farms with a view to rolling out to farmers in region • Historical climatic and agricultural conditions profiling of the province • Trend and variation analysis based on a comparison between recent (monthly) climate and agricultural conditions and the long term average or normal pattern • Drought monitoring using remote sensing • Develop online (web) access portal for regional agricultural information • Research in crop alternatives better suited to projected climate changes
Water	• Ongoing management of invasive alien vegetation • Development of Integrated Water Resources Strategies • Integrated resource management and planning focus on the Berg River
Local authorities	• Municipal Adaptation Plans • Adaptation interventions • Integrating climate change considerations into key strategic and policy documents such as the IDP, SDF, DMP, etc

Sector	Activity
Biodiversity	• EPWP programmes centred around ecological infrastructure, e.g. working for water, working for wetlands, working on fire, working for energy • Fine scale biodiversity planning
Integrated Coastal Management	• Development of coastal set-back lines for the Overberg, Eden and West Coast, as well as the City of Cape Town • Development of Estuarine Management Plans • Upgrading of coastal defences
Communication and Awareness Raising	• Audience specific climate change awareness materials
Research	• Partnering with climate scientists around bridging the climate science / policy makers gap • Climate change research theme under Cape Higher Education Consortium

5.2 Policy, tools and legislation

In the growing recognition by the global community of climate change, a number of laws, policies and strategic frameworks with relevance to different spheres of government (National, Provincial and Local) and business have been established. Key documents are highlighted below.

Table 3: Summary of policy, tools and legislation relevant to Climate Change

International Responses	1992	United Nations Framework Convention on Climate Change (UFCCC)
	1987	Montreal Protocol on Substances that Deplete the Ozone Layer
	1997	Kyoto Protocol
	2007	IPCC Fourth Assessment Report
National Responses	1996	Constitution of the Republic of South Africa (Act 108 of 1996)
	1998	National Environmental Management Act (Act 107 of 1998)
	1998	National Water Act (Act 36 of 1998)
	1999	National Heritage Resources Act (Act 25 of 1999)
	2002	Disaster Management Act (Act 57 of 2002)
	2004	National Environmental Management: Air Quality Act (Act 39 of 2004)
	2005	National Biodiversity Strategy and Action Plan
	2010	Environmental Impact Assessment (EIA) Regulations (Regulations No. R.543 to R.546 published under sections 24(5), 24M and 44 of NEMA)
	2010	South African Risk and Vulnerability Atlas
	2010	National Strategy for Sustainable Development
	2010	'Government Outcome 10' delivery agreement
	2011	National Climate Change Response White Paper
	2012	National Development Plan 2030
	2012	Draft National Energy Efficiency Strategy (Second Review July 2012)
Provincial Responses	2008	Western Cape Climate Change Strategy
	2010	Eden District Municipality Sea Level Rise and Flood Hazard Risk Assessment
	2011	West Coast District Municipality Sea Level Rise and Flood Hazard Risk Assessment
	2012	Overberg District Municipality Sea Level Rise and Flood Hazard Risk Assessment
	2012	Draft Western Cape Climate Change Response Strategy
	2013	Western Cape Green Economy Strategic Framework
	2013	Energy Consumption and CO_2 Emissions Database for the Western Cape
Local Authority	2003	City of Cape Town Biodiversity Strategy

Responses	2006	City of Cape Town Energy and Climate Change Strategy
	2006	Framework for Adaptation to Climate Change in the City of Cape Town (FAC4T)
	2008	City of Cape Town's report on Sea Level Rise (SLR)
	2011	Moving Mountains: Cape Town's Action Plan for Energy and Climate Change
	2011	State of Energy and Energy Futures Report

6 CONCLUSION

OUTLOOK: DECLINING

Although climate change is taking place right now, the change is still mostly imperceptible due to the scale of the changes and the context of the inherent variability of weather and climate patterns. However, we will recognise the 'symptoms' of climate change over time, as pressures on our daily activities mount – pressures such as water shortages, rising costs of food and overtaxed public health systems. It is therefore necessary that we recognise both the Western Cape's contribution to the problem, and the impacts that climate change will have on the proper functioning of the province on socio-political and socio-economic levels.

Western Cape GHG emissions are on the rise. Analysis shows that the highest emissions stem from the transportation and industrial sectors, and efforts can therefore be focussed on improving their efficiency and environmental impact. Further efforts should be directed at improved emissions tracking and carbon accounting in the province.

Adaptation to unavoidable climatic changes and the impacts that will result from those changes need also take place in order to create a society that can 'weather the storms'. This includes creating social systems that can cope with increased climate stress, infrastructure with sufficient capacity to compensate for variations in temperature and precipitation, and economic activity that has a built-in resilience towards external shocks.

The findings of the Climate Change can be summarised as an overall declining outlook. Table 4 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action. Table 5 contains the anticipated changes or outlook for the future of Climate Change, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding of the dynamics.

Table 4: Summary of key aspects identified in the chapter

Aspect	Summary of key points
Pressures	• Energy use • Land use change • Transportation • Built environment
Impacts	• Natural disasters • Distribution of species • Water stress • Limitations on agriculture • Tourism • Living conditions

Aspect	Summary of key points
Challenges	• Long term, cross-sector interventions, e.g. public transport, renewable energy • The role of- and impact of private sector • Theoretic nature of cost adaptation measures
Progress	• Framework and planning in space
Critical areas for action	• Stimulate large-scale changes to energy and transport systems • Refine adaptation planning to increase social-ecological resilience • Actively strengthen ecological goods and services to limit impact on the poor

Table 5: Summary of the outlook for Climate Change based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend
Projected change	• 1°C warming by late 2030s, warmer minimum and maximum • Highly uncertain, but possibly drying towards the west, and shorter rainy season, stronger winds, and approximate 5cm sea level rise over 25 years	Declining
Carbon footprint	• Total emissions (contribution to greenhouse effect measured in carbon dioxide equivalent (CO_2e) emissions): o 41 303 482 tonnes CO_2e (2009) (compared to ~17 000 000 tonnes CO_2e in 2001) o 53% of provincial total due to electricity consumption • Carbon intensity: o Emissions relative to population size - 8 tonnes per capita (2009) compared to 5.8 tonnes per capita in 2001 o 178 tonnes per million Rand contribution of Gross Domestic Product (GDP) (2009) • GHG contributions: o 36% from industry, 28% from transport o City of Cape Town 57% of total, West Coast District 22%	Limited historical record

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1 INTRODUCTION

The human population, and indeed natural processes on the earth itself, are sustained by energy. Energy sustains human livelihoods and powers the economy of South Africa. For application in human society, energy is derived from many sources including direct sunlight, fossil fuels as well as natural forces, and is conveyed over distance as electricity, liquid, gaseous and solid fuels, or different forms of enriched mediums.

The energy sector is critical to South Africa's economy, where it indirectly and directly contributes approximately 15% to the country's Gross Domestic Product (GDP) and therefore underpins the rest of the economy (GCIS 2012). As the economy continues to grow, energy is increasingly becoming a key focus. A transformation of the energy sector is regarded as one of the major requirements through which equitable economic growth and sustainable development can be achieved (NPC 2011). South Africa currently has a well-developed energy supply and production system, but the challenge is to maintain and expand it to keep up with and support the growing economy. It is also characterised by the duality of low production costs but high environmental impacts as a consequence of a heavy reliance on large coal reserves and other imported fossil fuels. In fact, about 70% of primary energy and 90% of electricity are derived from coal (NPC 2011). The low production costs have over time encouraged heavy industry and especially the minerals sector to invest in energy intensive beneficiation processes (NPC 2011).

Unfortunately, the energy intensity and reliance on fossil fuel derived energy translates into relatively high greenhouse gas emissions such as carbon dioxide (CO_2) whether measured either per capita or by greenhouse gas (GHG) intensity (emissions per unit of GDP). A heavy reliance on energy is also increasingly becoming a liability as energy prices rise to compensate for the progressive internalisation of the environmental and social costs of generating energy.

This chapter describes the energy sector in the Western Cape in terms of how energy production and consumption affects environmental change. Specifically, indicators of Energy Use, Energy Production, Energy Intensity and Domestic Energy Use are tracked in order to understand the energy picture and identify trends. The chapter also provides a discussion on the various responses of the Western Cape to issues related to energy. Readers are encouraged to read this chapter along with those on Air Quality and Climate Change due to close relationships between the three spheres.

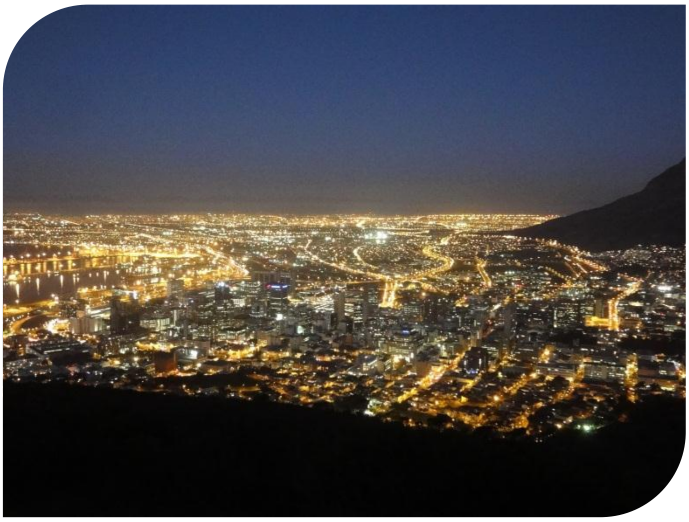
2 OVERVIEW OF DRIVERS AND PRESSURES

The energy requirements of the different economic sectors in South Africa are supplied from a wide range of energy sources or carriers, including coal, electricity, nuclear, liquid fuels (refined from crude oil and coal), gas and renewable energy sources. Energy generation and consumption, however, place considerable pressures on the environment through impacts such as the release of greenhouse gas emissions and air pollutants, the alteration of land-use patterns, and consumption of water resources. This contributes to climate change, damages natural ecosystems, and compromises the man-made environment; all of which combines to impact on human health (Modi *et al*. 2005).

It is demand side factors that determine the scale of the environmental change that can be ascribed to energy. Consumption patterns, and particularly the total amount of energy and the efficiency at which energy is used, ultimately determine the overall impact. Drivers of consumption can therefore be seen as the primary determinants of environmental change that impact on environmental features through various activities or pressures.

2.1 Drivers

In terms of drivers, the primary agent driving the impact that energy generation and use has on the environment is human population growth. As a rule of thumb, total energy usage will increase along with population numbers. However, population dynamics can materially influence or determine the patterns of consumption, and therefore the rate of increase. Relative wealth has been shown to correlate with high per capita energy usage (IEA 2008), as has urbanisation, population age structure and household size (Jiang & Hardee 2011).



The Western Cape satisfies, or show rising trends for all the criteria mentioned. The population structure itself can be described as young (<35 years old), urbanised and living in small households (3.6 people per household). Well over 90% of households in the Western Cape have access to electricity, and most have access to basic services as well as a radio, television, refrigerator, landline telephone and at least one cellular telephone (StatsSA 2012a). The 2011 Census also shows a 2.5% annual population growth in the Western Cape. All of this implies that the population of the Western Cape acts as a major driver of energy usage, and therefore also the associated environmental impacts.

2.2 Pressures

It holds true that for both economic activities and household activities, the amount of energy that is consumed is related to the efficiency of use, and this efficiency is determined by inherent characteristics of the particular application. Domestic uses, for example, require small units of energy for application in lighting, heating and cooking, as well as to power a range of electronic appliances and gadgets. This need can be satisfied through energy from biomass, coal, renewable sources or grid-supplied electricity. In comparison, an energy intense industry like mining or smelting requires a constant large amount of energy which in the Western Cape can only be supplied through coal, coal-based grid supplied electricity or nuclear energy. The nature of the energy consumption also determines whether opportunities exist for improvements in energy efficiency or wholesale shifts to different forms of energy. Transportation, for example, will remain heavily dependent on liquid fuels unless significant shifts in modal choice can be achieved to allow for more electricity driven public transport and non- motorised transport. Consequently, the composition and size of the local economic system will influence the pressure that energy consumption has on the environment.

The economy of the Western Cape is growing slightly faster than the rest of South Africa, with 3% GDP growth in 2010, in part driven by a 5% growth in manufacturing (WCG 2012). The Provincial Economic Review and Outlook (WCG 2012) further indicates that manufacturing contributes 15% to the GDP while the built environment (services, business and commerce) contributes well over 80%. This implies an inherent dependence on bulk electricity supplies for the built environment, but also a mix of electricity, coal and diesel for various forms of manufacturing. It also implies that the bulk of the economic activity would not necessarily be locked into a particular type of primary energy, as long as the requisite supply of electricity is provided. It is necessary though to ensure that the supply of energy and integrity of the supply networks keep pace with the consistent economic growth.

> *South Africa is the 27th largest economy in the world, but the 12th largest carbon dioxide emitter. This is mainly because the energy intensive economy is largely dependent on carbon-based fuels. As the world takes steps to cost the negative effects of carbon, South Africa is likely to face challenges (and opportunities) in reducing emissions... It will have to find ways of... improving both the water and energy efficiency of industry.*
>
> National Development Plan - 2030

Transportation affects energy usage in two ways. On the one hand it represents a direct consumption of energy as goods and passengers are moved across the landscape. It is calculated that in 2009 in Cape Town, the transportation sector comprised 57% of the total energy use in the city once aviation and maritime uses are excluded. The figure rises to 71% with aviation and maritime uses included (WCG 2013). On the other hand, the built-in efficiencies and coverage of transport networks determine user behaviour and consequently the energy intensity of human activities. The relative energy intensity of the different modes differs, and therefore also the relative impact of shifts in modal choice.

3 STATE

This section provides information on the current state of energy in the Western Cape, using energy generation, energy consumption, energy intensity and domestic use as indicators. An attempt is made to provide a comparison between the state of energy in 2005 and the current state, although comparable information remains limited. Where possible, information is presented at a District Municipality level in order to present a more refined perspective on the energy sector in the province.

> **Tracked indicators of the *status* of Energy:**
>
> - Types of energy generation
> - Renewable energy sources
> - Energy use
> - Energy intensity

3.1 Energy generation

The indicator on energy generation depicts the production of energy in the Western Cape Province, including energy from both renewable and non-renewable sources. The rationale behind the use of the indicator for the state of the energy sector is to identify trends in the responses to changes in energy demand, to highlight what the local energy supply mix will consist of in future, and broadly indicate where the local environment will be directly impacted on by energy generation. It should be recognised though that not all the energy generated in the province is necessarily utilised within its borders, and not all the energy consumed in the province originates from the Western Cape. This is due to over- or undersupply of particular forms of energy or energy carriers relative to the local energy demand.

Primary energy supply in South Africa is a mandate of National Government (in terms of the National Energy Act, Act 34 of 2008). According to statistics from StatsSA (2012b), the South African energy supply in 2009 was dominated by coal, which provided 61.8% of the primary energy. This is followed by petroleum products (sourced from oil, coal and gas) at 16.3%, crude oil at 13.2%, and renewables and wastes at 5.3%. Small amounts of Gas (1.5%), Nuclear (1.7%) and Hydro (0.2%) round off the list (Figure 1).

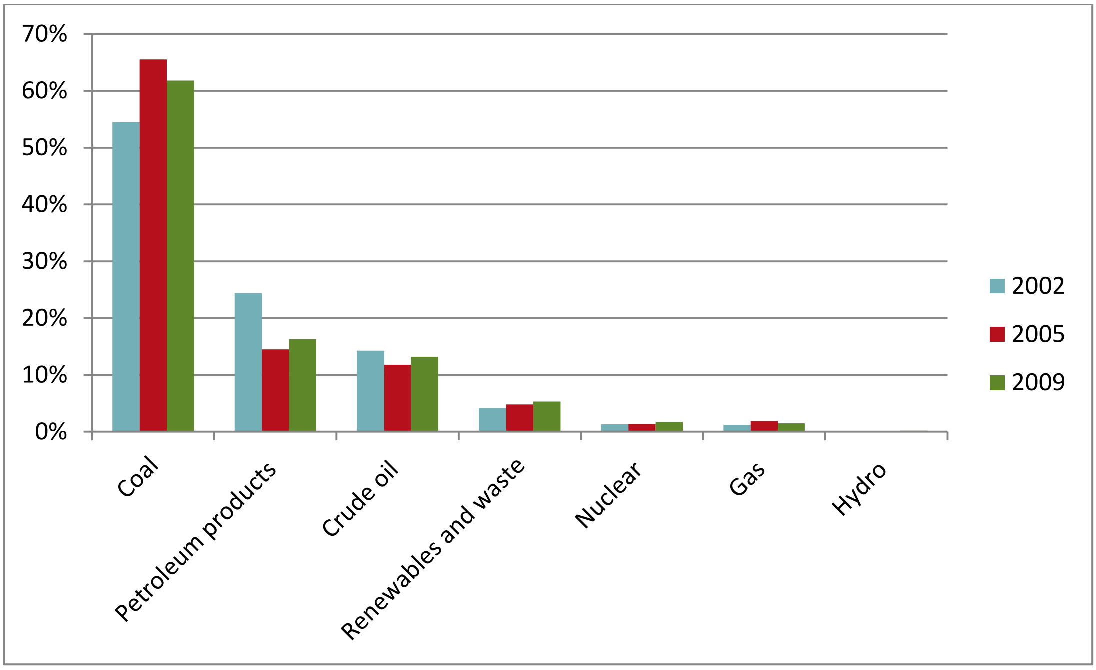


Figure 1: Percentage supply of primary energy (excluding electricity production) by source in South Africa, 2002–2009 (StatsSA 2012b)

The Western Cape is home to only some of these energy generation activities. Most notably, these include the Koeberg nuclear power station, the Open Cycle Gas Turbine peaking power stations at Gourikwa (Mossel Bay) and Ankerlig (Atlantis), the Darling and Windheuwel Wind Farms, oil refineries, as well as natural gas off both the South and West coasts.

Oil and gas refineries produce petroleum products such as petrol, diesel, residual fuel, oil, paraffin, jet fuel, aviation gasoline, liquefied petroleum gas (LPG) and refinery gas (StatsSA 2012b). Apart from the PetroSA refineries in Mossel Bay, a major refinery with an approximate capacity of 100 000 barrels per day (bbl/d) is operated by Chevron in Cape Town (Petroleum Agency of SA 2010).

3.1.1 Coal

The energy sector in South Africa is dominated by coal, and especially coal-based electricity, due to the country's large coal reserves. Despite this, no coal is mined in the Western Cape. Coal for direct application in industries is brought in by truck and rail from coal fields in the northern provinces (especially Mpumalanga and KwaZulu-Natal) and coal-based electricity is sourced from the national electricity grid to satisfy the bulk of the electricity consumption in the Western Cape.

The South African coal reserve which is estimated at 30 billion tonnes, are at current exploitation rates enough for another 121 years (StatsSA 2012b). Most of the coal mined in South Africa is used for the generation of electricity, with a small yet significant portion transformed into liquid fuels or other petrochemicals by Sasol. In 2006, 68.7 million tonnes of coal were exported (DMR 2009).

As part of Eskom's electricity generation expansion programme, two new coal-fired power stations – Medupi and Kusile – will be commissioned in Limpopo and Mpumalanga respectively. The investment in coal-based electricity generation implies that the current coal-dependent national electricity supply to the Western Cape will not change in the near future.

3.1.2 Oil

South Africa relies heavily on imported crude oil for its liquid fuel demands, with most of the supply being sourced from the Middle East (Saudi Arabia, Iran, Kuwait, the United Arab Emirates, Yemen, Qatar and Iraq) and Africa (Nigeria, Egypt and Angola) (StatsSa 2012b). Local reserves of crude oil are all located offshore, in an exploration area known as Block 9 in the Bredasdorp basin South of Mossel Bay. Block 9 contains three fields – Oribi, Oryx and Sable - although since 2008 exploitation at Sable has shifted to gas and condensate (Figure 2 and Figure 3).

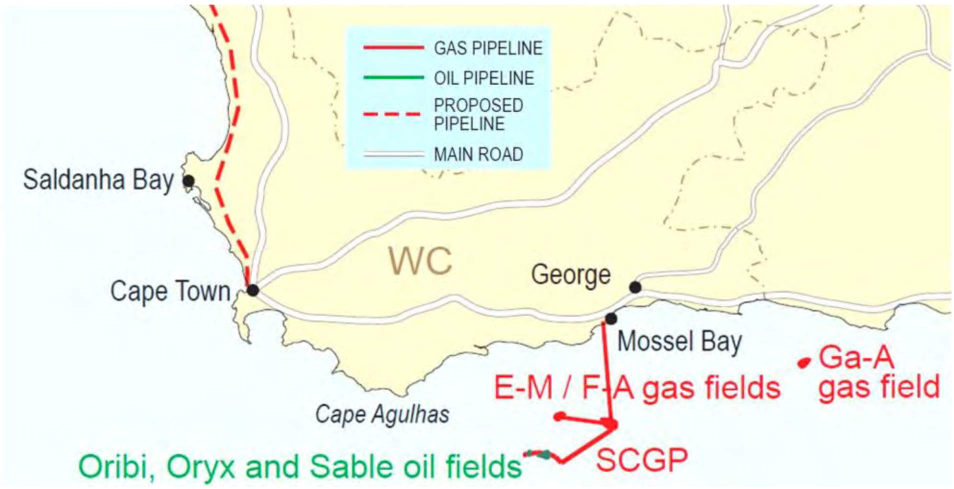


Figure 2: South African oil and gas infrastructure (adapted from Petroleum Agency of SA 2010)

The Oribi/Oryx oil field, the site of South Africa's first conventional oil production field, began production in 1997 and produces about 2% of the country's liquid fuel requirements (Petroleum Agency of SA 2010). Oil production is currently at a rate of less than 2 000 bbl/d (PetroSA 2013).

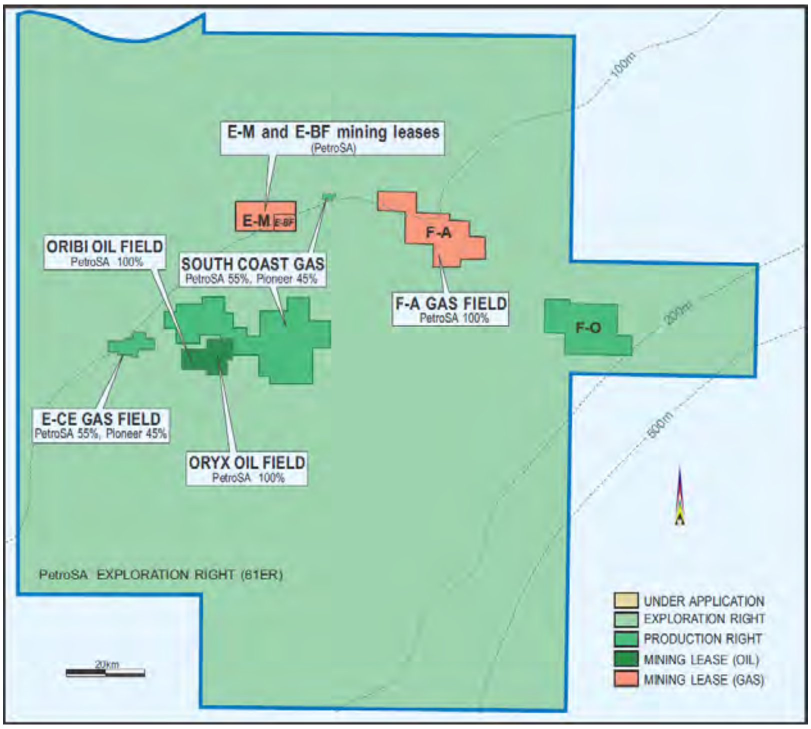


Figure 3: Production and mining rights in Block 9 (Petroleum Agency of SA 2010)

Supplementation of the liquid fuel supply takes place through coal-to-liquid and gas-to-liquid conversion processes (Sasol) as well as natural gas-to-liquid fuels conversion (PetroSA)(StatsSA 2012b). At the PetroSA gas-to-liquid plant in Mossel Bay (Mossgas), a modified version of the Fischer-Tropsch process can produce 36 000 bb/d liquid fuels (Petroleum Agency of SA 2010).

Open Cycle Gas Turbine (OCGT) power stations run on liquid fuels are located in Mossel Bay and Cape Town. These plants are key components of the Eskom Peaking Capacity strategy, as they can begin generating electricity within 30 minutes of start-up. The Gourikwa OCGT power plant at Mossel Bay (746 MW) comprises a fuel supply pipeline from the PetroSA facility to the power plant, a substation at the OCGT power plant and two transmission lines to transfer electricity from the OCGT substation to the Proteus substation (and hence the national grid). A similar arrangement is found at the Atlantis (Ankerlig) OCGT plant in Cape Town (1 338 MW), with fuel sourced from the refineries in Milnerton and a connection to the Koeberg-Aurora transmission power line (ESKOM 2013a).

Two gas turbine power stations are present inside the City of Cape Town urban fabric. Acacia power station is located in the vicinity of Wingfield. It is primarily intended as a back-up power supply for the Koeberg nuclear reactor but otherwise functions as a peaking power station in the ESKOM national grid. It consists of only three 57 MW gas turbine generators, totalling 171 MW installed capacity (Eskom 2013b). Additionally, there is the Roggebaai OCGT which has a capacity of 36 MW.

3.1.3 Natural gas

The 2005 Western Cape State of Environment Report (DEADP 2005) stated that despite playing a very small role compared to other countries, the rapidly expanding gas sector of South Africa is of increasing importance to the local energy economy. This remains true, and equally so for the Western Cape Province. Both on- and offshore natural gas reserves are located in the Western Cape, with offshore natural gas found at the oil and gas fields off the coast of Mossel Bay and large shale gas reserves presumably located in the Karoo Basin.

Natural gas extracted from the F-A and E-M gas fields that form part of Block 9 off Mossel Bay are converted into liquid fuels by PetroSA at the Mossgas plant. Several other exploration blocks and mining rights are located in the same vicinity, and these are under constant appraisal to determine feasibility of extraction (Petroleum Agency SA 2010). Along the West Coast, gas is found at the Ibhubezi gas field which is located 380 km north west of Cape Town just outside the boundary of the Western Cape. The field is capable of producing 225 Million Standard Cubic Feet (MMscf)/day, which is equal to approximately 30% of the energy used in the Western Cape. Plans are underfoot to provide a gas pipeline past the Ibhubezi cluster, from the Kudu field in Namibia to Cape Town, should gas fields off the West Coast prove to be sufficiently viable (Petroleum Agency of SA 2010).

Onshore gas has recently made headlines as interest grows in the exploitation of shale gas from the Karoo Basin. A study by the International Energy Association estimates a gas reserve in the Southern Karoo of 485 trillion cubic feet (tcf) (EIA 2011). A small portion of the exploration fields is located in the Western Cape, to the east of the Cape Fold Mountains between Beaufort West and Murraysburg. Should the shale gas reserves live up to their promise, the energy picture of South Africa will change dramatically as new infrastructure is developed and a shift towards a higher overall reliance on gas takes place.

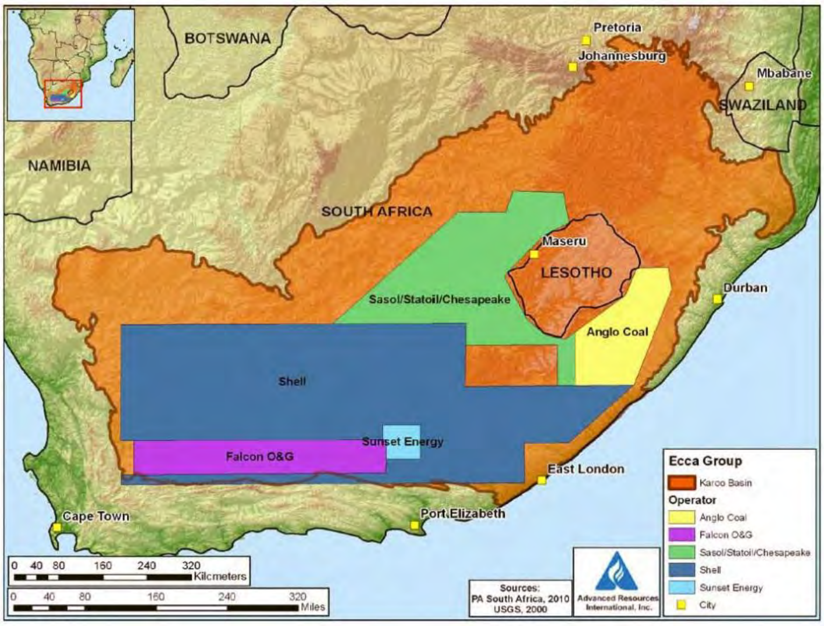


Figure 4: Map showing the location of the shale gas exploration permit blocks in South Africa

Shale gas is extracted through a process known as hydraulic fracturing, also referred to as 'Fracking'. This process has gained notoriety due to a range of environmental impacts and pollution incidents associated with the process. Current knowledge on the South African shale gas resources and potential impacts from hydraulic fracturing is limited to the information released in a report from the Department of Mineral Resources - *Report on Investigation of Hydraulic Fracturing in the Karoo Basin of South Africa* (DMR 2012). This report highlights the concerns with regards to potential environmental impacts and conflicts with radio-astronomy operations, but also acknowledges the potential social and economic benefits that responsible exploration can have for the region and the country. It therefore recommends further investigative exploration and research (without actual hydraulic fracturing), along with the augmentation of the regulatory framework before any fracturing is allowed to proceed. The Western Cape Government is understandably cautious about both the unproven potential and uncertain environmental impacts, and has consequently taken a position to support the national stance that further studies and proper consultation need to be undertaken before any definitive judgments can be made.

3.1.4 Nuclear energy

South Africa has two commercial nuclear reactor units at Koeberg, Cape Town, generating 4% of the national electricity supply.

The Koeberg plant has been in operation since 1984. It has a pressurised water reactor design and it boasts the largest turbine generators in the southern hemisphere. Koeberg is owned and managed by Eskom and has a total installed capacity of 1800 MW. Low and intermediate level waste from Koeberg is transported by road in steel and concrete containers to a remote disposal site at Vaalputs in the Northern Cape. High level waste or spent fuel is stored on site in special pools equipped with high-density racking (Eskom 2013b).

3.1.5 Renewable energy

The Western Cape is blessed with significant renewable energy resources, specifically in terms of wind and solar potential, and there is far more energy available in the natural environment than is required for provincial energy needs. However, not much of this potential has been harnessed to date. As with the rest of the country, historic dependencies on coal-fired electricity, practical and administrative obstacles and concerns about cost-effectiveness are to blame.

Measuring the total amount of renewable energy that is produced off-grid or as alternatives to the national fuel supply line networks is technically challenging due to the multitude of data sources. It is therefore more common to report on large scale contributions of renewable sources to the electricity grid and liquid fuels or gas market. The 2005 State of Environment Report (DEADP 2005) estimated renewable energy contributing 5.6% to the total electricity production in South Africa (2000 statistics). This figure was reported by the National Energy Regulator of South Africa as being 8% in 2006 (NERSA 2006).

3.1.5.1 Wind Energy

Current applications of wind energy include water pumping, wind farms for hydroelectric systems, solar-hydro hybrid systems and distributed power generation, with the small scale water pump 'windpomp' structures on farms being a well-known South African image. Large scale wind prospecting is, however, in its infancy in South Africa and descriptions of the resource vary from abundant to merely modest. Estimations for the Western Cape indicate that 2800 MW from Wind Power installations can be accommodated in the national grid without "immediate challenges" (DEADP 2010). Based on figures from the IRP 2010 (DME 2010), this equates to approximately 6% of the national system capacity requirement for 2013. The most promising wind power potential is located along the West Coast, inland (Karoo) and Southern Cape.

Three large turbine based wind energy facilities are of relevance in the Western Cape. These are the two demonstration farms at Klipheuwel and Darling, and the proposed commercial scale Sere Wind Farm at Koekenaap.

The 3.2 MW demonstration facility at Klipheuwel in the Western Cape was developed by Eskom as the first large wind turbine facility in sub-Saharan Africa. The three-year experiment was designed to test the effectiveness of three types of turbines and the viability of wind power for large-scale grid applications. Darling Wind Farm was launched by an independent power producer in 2007 with 5.2 MW capacity shared between four wind turbines. The City of Cape Town is the off-taker (StatsSA 2012b). The project plans to increase the number of turbines from the current four to a total of ten, with a final installed capacity of 13 MW.

Eskom is expected to commence with construction of a commercial size wind farm, Sere, in the Koekenaap / Vredendal area in April 2013 as a preferred bidder for the supply and installation of the wind turbines was recently confirmed. This facility will have an installed capacity of 100MW, and consist of 46 turbines rated at 2.3MW each (ESKOM 2011).

Wind energy generation capacity to be created in terms of the national Renewable Energy Independent Power Producers Programme include four onshore wind power facilities, namely West Coast 1 (90.8MW), Gouda (135.2MW), Dassiesklip (26.2MW) and Hopefield (65.4MW) (DoE 2013).

3.1.5.2 Solar Power

Solar energy comprises different categories, the most well known being Solar Photovoltaic (PV), Concentrated Solar Power (CSP) and Solar Water Heating (SWH). Solar energy can be directly used to heat water, space, generate electricity and in some cases provide process heat for industrial activities.

The resource in the Western Cape is very good although not as good as in north western parts of the country. Averaged irradiance across the province ranges from 1500 kW/m2/pa in the East to over 2000 kW/m2/pa in the West (5 400 - 7 200 MJ/m2/pa) (Figure 5). This is comparable to the areas surrounding the Mediterranean Sea.

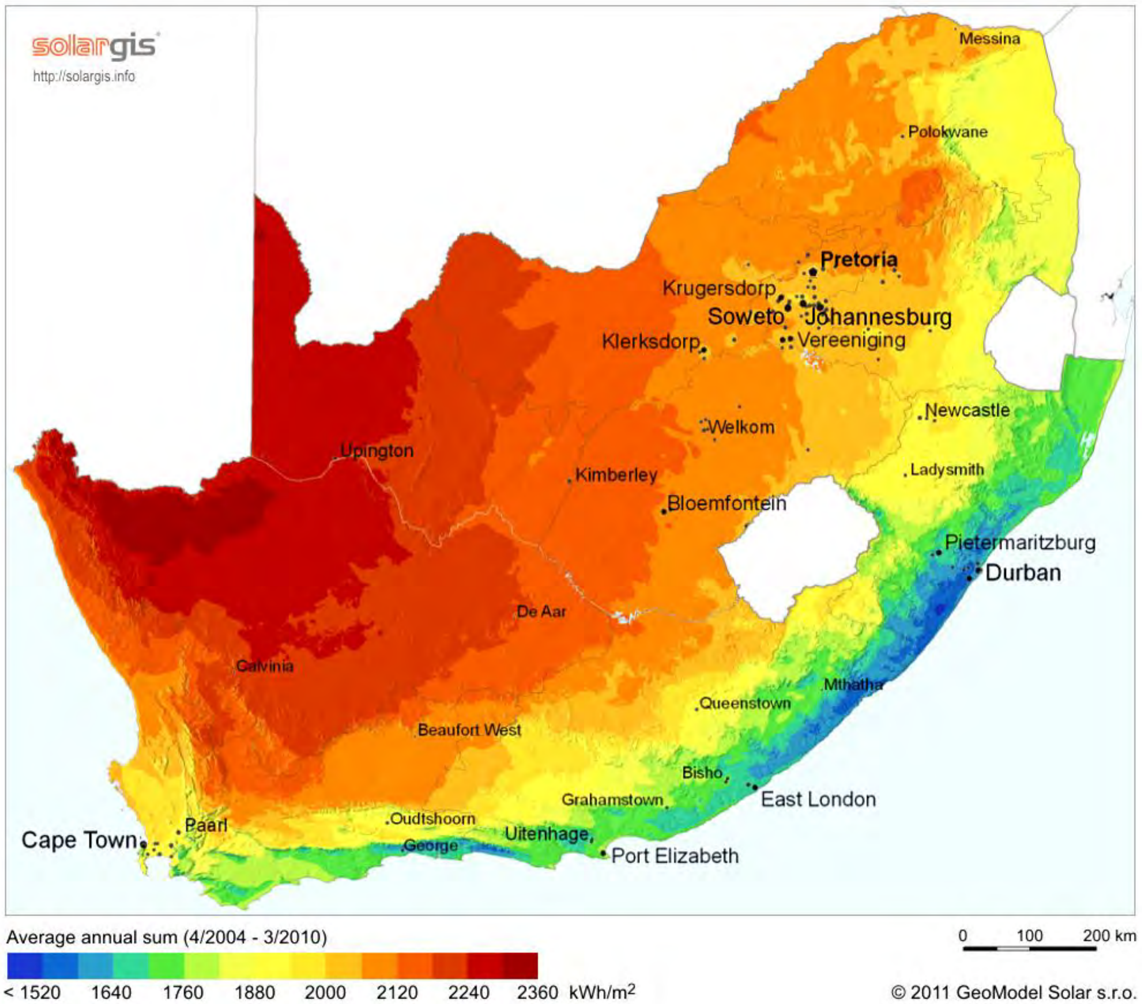


Figure 5: Global Horizontal Irradiation: South Africa (SolarGIS © 2013 GeoModel Solar s.r.o.)

Large scale solar power generation does not currently exist in the Western Cape, but in terms of the national Renewable Energy Independent Power Producers Programme four Solar PV projects have been given the go-ahead by the Department of Energy (DoE 2013). These include facilities in Vredendal (8.8 MW), Aurora (9 MW), Touwsrivier (36 MW) and in the Swartland (5 MW). Hessequa Municipality already has a 33 kW Solar PV installation from which the wastewater treatment works outside Riversdale is run. Ultimately, the goal is to expand the facility to 5 MW capacity.

3.1.5.3 Hydropower

Hydropower installations can either be primary power generation units or they can be installed as pumped storage units. Primary power is generated where gravity assisted water flow between higher level reservoirs or catchments and lower release points are allowed to run through turbines to generate electricity. A pumped storage scheme on the other hand pumps water from a lower to an upper reservoir using off-peak electricity and then releases the water to run through turbines to generate supplementary power at times of peak demand.

High level information on rainfall and topography indicate a reasonable potential for small scale hydro power within the province (Figure 6). However, the total practically realisable potential for small scale hydro power in the province is estimated at 20 MW (DEADP 2007). The only existing ordinary hydropower plant in the Western Cape is at Ceres in the Witzenberg Municipality, which has a capacity of 1.5 MW and produced 1 082 MWh in 2004 (DEADP, 2007).

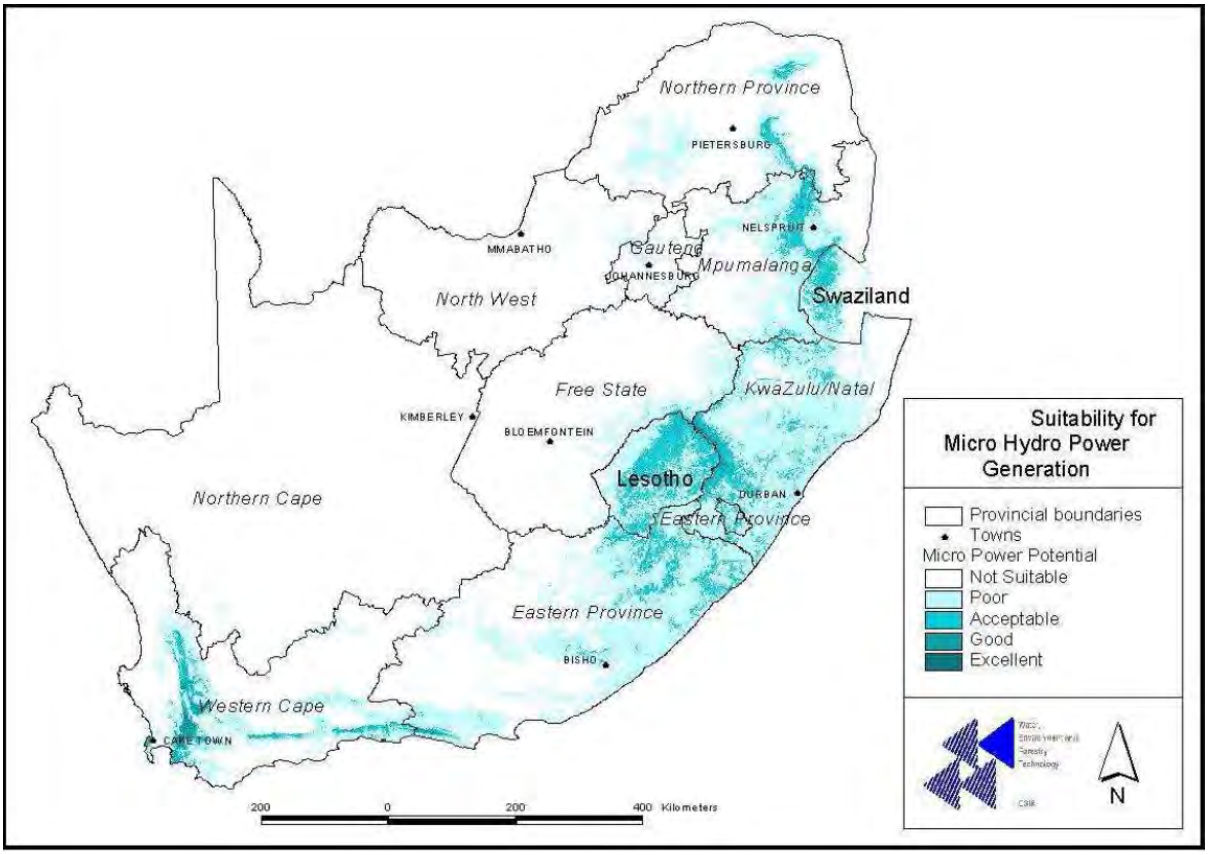


Figure 6: Overview of hydropower resources in South Africa (Source: DME/CSIR/Eskom 2002 cited in DEADP, 2007a)

The most significant hydroelectric power scheme in the Western Cape is the Steenbras / Palmiet Pumped Storage Scheme which is located in the Kogelberg Biosphere Reserve. The scheme plays a dual role of firstly providing peaking power for Eskom and secondly through its reversible pump turbines, providing water for Cape Town as part of an Interbasin Transfer Scheme. It has a capacity of about 580 MW.

3.1.5.4 Biomass

Biomass has the potential to contribute to Western Cape energy needs through a wide range of resources and conversion processes. At present it is primarily used as a cooking fuel or for space heating in low-income households (DEADP 2007), but large scale production and use, either for commercial production or distributed micro-generation is possible.

Bulk biomass energy production typically requires extensive dedicated farming or forestry activities, but may draw on existing agricultural waste products. It has the potential to enhance rural economic activity, but also goes hand-in-hand with environmental and socio-economic concerns such as land degradation or compromised food security. Further impacts result from the beneficiation of biomass or reprocessing of oils to convert it into sufficiently energy dense liquid fuels for ordinary application. Biomass is also used for direct application in the industrial sector as a feedstock for boilers or furnaces.

Domestic use of biomass occurs generally in poor households, where access to electricity supplied by the national grid is unavailable or unaffordable. Often, over-exploitation of natural woodlands and unsound harvesting practices lead to serious environmental problems in many rural areas. Newer technologies such as biomass digesters create opportunities for meeting domestic energy needs through micro-generation without the need to resort to excessive wood burning.

3.2 Energy use

An indicator that provides information on the provincial use of energy is presented as a means to show trends in energy use in the Western Cape Province as well as specific energy dependencies. Information on energy use is primarily sourced from the recently completed *Energy Consumption and CO_2 Emissions Database for the Western Cape* (WCG 2013) but also various other relevant publications.

According to the *Energy Consumption and CO_2 Emissions Database for the Western Cape* (WCG 2013), energy consumption in the province has grown from 247 742 000 GigaJoule (GJ) in 2004 to 270 887 000 GJ in 2009 (excluding aviation and marine figures). It should be noted though that various data uncertainties remain, and there is no consistent collection and analysis of data, but the overall trend can be taken as indicative.

Figure 7 shows the energy used per district municipality within the Western Cape. Clear distinctions are evident with Cape Town, as expected, being the heaviest user of energy. This can be attributed to the fact that the majority of the Western Cape's population is concentrated in Cape Town and surroundings, and it is also here that development is most extensive. The energy-intense heavy industry of the West Coast (notably the iron and steel and cement/sand industries) brings this otherwise relatively less populated area of the province in as the second-highest energy consumer.

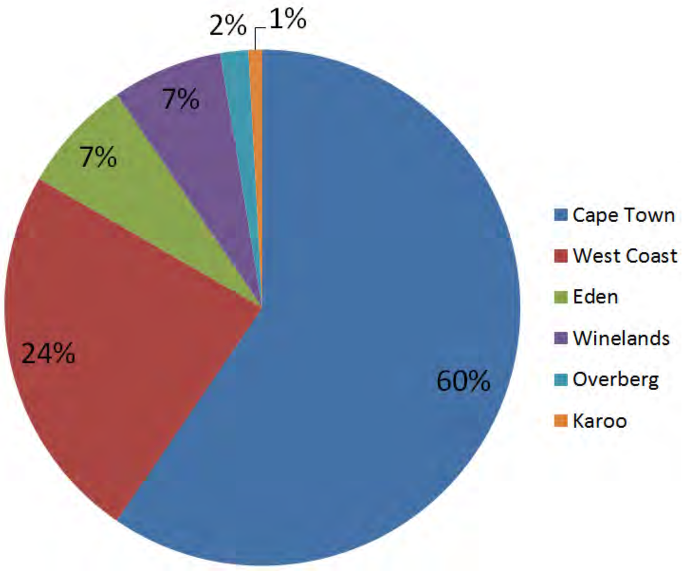


Figure 7: Energy use per District of the Western Cape (WCG 2013)

In terms of the application of different fuels, energy use in South Africa as a whole is characterized by a high dependence on historically cheap and abundantly available coal for industrial application and electricity generation, as well as imported crude oil. As shown in Figure 8, electricity, coal, petrol and diesel also dominate the mix of fuel consumed in the Western Cape, in that order (WCG 2013). This demonstrates the enormous reliance on fossil fuel in the province. Also, considering that only 30% of South Africa's liquid fuels are locally sourced, the high (30%) liquid fuel component of the Western Cape energy mix represents a dependence on foreign oil imports. This renders the province vulnerable to disruptions in fairly long supply lines. The analysis also points out that the direct use of coal in industry contributes substantially to the provincial energy situation.

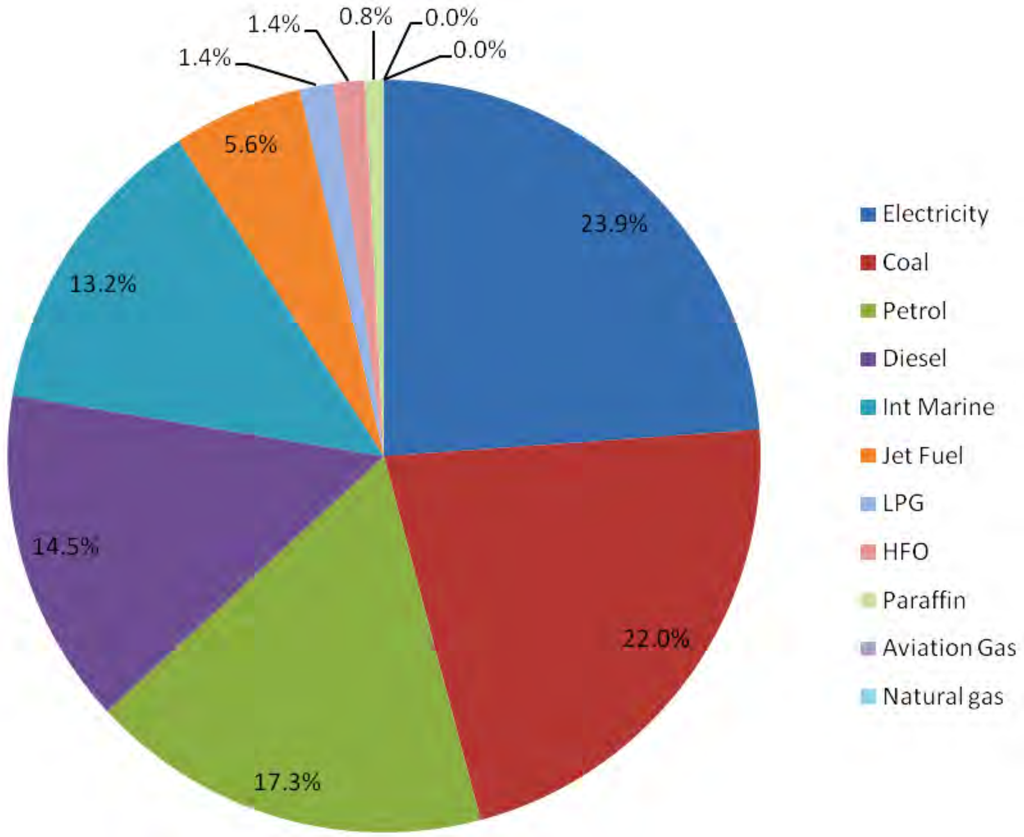


Figure 8: Energy use by fuel type (WCG 2013)

Reliance on fossil fuels also translates into the release of greenhouse gasses. With aviation and international marine values included, the energy consumption in the Western Cape totals 339 117 323 GJ. This equates to 41 303 482 tonnes of carbon dioxide equivalent (CO_2e) (WCG 2013). The Energy Consumption and CO_2e Emissions Database (WCG 2013) states that, at a glance, the Western Cape energy consumption and emissions outputs are in line with the province's relative population and economic size. Table 1 also gives the figures for the per capita energy use and CO_2e emissions for the Western Cape.

Table 1: Key energy use and CO_2e emissions Indicators for the Western Cape, 2009 (Source: WCG, 2013)

Indicator	Unit of measure	Western Cape 2009
Total energy	GJ	339 117 323
Total energy related GHG emissions	tCO_2e	41 303 482
Energy consumption per capita	GJ/capita	64
GHG emissions per capita	tCO_2e/capita	8
Energy consumption per GDP (R' mill)	GJ/GDP	1 428
GHG emissions per GDP (R' mill)	tCO_2e/GDP	178

In terms of a sectoral breakdown of energy use, transport and industrial applications seem to be solidly entrenched as the heaviest energy users. The *Energy Consumption and CO_2 Emissions Database for the Western Cape* show that 52% of energy consumption in the province is attributed to the transport sector, followed by industry at 34% (Figure 8). This compares to 2004 figures 35% and 49% respectively for the sectors. In terms of preferred energy source, transportation relies heavily on liquid fuels (petrol and diesel) whereas industry uses coal and electricity by preference.

Across the province the residential/household sector is only responsible for just under 9% of energy consumption. Together with commerce, this combined built environment energy consumption consumes some 13% of total energy. However, this contribution is proportionally larger when considering end use fuel carriers such as electricity on their own (WCG 2013).

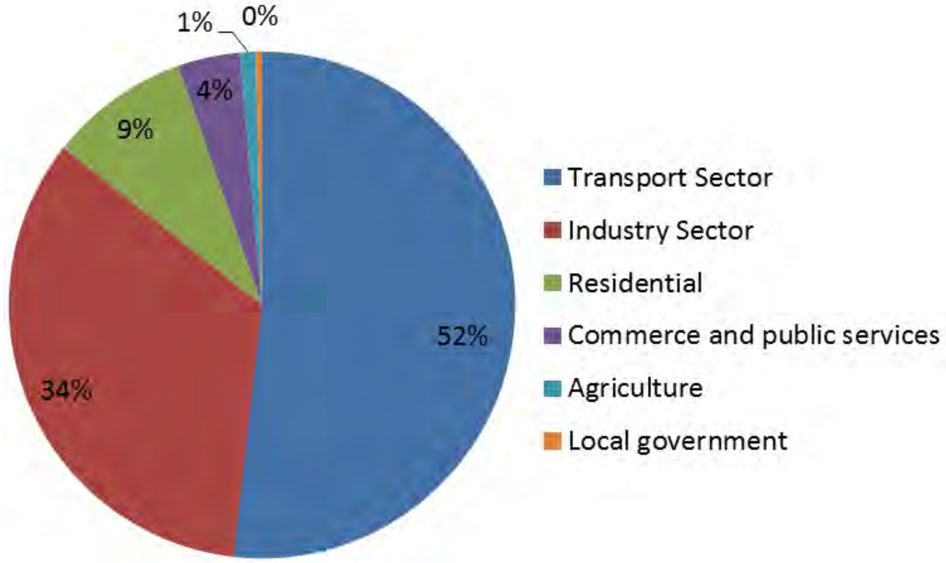


Figure 9: Energy use by sector (WCG 2013)

3.3 Energy intensity

For the purposes of this report, energy intensity refers to the relative amount of energy required to produce a unit of economic value. The provincial energy intensity in terms of population and GDP has already been discussed in section 3.2 (Table 1), therefore this section provides a comparison of the relevant intensity of energy use between the Districts of Western Cape.

When comparing the energy per GDP between the districts (refer to Figure 10), it can be seen that the industries of the West Coast render the District particularly energy intensive. In comparison, the City of Cape Town has much lower energy intensity, as the City's economy is based on service sectors that are relatively less energy intensive. It also indicates the energy efficiency achieved in this urban area - although it contributes to 74% of the province's GDP it accounts for only 60% of the province's energy use. The Central Karoo District has a relatively high energy intensity, but it should be kept in mind that a large proportion of the energy use within its boundaries is related to traffic passing through on the national highways (WCG 2013).

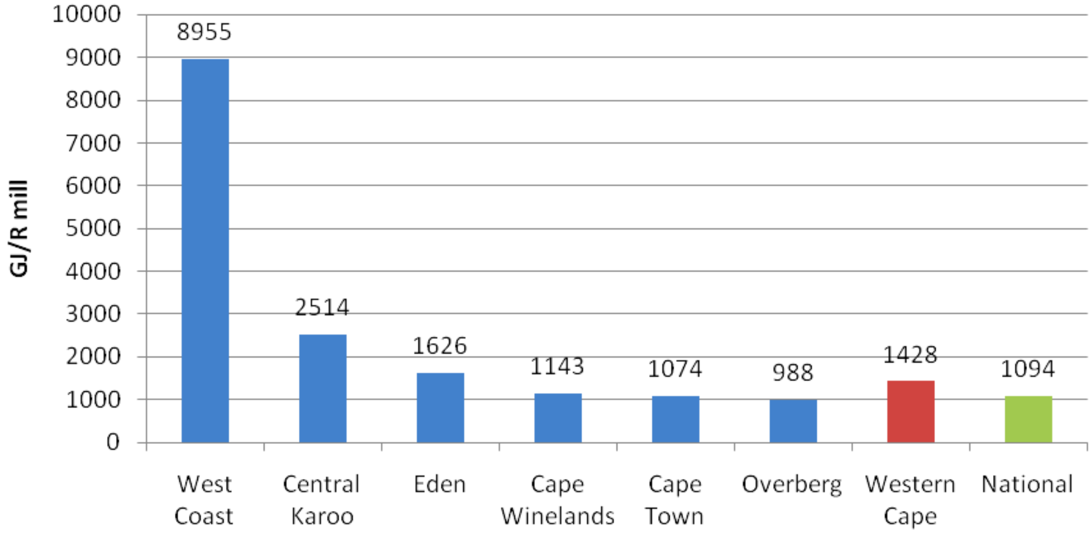


Figure 10: Energy per GDP for each District of the Western Cape (WCG 2013)

3.4 Domestic energy use

This indicator highlights aspects of domestic consumption. It shows trends in the domestic use of energy which assists in describing the state of the human environment as an environmental determinant of human health.

3.4.1 Electricity

The 2005 State of Environment Report showed that 83.5% of the houses in the Western Cape were electrified (DEADP 2005). However, data from StatsSA (2012a) show that in 2001, at least 88% of houses used electricity for lighting purposes. The Western Cape remains the best performing province of South Africa in this regard (Figure 11).

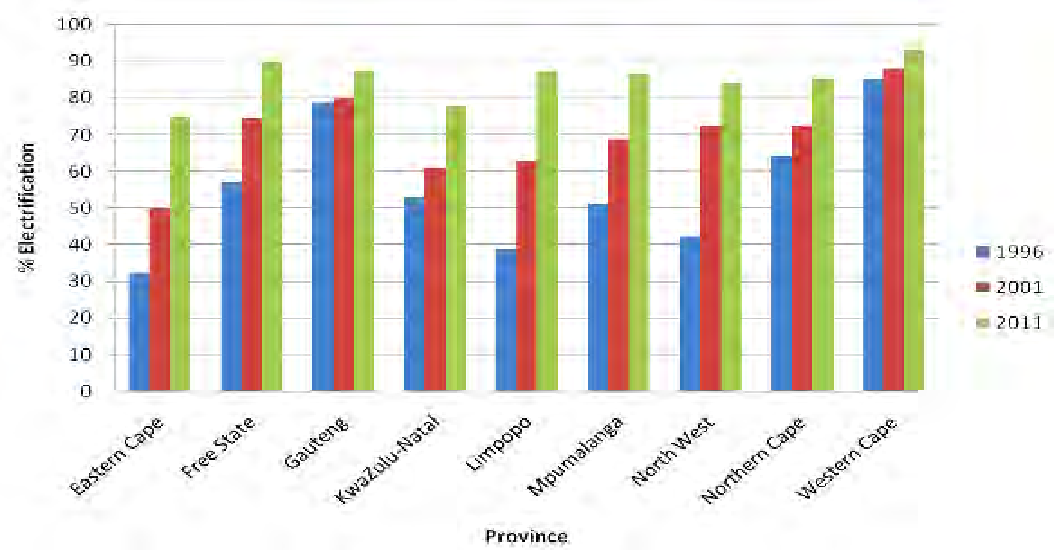
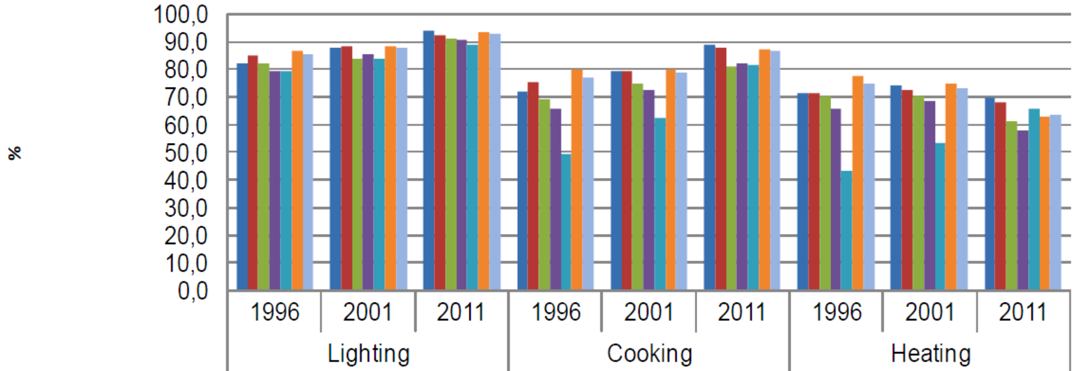


Figure 11: Percentages of Electrified Homes per Province 1996-2011 (StatsSA 2012c)

The most current information (from the 2011 census) shows that the current level of electrification is at 93.4% (Figure 12). The West Coast has the highest rate of connectivity (94.4%) whilst, as can be expected for a rural District with low population density, the Central Karoo has the lowest (89.4%). Despite the general increase in connectivity, the proportion of people who use electricity for heating purposes in the Western Cape decreased (StatsSa 2012a). This is most likely due to the cost of electricity.



	Lighting 1996	Lighting 2001	Lighting 2011	Cooking 1996	Cooking 2001	Cooking 2011	Heating 1996	Heating 2001	Heating 2011
West Coast	82,5	88,1	94,4	72,1	79,3	89,4	71,5	74,4	70,0
Cape Winelands	85,2	88,5	92,8	75,5	79,6	87,8	71,5	72,5	68,0
Overberg	82,6	83,9	91,2	69,4	75,2	81,4	70,4	70,5	61,1
Eden	79,3	85,6	91,1	65,8	72,7	82,6	65,9	68,9	58,0
Central Karoo	79,6	83,9	89,4	49,3	62,4	81,6	43,1	53,6	66,0
City of Cape Town	87,2	88,8	94,0	80,2	80,0	87,6	77,9	74,9	63,0
Western Cape	85,7	88,1	93,4	77,0	78,7	86,9	74,9	73,5	63,5

Figure 12: Electricity used for lighting, cooking and heating in the Western Cape (StatsSA 2012a)

3.4.2 Alternative fuels

Various alternative fuels are used by households as substitutes for electricity or as primary energy sources. These include gas (LPG), paraffin, wood, coal (anthracite), animal dung and small scale solar. Statistics collected during the 2011 census reveal that 7% of lighting needs, 13% of cooking needs and 21% of heating needs are satisfied through means other than electricity (StatsSA 2012a). Paraffin is preferred for lighting and heating, whilst gas is the preferred substitute for cooking purposes. What is concerning is that the burning of wood, coal and animal dung constitute 1.4% of energy needs for cooking and 5% of heating needs. Typically, the burning takes place indoors, which means that 22 000 and 85 000 households, respectively, are exposed to indoor air pollution and its associated health impacts. The collection of biomass for burning also impacts on the environment directly through deforestation and outdoor air pollution.

Although the use of alternative fuels are commonplace in rural households, it also persists in newly electrified and/or urbanised households that tend to continue to use fuel wood for a variety of reasons, including its low price or 'free' availability, cultural reasons, lack of money to buy alternative energy fuels, lack of money to buy appliances to run off other energy forms and general preference (DEADP 2007).

4 IMPACTS

This section provides an overview of the effects of changes in the environment. Driven by the Drivers and Pressures highlighted in section 2 above, the generation and use of energy result in impacts which bring about change in the environment such as poor air quality resulting from the emission of gases, contamination of water sources and loss of biodiversity.

The single most concerning impact is the close relationship that exists between the generation of energy and the release of greenhouse gases. This is particularly relevant where fossil fuel derived energy is prevalent. The use of fossil fuels result in the emission of gases that accumulate in the atmosphere and in varying degrees intensifies the earth's natural greenhouse effect. Based on 2009 figures, a total of 41 303 482 tonnes of CO_2e were released per year as direct result of our need for energy in the province (WCG 2013). Renewable energy sources, on the other hand, tend to have much lower embodied environmental footprints due to the inherent carbon neutrality and reduced operational and maintenance requirements.

The transport sector is the largest consumer of energy in the province, at 52% (WCG 2013). It is completely reliant on either coal-based electricity or combustion engines that emit gases that are hazardous to people and contribute to the greenhouse effect. However, the sector is calculated to only contribute 28% of total provincial greenhouse gas emissions as the use of liquid fuels has a lower emissions factor than coal-based electricity (WCG 2013). The environmental effects of transportation is especially aggravated on a local scale through the emission of combustion gases, because the emissions occur in close proximity to areas of high human exposure such as in cities. Energy use for transport activities furthermore causes impacts on water resources (water used for power generation and hydrocarbon pollution) and soil (hydrocarbon pollution from spillages).

Sectors that are more completely dependent on fossil-fuel derived electricity, such as industry and the built environment, have relatively high contributions to the provincial GHG emission total. Industry constitutes 36% of the provincial emissions and the built environment 26% (WCG 2013).

The generation of electricity in South Africa is not only responsible for the bulk of our GHG emissions, but also goes hand-in-hand with impacts associated with the mining and beneficiation of minerals. Mining activities cause disturbances in the earth's surface and can result in the loss of surface productivity through contamination or degradation, or the contamination of water resources through excessive abstraction or polluted mine drainage. The mining industry in South Africa is also responsible for many toxic by-products, such as methane, uranium, thorium, and other radioactive and heavy metal contaminants. In addition, raw materials need to be transported between the extraction site and the power station, which itself requires energy and extensive infrastructure. In comparison, solar and wind power generation do not emit harmful gasses since no fuels are combusted during the generation of electricity. However, the production of generation equipment, installation of infrastructure and operational processes can have impacts on the environment.

In terms of solar systems, photovoltaic systems do not require any water to create electricity, but the maintenance of the photovoltaic panels can include cleaning with water. Solar-thermal technologies on the other hand often require water to generate steam as part of the generation process, although some of the steam can be condensed back to water and re-used.

Wind energy systems do not cause water or air emissions and do not produce any kind of hazardous waste as part of the generation process. Moreover, wind power does not make use of natural resources like oil or gas and will therefore not cause damage to the environment through resource transportation and extraction. Additionally, no water is needed during operation. However, wind power plants do have some effects on the environment, including potential noise pollution and visual impacts, as well as avian, insect and bat mortalities.

As indicated previously, the use of alternative fuels in household applications can have severe implications for human health and the environment, especially where the burning of biomass or coal is involved. Conversion to cleaner burning fuels such as LPG gas can improve the efficiency of energy use and reduce the local (indoor) emissions and pollution. It should however be noted that the use of more efficient forms of energy, such as electricity, does not necessarily lead to an overall reduction in environmental impact since the impact remains partly dependent on the total amount of energy that is used. For example, more efficient energy mediums could be more affordable and therefore lead to an increase in energy usage.

5 RESPONSES

5.1 National programmes

The Integrated Electricity Resource Plan for South Africa - 2010 to 2030 (IRP 2010) (DME 2010) is currently the most central policy regarding the planned mix of electricity generation and supply in the country. According to the IRP 2010, an acceptable 'balance' between affordability, carbon emissions reductions, uncertainties around new technologies, water usage, job creation and security of supply, will result in an energy mix that still relies heavily on coal-based electricity. Nevertheless, large components of the future capacity requirements will be satisfied through nuclear (25%), renewable energy (42%) and gas (25%). Demand side management programmes will also be instituted to reduce the total energy requirements.

With regards to the potential to produce energy from renewable sources, biomass, wind, solar, small-scale hydro and waste, South Africa can be seen as very gifted, though these resources remains largely unexploited. Momentum is building at a national level to make use of the opportunities in the renewable energy field to supplement the national energy supply network and empower individual households through low cost energy generation solutions. Several important strategic initiatives have been launched in support of the development of wind power. The first is a project by the Department of Energy to generate a Wind Atlas of South Africa. This atlas models a generalised wind climate at 100m above ground for a 5km x 5km grid covering the Northern, Western and Eastern Cape. The information is available for application from the CSIR as one of the project partners (www.wasa.csir.co.za).

The erstwhile Department of Minerals and Energy published a Renewable Energy White Paper in 2003 which stipulated a target of 10 000 gigawatt hours (GWh) to be produced from renewable energy by 2013. This White Paper has, however, not been updated as a stand-alone document, but instead was superseded by integrated electricity supply planning that included renewable energy as a component. Specifically, the IRP 2010 (DME 2010) makes provision for targets for different types of renewable energy as part of the planned electricity mix for the country. According to the IRP 2010, renewable energy will contribute 18.2 GW of new capacity for electricity generation by 2030 (about 42%). Wind will contribute 8.4 GW to this total; solar PV 8.4 GW; concentrated solar 1 GW and other renewables 0.4 GW.

The most important programme for renewable energy generation is the Renewable Energy Independent Power Producer Procurement Programme administrated by the Department of Energy (www.ipprenewables.co.za). Under this programme, private power producers independent of the parastatal Eskom are offered the opportunity to generate a portion of the national target for renewable energy as stated in the IRP 2010. The programme is currently in its third bidding window (of a potential five), with 1 416 MW and 1 044 MW respectively allocated during the first two windows and an additional 1 266 MW being offered in window 3. Although the total generation capacity is limited, the programme is aimed at stimulating the local renewable energy industry and promoting sustainable development and growth. At current prices for electricity generation from new build projects, it appears as if it makes economic sense to push for investment in renewable technologies. It is calculated that new coal fired power (Madupi & Kusile) will cost 97c/kWh to generate, as compared to 89c/kWh to procure wind power from Independent Power Producers (SAREC 2013).

The Koeberg Nuclear Power Station, one of only a handful of nuclear power stations on the African continent, generates about 4% of total energy in South Africa. The use of nuclear technology for energy generation is governed by the Nuclear Energy Policy (DME 2008), and currently Eskom (as national electricity provider) is investigating the possibility of building new nuclear power stations, with two of the potential sites under investigation being in the Western Cape (Bantamsklip and Koeberg). Under the IPR 2010, 9 600 MW of new nuclear power capacity will be developed by 2030, constituting 25% of the new build programme (DME 2010). This will undoubtedly have a major impact on the carbon intensity of the county's energy sector, as nuclear is considered much 'cleaner' than fossil fuel based generation.

The Department of Energy's Energy Efficiency Strategy (draft second review 2012) sets targets and guides the implementation of energy and demand savings through by independent measurement and verification professionals. The strategy includes mass energy efficiency programme roll-outs and individual sectoral strategies for energy efficiency gains (DME 2012). A related initiative to promote energy efficiency is the amendment of sections 12(i) and 12(l) of the Income Tax Act, 1962 (Act No. 58 of 1962) to incentivize companies to minimize electricity use.

Realising that transportation plays a large role in energy efficiency, the Energy Efficiency Strategy includes specific targets for efficiencies for the transport sector, and alludes to the carbon tax being imposed on less fuel efficient vehicles. The intended outcome is a greater uptake of public transport.

5.2 Western Cape

The Western Cape Government has recognised the need for a more sustainable energy sector, and in September 2010, the Western Cape Department of Environmental Affairs and Development Planning (DEADP) published a White Paper on Sustainable Energy for the Western Cape Province. The 2014 Sustainable Energy Vision for the Western Cape is presented as:

"The Western Cape has a secure supply of quality, reliable, clean and safe energy, which delivers social, economic and environmental benefits to the Province's citizens, while also addressing the climate change challenges facing the region and the eradication of energy poverty" (DEADP 2010).

The White Paper follows on the Proposed Renewable Energy Plan of Action (2007), Sustainable Energy Strategy and Programme of Action (2007) and Draft Integrated Energy Strategy (2007). In order to achieve the vision of sustainable energy supply that moves away from a dependency on fossil fuel based energy, energy demand management programmes will be pursued, as well as a mix of renewable energy generation and clean energy technologies. This will all be supported through the necessary legal, financial, research and skills development initiatives (DEADP 2010).

In terms of the bulk generation of renewable energy, the Western Cape is particularly suited to wind and solar power technologies. DEADP has developed a Strategic Environmental Assessment for the Placement of Wind Energy Facilities, which mapped the entire Western Cape in terms of environmental and planning considerations in order to identify preferred areas for the placement of wind energy facilities. This tool can be used by developers and officials responsible for EIA authorisations to support decision-making. DEADP drives additional projects which aim to stimulate investment in wind power in the Western Cape through the removal of institutional and administrative obstacles. This includes a regulatory process guide and an electricity grid assessment.

The province will, however, not be able to move away from fossil fuels entirely. Bulk electricity will still be sourced from the main supply grid, whilst the industrial and mining hub in Saldanha Bay is envisaged as a key development point for the near future. Specifically, the Saldanha Industrial Development Zone has been earmarked for the development of an Oil and Gas Cluster, offering maintenance and repair as well as fabrication services to external customers (oil drilling platforms and the like) and communal and supply services to internal clients (SBIDZ 2012).

Also on the horizon is the development of a 'Green Economy' focussed manufacturing and industrial hub in the vicinity of Atlantis under the auspices of the GreenCape initiative. The GreenCape initiative as a whole is aimed at positioning the Western Cape as a leader in the green and renewable technology sphere, to generate employment through green development, and to promote the transition of the Western Cape economy to greater resource efficiency and a low-carbon future. Current projects include investigation into the slow roll-out of solar water heaters, unlocking the potential in waste, and promoting a green procurement programme.

In terms of transportation, the White Paper on Sustainable Energy for the Western Cape Province promotes a vision that the province will see a modal shift toward transport systems, technologies, fuels and vehicles with lower pollution values, and that clean propulsion systems will be dominant. In order to facilitate the shift, strategically planned public transport infrastructure development will take place, along with a strong focus on promoting the use of renewable energy in the sector.

5.3 Energy related targets

By 2016, 15% of all electricity must be from renewable sources[1], and a 20% energy reduction in energy consumption must be achieved in the Western Cape (Table 2). Similar targets have been set on a national level, as well as for the City of Cape Town. These commitments stimulate a market for companies in the renewable energy resources sector, thereby creating momentum for a transformation of the sector.

[1] Calculation of the "15%" target will be based on a calculation of the actual renewable energy generated in the Western Cape, rather than calculating specific power purchase agreements for renewable energy.

Table 2: Energy Targets for the City of Cape Town, Western Cape Province and National Government

ENERGY AND CARBON EMISSIONS TARGETS FOR THE CITY OF CAPE TOWN, WESTERN CAPE PROVINCE AND NATIONAL			
	CITY OF CAPE TOWN	WESTERN CAPE PROVINCE	NATIONAL
Sources	- *City of Cape Town Environmental Agenda (CoCT 2009)* - *Moving Mountains: Cape Town's Action Plan for Energy and Climate Change (CoCT 2011a)* - *State of Energy and Energy Futures Report (CoCT 2011b)* - *Integrated Development Plan (CoCT 2012)*	*Provincial Strategic Objectives : Energy Work Group Targets*	- *White Paper on Renewable Energy Policy (DME 2003)* - *Draft Energy Efficiency Strategy (DoE 2012)*
Energy supply and consumption	- Renewable energy share equal to 10% of energy consumed by 2020 (CoCT 2011a, 2011b, 2012) - By 2014, reduce electricity consumption by 10% from 2007 levels (CoCT 2009)	- By 2014, a 20% reduction in energy consumption - 15% of the electricity consumed must be from renewable sources by 2016	- 12% final energy demand reduction by 2015 (DoE 2012) - 10 000GWh of renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar & small scale hydro (DME 2003)
Government operations	- 10% reduction in energy consumption by 2012 (City of Cape Town 2011a & 2011b)	- 30% electricity reduction in all provincial buildings	
GHG Emissions	- Per capita carbon footprint reduced to 5 tonnes CO_2e by 2014 (CoCT 2009)		- CO_2 emissions to peak between 2020-2025 (DME 2003) - CO_2 emissions reduced to 34% below expected levels by 2020, and 42% by 2025 (DME 2003)

5.4 Policy, tools and legislation

The creation of a regulatory and policy environment for the development of a renewable energy sphere and an ongoing improvement in the efficiency of energy use commenced with the publication of the White Paper on Energy Policy for the Republic of South Africa (1998). The White Paper set the framework for energy policy and planning and made provision for:

- The development of new and renewable sources of energy;
- Adjustment of electricity market structures to achieve effective forms of competition;
- Regulations which promote a cost-of-supply approach to electricity pricing for non-domestic consumers; and
- Investigations into an environmental levy on energy sales to fund the development of renewable energy, energy efficiency, and sustainable energy activities.

Since the publication of the White Paper, a number of policies, regulations and implementation programmes came into effect. This includes the Integrated Electricity Resource Plan for South Africa - 2010 to 2030 (IRP 2010), Eskom's National Efficient Lighting Programme, the Renewable Energy Independent Power Producer (REIPP) Procurement Programme, Eskom's Medium Term Power Purchase Programme, the National Energy Efficiency Strategy (2012). In the Western Cape, this was mirrored in the form of a range of similar policy documents and regulations. Responses in the form of policies, tools and legislation across all scales applicable to this theme are listed in the summary table below:

Table 3: Summary of policy, tools and legislation related to Energy

National Responses	1998	The White Paper on Energy Policy for the Republic of South Africa.
	2003	The White Paper on Renewable Energy
	2003	Electricity Basic Services Support Grant (Free Basic Electricity) Policy
	2003	The Integrated Energy Plan
	2007	Free Basic Alternative Energy Policy (Household Energy Support Programme)
	2008	The National Energy Act (Act 34 of 2008)
	2008	National Energy Security Master Plan: Liquid Fuels
	2010	National Strategy for Sustainable Development and Action Plan – 2011-2014
	2010	Integrated Electricity Resource Plan for South Africa - 2010 to 2030 (IRP 2010)
	2011	National Climate Change Response White Paper
	2011	Renewable Energy Independent Power Producer Procurement Programme
	2011	National Development Plan 2030
	2012	Draft National Energy Efficiency Strategy (Second Review July 2012)
Provincial Responses	2007	Proposed Renewable Energy Plan of Action for the Western Cape. Resource Assessment, Scenarios, Proposed Objectives and Actions. A Component of the Provincial Sustainable Energy Strategy
	2007	Sustainable Energy Strategy for the Western Cape
	2010	White Paper on Sustainable Energy
	2013	Energy Consumption and CO_2 Emissions Database for the Western Cape
Local Authority Responses	2006	City of Cape Town Energy and Climate Change Action Plan
	2006	City of Cape Town Framework for Adaptation to Climate Change
	2009	Fleet Greening Framework
	2011	City of Cape Town State of Energy and Energy Futures Report
	2011	City of Cape Town Smart Living Handbook
	2011	City of Cape Town – Moving Mountains, Energy and Climate Change Plan of Action
	2011	Eden District Demand Side Energy Awareness Program

	2011	Energy Scenarios for Cape Town to 2050
	2013	Sustainable Energy Plans as part of the Provincial Municipal Support Programme

6 CONCLUSION

OUTLOOK: STABLE/DECLINING

While the Western Cape's energy supply remains dominated by conventional technologies and fossil fuels, there is a concerted move from non-renewable to renewable energy, with firm targets set and various projects or programmes underway to stimulate change. The challenge is, however, to put the planning into practice during the coming years.

In comparison to the other provinces of South Africa, the Western Cape remains at a good standard in terms of electrified homes, with the majority having access to electricity. While the Western Cape population increased from 2001 to 2011 by 29%, there was also an increase in electrified homes, from 86% to 93%, which renders it the best performing province in this regard. Nevertheless there still remains a significant portion of the population within the region that either do not have access to electricity supplied by the national grid or that cannot afford electricity. These people typically resort to the use to biomass for energy needs, which comes with a range of associated undesirable consequences.

A particular focus for the short term should be the aggregation of accurate data on energy generation and usage, to compensate for a dearth of actual usage data on a national scale. In particular, information on independent generation of renewable energy must be assembled in order to paint a clear picture of the energy sector in the Western Cape. Attention should also be focussed on adjustment of policies, regulation and infrastructure related to private microgeneration to supplement to the main electricity supply grid. The current regulatory environment discourages such contributions, and planning for large scale infrastructure roll-out such as smart metering must commence.

The findings of the Energy chapter can be summarised as an overall outlook for the future as potentially stable or declining, depending on a number of connected factors. Table 4 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action. Table 5 contains the anticipated changes or outlook for the future of Energy, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding.

Table 4: Summary of key aspects identified in the chapter

Aspect	Summary of key points
Pressures	• Population growth • Growing consumerism • 3% economic growth
Impacts	• Carbon footprint • Competition for land • Air quality • Displaced impacts of generation, e.g. mining, power station, transmission
Challenges	• Energy dependencies, e.g. liquid fuels for transport • Grid-based electricity supply • No information on private sector initiatives • Role of - and impact of natural gas • Mandates of government
Progress	• Green economy initiatives • GreenCape • IPP facilitation
Critical areas for action	• Drive renewable energy development • Built environment and urban infrastructure innovations – rethink energy provisions • Gather information on private sector initiatives • Address energy intensity and dependencies • Improve understanding of natural gas potential and impact

Table 5: Summary of the outlook for energy based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend
Energy generation	• Oribi/Oryx oil field (2% of RSA liquid fuels) • PetroSA coal/gas-to-liquid plant • 2x open cycle gas turbines (2 084 MW) • 2x gas turbines (207 MW) • Koeberg nuclear reactor (1 800 MW) • Palmiet pumped storage (580 MW) • 4x solar, 4x wind farms planned under the Independent Power Producers (IPP) process • Eskom Sere wind farm under construction	Improving
Energy use	• Total excluding marine and aviation: o 247 742 000 GJ in 2004 o 270 887 000 GJ in 2009 • 52% used by transport (previously 35%) • Mostly coal based electricity and liquid fuels • CoCT consumes 60%, West Coast 24%	Declining
Energy intensity	• 64 GJ/capita • 8t CO_2e/capita • Even higher intensity per unit of GDP • West Coast 6x higher intensity than provincial average (industries) • Central Karoo relatively high due to overland transport	Concern

Indicator	Quantification	Trend
Domestic energy use	• Households electrified: o 83.5% in 2005 o 93.4% in 2011 • Decreasing % of households using electricity for heating • Energy other than electricity: o 7% for lighting o 13% for cooking o 21% for heating	Improving

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BETTER TOGETHER.

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ABBREVIATIONS

CH_4	Methane
CKDM	Central Karoo District Municipality
CoCT	City of Cape Town
CTC	Cleanest Town Competition
CWDM	Cape Winelands District Municipality
DMA	District Management Area
EDM	Eden District Municipality
HCRW	Health Care Risk Waste
IWMP	Integrated Waste Management Plan
MSW	Municipal Solid Waste
NEM:WA	National Environmental Management: Waste Act
NEMA	National Environmental Management Act
NWMS	National Waste Management Strategy
ODM	Overberg District Municipality
PIWMP	Provincial Integrated Waste Management Plan
SAWIS	South African Waste Information System

GLOSSARY

Leachate	Any liquid material that drains from land or stockpiled material and contains significantly elevated concentrations of undesirable material derived from the material that it has passed through
Building and demolition waste	Waste, excluding hazardous waste, produced during the construction, alteration, repair or demolition of any structure, and includes rubble, earth, rock and wood displaced during that construction, alteration, repair or demolition.
General waste	Waste that does not pose an immediate hazard or threat to health or the environment, and includes: • Domestic waste; • Building and demolition waste (excluding asbestos); • Business waste; and • Inert waste
Hazardous waste	Any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment.
Industrial symbiosis	The sharing of services, utility, and by-product resources among industries in order to add value, reduce costs and improve the environment.

Waste	Any substance, whether or not that substance can be reduced, re-used, recycled and recovered –
	• That is surplus, unwanted, rejected, discarded, abandoned or disposed of;
	• Which the generator has no further use of for the purposes of production;
	• That must be treated or disposed of; or
	• That is identified as a waste by the minister by notice in the gazette, and includes waste generated by the mining, medical or other sector; but –
	  o A by-product is not considered waste; and
	  o Any portion of waste, once re-used, recycled and recovered, ceases to be waste.

1 INTRODUCTION

Waste production is driven by factors such as the growing population and increasing demands for goods. As consumerism, industrialisation and urbanisation continue to increase, so too does waste generation. This places significant pressure on a finite ability of natural and man-made systems to process waste material.

However, while waste has traditionally been viewed as a by-product or end-of-use material that is to be disposed of, this opinion has shifted over recent years. 'Waste' can play a role as a valuable resource to further economic growth in the manufacturing of second generation products, materials recovery and recycling industry, generation of energy, up-cycling and art, amongst others. This shift in the management approach to waste provides some relief to the pressure placed on finite resources, e.g. less virgin material used in manufacturing. It also results in less waste being landfilled which can then be significantly reduced if waste can be used as a source of energy.

In recent years, the Western Cape has made significant strides in improving waste management and more importantly the integration of sustainable practices that recognises waste as a resource rather than a liability. However, there is still room for improvement as the province builds on its current achievements.

This chapter aims to outline the current pressures driving waste generation and the resulting impacts of this industry. It also provides a snapshot of the current waste generation quantities and types across the province, the services and facilities used to handle and process waste and how the province has developed towards a greener economy.

Definition of waste

The National Environmental Management: Waste Act (Act 59 of 2008) introduced a definition of waste, which has major implications for those activities that were traditionally not treated or regarded as waste. The Act defines waste as:

"any substance, whether or not that substance can be reduced, re-used, recycled and recovered".

Waste can further be divided into two categories namely general waste and hazardous waste. General waste is defined as waste that does not pose an immediate hazard or threat to health or to the environment and includes domestic waste, building and demolition waste, business waste and inert waste. General waste may be disposed of at any authorised waste disposal facility. General waste sites must have leachate management systems, given that general waste can produce leachate with unacceptably high pollution potential. Hazardous waste is defined as any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment. Hazardous waste is rated according to its toxicity and has to be treated and disposed of in facilities appropriate for its rating (DEADP 2004).

2 PRESSURES

2.1 Modernisation and urbanisation

Modernisation is a process in which a society transforms itself from a traditional rural agrarian society into one that is urbanised and primarily based on industrial production. The waste generated within this 'modern environment' comes in many forms and shapes: as by-products of manufacturing, as packaging that make the transportation or preservation of items possible, agricultural processes and by-products, and as consequences of inefficient consumption patterns. Modernisation also creates materials that are not present in the natural environment, either as a type of material or in a particular concentration. A typical example of this can be found agricultural products, e.g. fertilizers, pesticides and herbicides. These materials consequently need to be processed through further modern activities of waste management and disposal.

Urban areas are typically the focal points for industrial activity, manufacturing, trade, logistics and residential concentrations, and hence generate significant waste volumes and many different waste streams. The concentration of people in urban areas also concentrates the generation and disposal of waste products, intensifying the need for adequate waste management and disposal. On the positive side, urban areas offer possibilities for consolidation of waste streams in order to optimise opportunities for coordinated collection, re-use or recycling of waste products and concentrated disposal.

2.2 Consumer behaviour

As the Western Cape's population grows, and the industrial and urban developments accelerate in support of a growing economy, the population uses increasing amounts of consumer items such as food, clothing and electronics. This demand for consumer goods is intensified as average household size decreases (StatsSA 2012), thereby creating more households that require more individual residential units and associated waste generation and collection. This increased consumption rate places pressures on the environment and results in an increased waste generation. Increased consumption, in the absence of significant re-use of waste materials, also implies unnecessary raw material extraction and processing in order to satisfy the consumptive behaviour, which leads to environmental impacts at the source of the consumer items.

2.3 Means of disposal

Typically, waste is disposed of by concentrating it in landfills of various sizes, incinerating or burning it, or by scattering it in the general environment (e.g. illegal dumping, littering or incorrect landfilling). All three means result in the concentration and release of pollutants to the water, air and soil, and hence are detrimental to the natural environment.

Disposal to landfill is the most common form of waste disposal. Typically, waste would be collected from various points within a municipality, taken to transfer stations for compaction and then taken to a landfill site for disposal. Landfills of all sizes have similar environmental impacts, e.g. concentration of waste, soil and groundwater contamination, nuisance vectors and air pollution. The severity of these impacts varies depending on environmental factors such as soil type, water table levels, amount of precipitation, and landfill design and management. The size of landfills is typically measured in terms of the volume of space that the landfill will occupy, rather than absolute volumes or weights of waste materials. This volume of space is termed 'airspace', and is used for permitting processes to specify a landfill's final allowable size.

The incineration or burning of waste results in direct negative air quality impacts on the atmosphere and the health of people. Unlicensed incineration is therefore illegal under the National Environmental Management: Waste Act. Although, authorised / licensed incineration still remains the best available means of disposal of health care risk waste to avoid the spread of disease or contaminants, and correctly designed and operated incineration facilities (e.g. high temperature incineration or pyrolisis facilities) can significantly reduce the environmental impacts.

Illegal dumping and littering is a problem commonly experienced in areas where awareness of waste impacts is low, and/or where waste collection and disposal systems are inadequate. This can give rise to biological risks and health hazards related to the decomposition of organic waste, the attraction of disease vectors and chemicals leak into the environment. Proper landfilling techniques and the treatment of waste (e.g. incineration, non -combustion processes, etc.) can reduce the environmental impacts.

3 STATE

The Western Cape faces numerous challenges in waste management similar to the challenges experienced in the rest of the country. The Provincial Integrated Waste Management Plan (IWMP) (DEADP 2012a) outlines a number of key challenges for the province which includes, amongst others:

Tracked indicators of the *status* of Waste Management:

- Volumes and type of waste generated
- Types of waste generated
- Waste collection services
- Quantities and types of waste management facilities

- A shortage of airspace and unlicensed landfill facilities
- The rising cost of managing waste collection, transportation and disposal of waste
- Shortage of appropriate waste management infrastructure which includes recovery and recycling infrastructure
- Non-payment of municipal charges for waste disposal
- Lack of capacity or expertise in the municipality with regards to waste management
- Increasing incidences of illegal dumping and the cost of removing dumped waste
- The looming funding crisis in waste management at both provincial and municipal spheres
- Tariff setting (not based on full cost accounting and dependant on cost recovery through waste collection and disposal charges and cross-subsidization)
- Poor compliance monitoring and enforcement of enabling environmental legislation and authorisations
- Poverty crisis leading to the informal and often dangerous reclaiming of food and recyclables on landfill facilities

- Paucity of waste information
- Increase in consumption patterns placing pressure on current waste collection, transportation and disposal
- Limited waste avoidance and minimization practices

The sub-sections that follow aim to highlight the current status of all aspects related to waste management in the Province; the progress that has been made to correct the identified challenges in this field and areas that still require attention.

3.1 Waste generation

3.1.1 Waste volumes

Solid waste generated in the Western Cape in 2010 amounted to some 3 807 765 tonnes per annum[1], based on a comparison of four different waste quantification methods (DEADP 2012a). In comparison, the 2005 State of Environment Report for the Western Cape reported a figure of 1 446 500 tonnes for 2001 (DEADP 2005). High range projections for waste generation for 2015 and 2020 are respectively set at 4.7 million tonnes and 5.2 million tonnes per annum (DEADP 2012a).

Relative contribution from the different Districts show that the City of Cape Town represents approximately 70% of the total waste generated in the province, with the Cape Winelands and Eden Districts ranking a distant second and third (Figure 2). The corresponding analysis from the 2005 State of Environment Report is provided for comparison (Figure 1). As can be seen, the relative contribution of the Districts have eaten into the dominance of the City of Cape Town, which can be due to an increase in waste generation in the Districts, but more than likely rather due to an effort on the part of the City of Cape Town to reduce waste.

Estimates of annual waste disposal volumes derived from the waste characterisation study for Cape Town show that in 2007, the City of Cape Town landfill sites would have received a total waste volume of 2 370 113 tonnes (DEADP 2007a). This compares well with the 2010 baseline of 2 670 836 calculated for the purposes of the IWMP (DEADP 2012a). Of the total waste, general waste would be about 614 879 tonnes, the rest would be garden refuse, rubble and other waste not collected by the Municipal vehicles (DEAD 2007a).

Figure 3 provides the actual waste tonnage annually generated in each municipal area (Districts and City of Cape Town), with corresponding values from the 2005 State of Environment Report. Severe increases in volumes appear to be present but these can be assumed to reflect improving monitoring and reporting on waste volumes rather than actual increases.

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[1] It is generally acknowledged though that information on waste generation and disposal in South Africa as a whole is poor (DEA 2012a, DEADP 2012a). This uncertainty is acknowledged in the latest calculations for the Western Cape, and consequently the annual amount of waste can be up to 12.5% higher or lower than calculated.

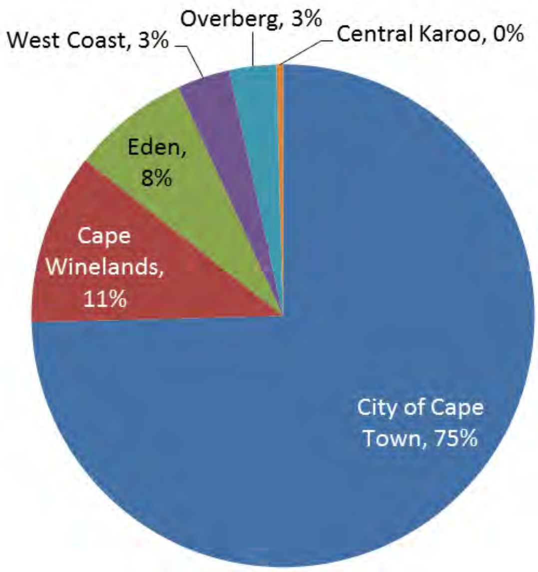


Figure 1: Distribution of waste generation in the Western Cape 2001 (DEADP 2005)

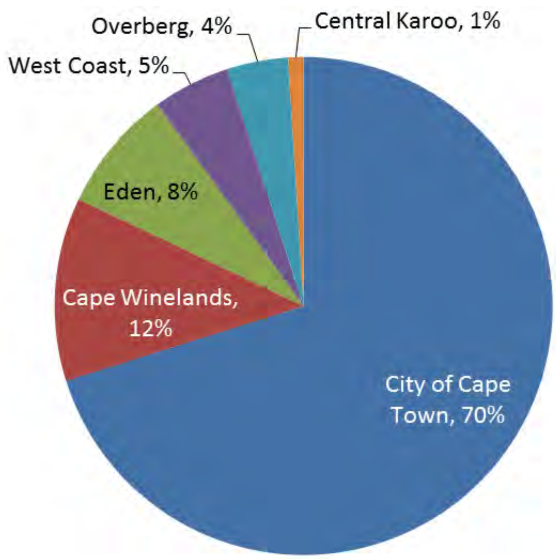
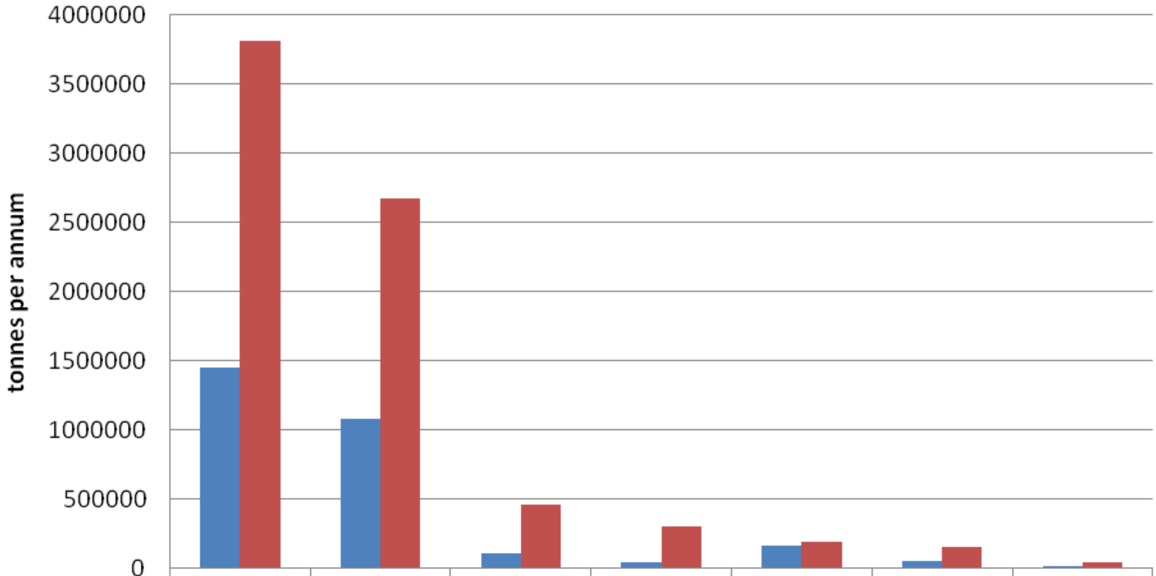


Figure 2: Distribution of waste generation in the Western Cape 2010 (DEADP 2012a)



	Western Cape	City of Cape Town	Cape Winelands	Eden	West Coast	Overberg	Central Karoo
2005	1446500	1079014	108853	43619	159585	49235	6194
2010	3807764	2670836	453505	302745	190994	151618	38066

Figure 3: The distribution of waste generation within the Western Cape, as tonnes per annum for the years 2005 and 2010 (DEADP 2005; DEADP 2012a)

3.1.2 Waste characterisation

Understanding what the general waste stream consists of is a key requirement for successful waste management planning. In this regard, a waste stream analysis was done for the purposes of compiling the Western Cape IWMP (DEADP 2012a). The characterisations for the different districts are shown in Figure 4. It should be noted though that information for the Central Karoo is still uncertain at this stage and needs to be verified.

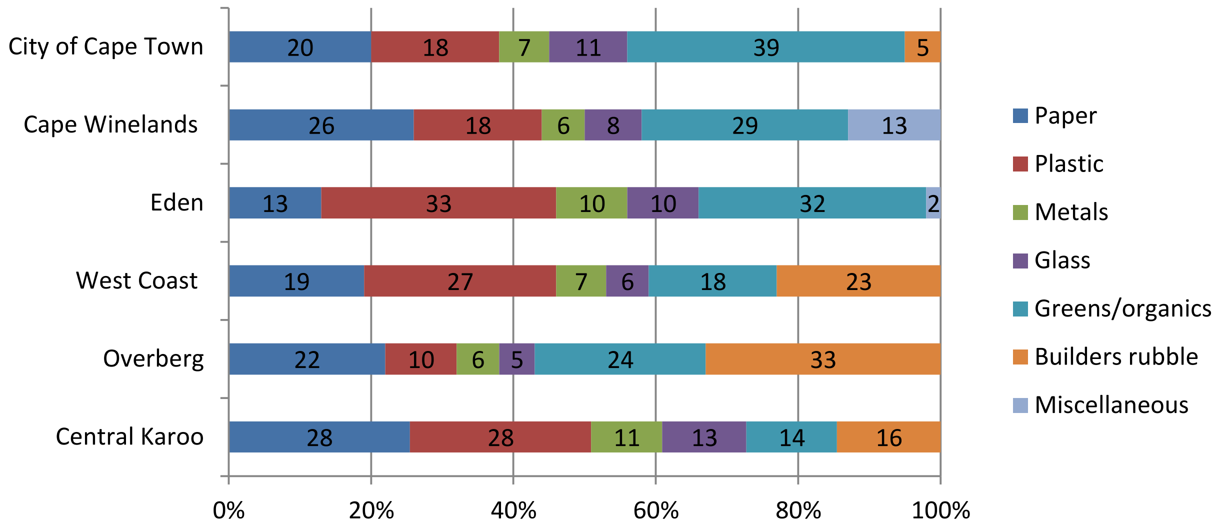


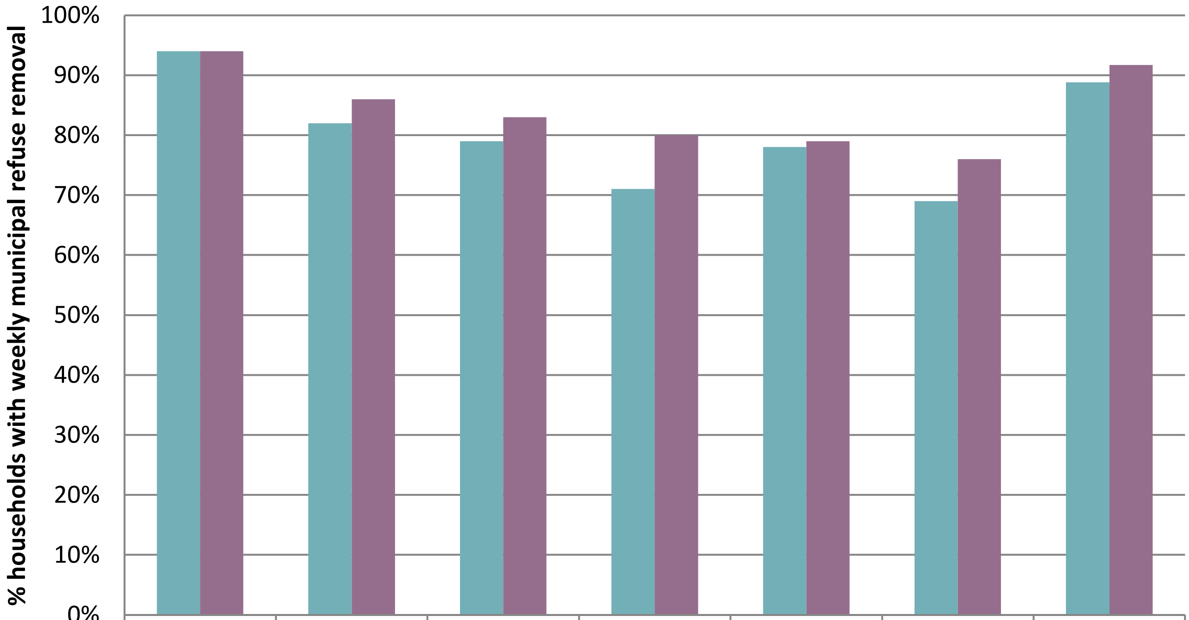
Figure 4: Waste stream analysis for the Western Cape (DEADP 2012a)

The main observations from the characterisation study data include (DEADP 2012a):

- The Central Karoo District showed a high paper and plastics percentage but is low in other categories of waste.
- Paper, plastics, metals and glass percentages in the waste stream were higher in the City of Cape Town than what is found in Johannesburg.
- Builders' rubble figures, although in most cases not reported, were noticeably high for the Overberg District.
- The City of Cape Town has a significant green waste component, as does Eden and the Cape Winelands
- Eden, Central Karoo and West Coast Districts have significantly high plastic waste percentages

3.2 Municipal waste collection services

Population growth, commercialism and urbanisation, and migration of the population to urban nodes all place increasing pressure on municipalities to improve on waste management services. Nevertheless, during the past decade the rate of formal waste removal services has kept pace, and indeed improved throughout the province. In the City of Cape Town the percentage remained at 94% despite significant population growth. As is shown in Figure 5, the percentage of households with access to weekly domestic waste collection services has grown in all districts between 2001 and 2011 (StatsSA 2012).



	Cape Town	Eden	Overberg	Cape Winelands	Central Karoo	West Coast	Western Cape
2001	94%	82%	79%	71%	78%	69%	88.8%
2011	94%	86%	83%	80%	79%	76%	91.7%

Figure 5: Weekly waste removal taking place across the Western Cape (StatsSA 2012)

Municipal waste collection services play an important role in the management of solid waste, in particular domestic waste. Efficient collection services, executed hand-in-hand with street cleansing, ensure that social conditions are maintained at an acceptable level, prevent pollution of the natural environment and limit the spread of disease.

Waste collection services undertaken by private contractors, particularly for the industrial and commercial customers also play an active role. It is estimated that the split in tonnage between municipal waste collection and private companies is 40:60 in the City of Cape Town, including services such as 'pay as you throw', separation at source and recycling opportunities.

3.3 Waste management facilities

In 2006 some 240 waste management facilities were recorded in the Western Cape, the majority being either permitted landfills or illegal waste disposal sites (DEADP 2012a). Of these, 193 are operational (DEADP 2012b). It includes 92 general waste disposal sites, 54 drop-off facilities, 15 transfer stations and 13 materials recovery facilities. Regional waste collection facilities in the less densely settled districts are having an impact, with drop-off and transfer stations becoming quite prevalent (Table 1).

Table 1: Operational waste management facilities in the Western Cape (DEADP 2012b)

Facility type	Cape Winelands	Central Karoo	CoCT area	Eden	Overberg	West Coast	Western Cape
General disposal	13	5	3	22	16	33	92
Hazardous disposal			1				1
Drop-off	6	2	19		16	11	54
Transfer station	3		3	5	4		15
Composting	2		1				3
Materials recovery	3	1	7		1	1	13
Recycling			2	2			4
Treatment			2	1			3
Hazardous Storage			6	1			7
Gas extraction plant			1				1
Total	**27**	**8**	**45**	**31**	**37**	**45**	**193**

3.3.1 Waste disposal facilities

With ever increasing quantities being generated in the province, disposal practices continue to be an important waste management requirement. The City of Cape Town has three municipal waste disposal facilities in operation: Coastal Park, Vissershok and Bellville South. The largest of these is Vissershok at 117 hectares. Coastal Park waste disposal facility site is about 75 hectares in extent and Bellville South slightly smaller, taking up about 60 hectares.

Coastal Park is currently in a second phase of operation, following the installation of a multi layered lining. This allows the site to increase its current height by 15 metres, which will culminate in a final height of between 35 - 45 metres above ground level. Estimations are that Coastal Park will reach capacity in 2027. Vissershok will reach about 65m above ground level, once closed. At present, most individual cells of the site are either full or in advanced stages of filling. Plans to extend the site will give Cape Town an additional 18 million m^3 and about six to nine years of airspace. Bellville South is filling up rapidly, with closure being planned for 2018 (CoCT 2013).

The rest of the province plays host to 89 operational disposal sites, most of which are located in the West Coast and Eden Districts (DEADP 2012b). These sites would be small, local disposal areas at individual towns. New regional waste disposal facilities are planned as (DEADP 2012b):

- 2 for the Cape Winelands District
- 1 for the Eden District
- 2 for the West Coast District
- 1 for the City of Cape Town

New waste disposal facilities are costly to develop and hard to fit within the matrix of land uses where most waste is generated. The available remaining capacity of existing waste disposal facilities consequently needs to be considered as a key aspect of solid waste management in the province. For example, estimations show that with a 7% growth in waste generated per annum, even if a planned new waste disposal facility was developed in the City of Cape Town in 2012, the landfill airspace availability for the City will be exceeded around the year 2025, as depicted in Figure 6 (Muller 2012). It is therefore quite clear that innovative solutions to reduce the amount of waste reaching waste disposal facilities must be found in order to prevent a waste overload and subsequent environmental impacts.

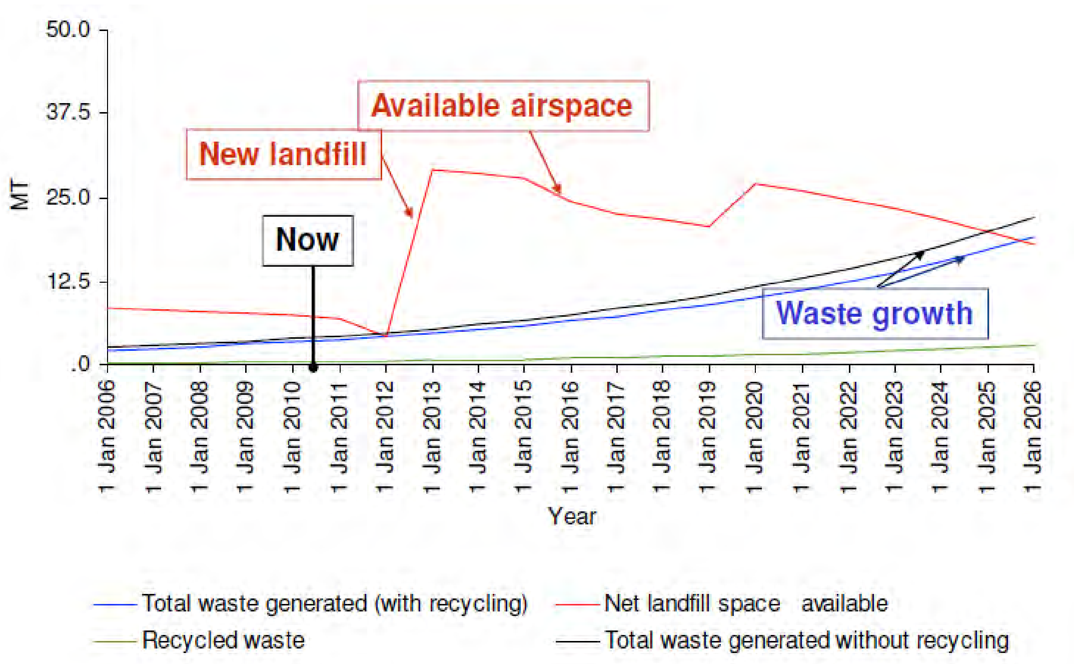


Figure 6: Available landfill airspace in Cape Town (Muller 2012)

3.3.2 Materials recovery and recycling facilities

Intermediate storage, sorting and recovery facilities offer the opportunity for recyclable waste to be diverted out of the general waste stream. Such facilities are commonly provided at transfer stations or 'drop-offs' at centralised locations. In a simple form, these facilities receive builder's rubble, garden or green waste and recyclables from individuals and waste collection companies, in order to limit the amounts of these types of waste that enters the general waste stream. However, integrated facilities, such as provided at Kraaifontein in the City of Cape Town, can further improve waste recovery. Kraaifontein has a drop-off facility, materials recovery facility, a refuse transfer station and a green waste chipping area. Recyclable waste that is received is sorted, separated, baled and then sold by a contractor. At present this site has the capacity to manage up to 960 tons of mixed general waste per day (Muller 2012).

In 2010, 10 transfer stations were in operation in the province, where opportunities exist for diversion of garden waste and recyclables (DEADP 2012a).

3.3.3 Hazardous waste disposal

The Vissershok waste management facilities in Cape Town, managed by Enviroserv and WasteMan, and a facility at PetroSA in Eden District, are the only two sites commercially used for hazardous waste disposal in the Western Cape Province. The PetroSA waste disposal facility serves the PetroSA operations located in Moss Industria (Mossel Bay) for hazardous waste but also has a facility that caters for the greater Eden area with regards to general waste disposal.

According to the Hazardous Waste Management Plan for the Western Cape (DEADP 2006), seventeen physical hazardous waste treatment technologies are used in the Western Cape including ash blending, incineration, encapsulation, evaporation, filtration, flocculation, solidification and immobilization of which flotation is the most common. Seven chemical treatment technologies, including dechlorination, electrolysis, hydrolysis, neutralisation, oxidation, precipitation and reduction, are present. Biological treatment technologies are not commonly used in the Western Cape, however when applied, they are used for the treatment of organic effluents and spills.

3.3.4 Incinerator facilities and Electro Thermal Destruction

Based on health care waste treatment records, the waste stream almost doubled from 2003 to 2009 (DEADP 2012a). Health care risk waste is either incinerated as a means of disposal or treated through Electro Thermal Destruction. Incineration does not get rid of waste, but rather transforms it from one form into a range of others such as air emissions, ash and liquid discharge that are easier to process. It remains one of the most effective means to eliminate the risks posed by health care risk waste, and to reduce the overall volume of waste. The Hazardous Waste Management Plan for the Western Cape (DEADP 2006) lists thirteen incinerator facilities in the Western Cape (Table 2), although only two facilities remained in operation at the time of reporting, with a third operating in the George area.

Table 2: Existing incinerator facilities within the Western Cape Province (adapted from DEADP 2006)

No	Facility name	Regulatory status	Operational
1*	Sanumed Medical Waste incinerator	Temporary permit in terms of APPA, EIA authorisation	NO
2*	BCL Medical Waste Management: Medical Waste Incinerator	Authorisation in terms of Section 26 of ECA, permit in terms of APPA	YES
3*	Evertrade (Electro Thermal Deactivation Plant)	Permit in terms of APPA, licence in terms of offensive trade regulations, authorisation in terms of Section 26 of ECA	YES
4*	Envirologic	Application for EIA authorisation & scheduled process permit ongoing	NO
5*	Milnerton Medical Incinerator	No authorisation or permits in terms of Section 21 of ECA or APPA	NO
6*	Prince Albert Provincial Incinerator	No authorisation or permits in terms of Section 21 of ECA or APPA	NO
7*	Swellendam Provincial Incinerator	No authorisation or permits in terms of Section 21 of ECA or APPA	NO
8*	Caledon Provincial Incinerator	No authorisation or permits in terms of Section 21 of ECA or APPA	NO
9*	Malmesbury Provincial	No authorisation or permits in terms of	NO

No	Facility name	Regulatory status	Operational
	Incinerator	Section 21 of ECA or APPA	
10*	Porterville Provincial Incinerator	No authorisation or permits in terms of Section 21 of ECA or APPA	NO
11*	Clanwilliam Provincial Incinerator	No authorisation or permits in terms of Section 21 of ECA or APPA	NO
12*	Vredendal Provincial Incinerator	No authorisation or permits in terms of Section 21 of ECA or APPA	NO
13*	Vredenburg Provincial Incinerator	No authorisation or permits in terms of Section 21 of ECA or APPA	NO

4 IMPACTS

Poor management of waste or of waste management facilities, especially with regards to leachate and methane, has an adverse impact on the environment, manifesting as impacts such as contamination of air, land and water sources, an increase in the spread of diseases, and can result in detrimental living conditions for all forms of life exposed to concentrations of waste. These impacts are further elaborated on in the subsequent sections.

4.1 Land use

Waste disposal facilities are generally unwelcome spaces due to aspects such as smell, informal reclaiming of waste products, traffic, noise, dust and vermin that often accompany such facilities. Waste disposal facilities are bio-chemically active places where decomposition takes place and materials are broken down into their constituent compounds. This interacts with environmental systems, often with disastrous results for natural ecosystems. The longevity of the disposed-of materials and concentration of waste also means that despite the best preventative measures and good designs, the potential impact of landfills on the environment extends beyond their closure. In some cases this could be well beyond 50 years.

With waste disposal facilities rapidly reaching capacity across the Western Cape, new land must be identified for the development of facilities to manage waste. The result is loss of land in the sense that land that could be utilized for other land uses, such as housing or industry. This also includes land in the immediate vicinity of waste disposal facilities that will be compromised by the associated impacts. The implications surrounding the social, environmental and economic costs of new waste disposal facilities construction continues to make the waste management approach impractical. Placing new waste disposal facilities too far out of the city would pose huge costs for the municipality, while locating them closer could infringe on the quality of life of people living near to them. Sites should also not be located near bodies of underground or a high water table as contamination can easily occur. This makes it extremely difficult to locate suitable pockets of land for this activity.

4.2 Health

Community health is likely to suffer in the vicinity of waste accumulation. Apart from the general nuisance effects such as odour and elevated levels of dust and wind-blown litter, waste accumulation can promote the spread of disease vectors and result in specific adverse health effects associated with pollution, such as birth defects, cancer and respiratory illnesses.

Of particular concern around waste disposal facilities is air, soil and water pollution. Air pollution will occur in the form of dust and hazardous compounds (e.g. methane, carbon dioxide and aldehydes) if the landfills are not managed correctly. Water pollution, both above and below ground, will occur where improper precautions have been taken to prevent leachate seeping into the ground and water sources.

4.3 Cost to municipal operations

As highlighted in the provincial IWMP, the rising cost of managing waste collection, transportation and disposal of waste is a serious concern in waste management (DEADP 2012a). Costs to municipal administrations are also incurred through the removal of illegal dumping and other ancillary cost items such as awareness campaigns, clearing of stormwater management structures, fouling of wastewater treatment works. On a provincial scale, it is found that municipal solid waste revenues did not cover the operating costs of service provision, resulting in a deficit that averages approximately 15% of all expenditures across municipalities. This is particularly evident in smaller municipalities (DEADP 2012a).

4.4 Pollution

4.4.1 Landfill leachate

Leachate is any liquids that migrate from waste carrying dissolved or suspended contaminants. Contaminants in buried refuse may result from the disposal of industrial waste, ash, waste treatment sludge, household hazardous wastes, or from normal waste decomposition. If uncontrolled, landfill leachate can be responsible for contaminating ground water and surface water.

The risks from waste leachate are due to its high organic contaminant concentrations and high concentration of ammonia. Pathogenic microorganisms may also be present however counts reduce rapidly with time in the landfill. Toxic substances may however be present in variable concentration and their presence is related to the nature of waste deposited. Should toxic metals and organics be present, the pollution will result in toxin accumulation in the foodwebs or ecosystems.

Leachate may result in acute or chronic impacts on environmental resources, affecting both species directly and their habitats in general. The greatest environmental risks occur in the discharges from older sites constructed before modern engineering standards became mandatory; and also from sites where permitting requirements and industry standards have not been applied.

Vissershok waste disposal facility and leachate plant

The Vissershok waste disposal facility is classified as a hazardous (H:h) site. The original site is known as Vissershok South and comprises seven engineered cells. The site is currently undergoing a significant extension to the north, known as Vissershok North, which will involve the addition of 50 ha of lined cells.

Rain and liquid wastes disposed of at these hazardous landfill sites result in the production of leachate which is 10 to 30 times stronger than raw sewage. The extension would thus increase the volume of leachate generated by the landfill to approximately 330 m^3/day. However, the existing leachate treatment plant (commissioned in 2004) was only designed for 80 m^3/day. The plant is therefore being upgraded to handle the significantly larger volume of leachate and to ensure treatment meets a much stricter standard, which has to date not been achieved for leachate in South Africa.

The new plant consists of a primary biological treatment process incorporating denitrification. This is followed by a tertiary treatment process consisting of ultra-filtration membranes, ion exchange and finally reverse osmosis treatment. The plant will be fully automated and will also include aeration optimisation, automatic anti-foam and glycerol dosing. It will thus be able to treat between 200 m^3/day and 330 m^3/d without the operator having to make any manual adjustments to the process equipment.

The Vissershok leachate treatment plant will attain a number of firsts in South Africa, namely:

- First to involve the new denitrification processes
- First to treat to the Department of Water Affairs Special Limit effluent standards
- The largest leachate treatment plant in South Africa

Data source: Jeffares & Green 2013

4.4.2 Methane

Waste disposal facilities are one of the largest anthropogenic sources of methane (CH_4). Landfill methane is produced when organic materials are decomposed by bacteria under anaerobic conditions (i.e. in the absence of oxygen). Methane production varies greatly from disposal facility to disposal facility depending on site-specific characteristics such as waste quantities, waste composition, moisture content, landfill design and operating practices, and climate. Unless captured first by a gas recovery system, methane generated by the disposal facility is emitted when it migrates through the landfill cover. During this process, the soil oxidizes approximately 10% of the methane generated, and the remaining 90% is emitted. Methane is a powerful greenhouse gas, with approximately 72 times as much global warming potential than carbon dioxide over a 20 year period.

4.4.3 Illegal dumping and litter

Solid waste material that is illegally or incorrectly dumped, or even littered, is easily diffused in the natural or built-up environment. This has cost implications for authorities and general negative consequences for both the social and natural environments. Impacts include:

- Marine pollution when discarded waste is transported via the storm water drain system into the coastal marine environment. This necessitates beach clean-ups or interventions to deal with coastal water contamination.
- Decline of aquatic health in the receiving water bodies.
- Decline of water quality of riparian environments, which results in higher treatment cost for potable water.

Illegal dumping and littering is also often a major indicator of neighbourhood decline and disorder, alongside graffiti, vandalism and abandoned buildings. This leads to a decline in property values and a potential rise in criminality due to the perception of reduced authoritative control.

5 RESPONSES

Landfilling, dumping and incineration of waste are essentially unsustainable waste management practices that have negative effects on the planet and on populations who rely on a healthy ecosystem to survive. The disadvantages of waste may, however, be mitigated by focusing more on management of waste and less on its disposal. This realization has led to a shift in the approach to waste management at a national scale.

In the Western Cape, strategies have been set up to actively reduce the amount of solid waste reaching waste disposal facilities. The results of a cost analysis show that for a diversion rate of 25% there could be a 15% cost benefit, in other words the total waste management expenditure could be 15% less. It also gives an indication that for every 10% of waste that is diverted there will be a cost benefit in the order of 6% (DEADP 2012a).

A number of broad interventions aimed at influencing behaviour and improving waste management processes are underway in the province, and are discussed below.

5.1 Solid waste management

5.1.1 Materials recovery and recycling / waste minimisation

The Western Cape, and in particular the City of Cape Town, has embarked on a waste minimization initiative over the past few years with the aim of decreasing the amount of solid waste which is landfilled. This will increase the lifespan of existing landfill sites, but also promotes the use of waste as a resource, e.g. for energy generation, art and production of new items (i.e. up-cycling). Many of these projects rely on public-private partnerships, and therefore play a role in local economic development and skills generation.

Figure 7 illustrates progress that has been made in this regard in the City of Cape Town. The amount of waste prevented from being sent to landfills in the City of Cape Town has been calculated for the period 2006 to 2011, and as shown, up to 14% of the waste can be diverted from the waste stream. The reductions in waste disposal can be attributed to a number of the City's initiatives, including waste sorting facilities like the Kraaifontein Materials Recovery Facility where waste is sorted for recycling, and the various composting facilities around the city.

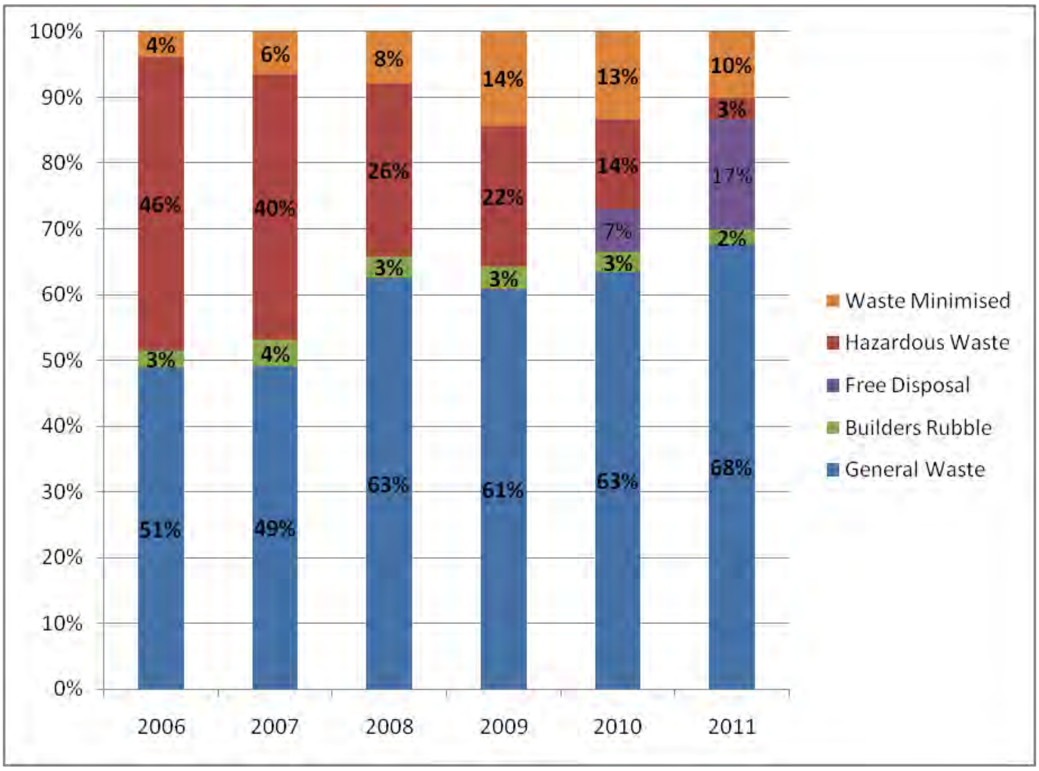


Figure 7: Composition of the waste stream in the City of Cape Town for 2006 to 2011, indicating waste generated but not landfilled (Information obtained from the Waste Management Department, City of Cape Town)

Garden waste and building rubble have specifically been identified as important wastes to be removed from the landfill stream due to their bulkiness as well as resource potential. The City of Cape Town has developed a number of drop-off sites which cater for garden waste and building rubble. Private companies contracted to the Municipality then collect the garden waste for the production of compost, or recover recyclables and portions of the building rubble waste stream for re-use. There are currently, however, no large-scale composting facilities for wet organic wastes such as food wastes. Other initiatives regarding minimisation of garden waste in the province include the Witzenberg Municipality's composting and food garden project within the Cape Winelands District Municipality.

5.1.2 Solid Waste Information System

The accuracy of general waste generation data in South Africa is often very low and estimated rather than measured in practice. Domestic waste quantities are typically estimated based on population statistics and economic activity within the municipality. Industrial waste quantities are largely estimated based on production figures. Waste data compared to production figures does, however, provide a good indication of process efficiencies within an industry. Nevertheless, where accurate information is available from industrial waste generators, the data is often considered to be sensitive or confidential which causes difficulties for reporting and understanding waste impacts. Similarly, in the case of commercial waste facilities, detailed waste treatment and disposal data, particularly on hazardous waste, is often considered as sensitive data since it can provide an indication of the company's market share. For these reasons, accessing hazardous waste data (generation, treatment and disposal) is problematic (DEA 2012). This also causes problems with regards to implementation or enforcement of principles rooted in the Integrated Waste Management Plan, including both the polluter pays principle and extended producer responsibility.

The Department of Environmental Affairs and Development Planning has developed an Integrated Pollutant and Waste Information System (IPWIS) which allow for registration of waste holders and the reporting of waste quantities. The Department is in the process of registering the waste holders that must report to the system and from July 2013 the reporting of the waste quantities will commence. The Department also embarked on a process to improve the recording of waste quantities at waste management facilities which will significantly improve the accuracy of the recording and reporting of waste quantities. Health Care Risk Waste Legislation was also promulgated on 15 March 2013 which make it now compulsory for generators, transporters, treaters and disposers of health care risk waste to register on IPWIS and to reporting their waste quantities on the system.

The waste information reported on the IPWIS will put the Department and municipalities in better position to manage the waste in the province.

5.2 Intervention programmes

5.2.1 2wise2waste resource efficiency programme

The 2wise2waste programme started in the Provincial Pollution and Waste Management Directorate in 2002. It focuses on improving resource efficiency in waste generation, as well as energy and water use. In 2004 the programme was extended to the rest of the Department and in 2007 approved and adopted by the other Provincial Heads of Departments (HOD's). Champions were nominated to drive the programme in the respective departments.

Obstacles to the roll-out of the programme include limited time capacity for programme champions, and limited budgets for basic equipment such as receptacles for waste separation, timers for energy savings and water aerators. Additionally, high staff turnover and attrition of departmental champions, together with changes in Heads of Department and senior management, have resulted in a decline in the participation rate. A survey conducted in 2009 on the level of awareness and staff participation in the programme indicated a low level of participation and highlighted the need for awareness to be raised around environmental issues.

The programme has responded to these challenges by providing a starter kit to initiate pilots in various departments with the hope that management support and dedicated budgets for further efficiency measures would follow. A number of pilots were also implemented in particular departments. Currently 7 WCG departments are actively participating in the programme.

5.2.2 Waste management in education

While some integrated waste management interventions aim at improving the capacity of municipalities to minimize waste, it is realised that one of the most critical areas for improvement lies in creating awareness about waste management issues. Consequently, DEADP initiated the Waste Management in Education project with a focus of integrating integrated waste management into the school curriculum. This is achieved by using waste management as a context for different learning areas.

Training workshops are conducted where resource materials are distributed to each school. The training material contains fully developed lesson plans and evaluation grids making the educators' responsibility easier and less "time consuming", and is in line with a drive by government to free up educators from administrative work so that they spend more quality time teaching. Following the rollout of the workshops, the Department also established a support plan in 2010 for educators that have been trained over the years. The support plan engages the educators in further workshops in order to maintain the connection and communication between DEADP and educators. The current thrust is a roll-out of the programme to all schools in the Western Cape.

5.2.3 Green procurement

Recognising the potential to make a meaningful difference through procurement practices, the Western Cape Government (WCG) has committed itself to developing a provincial Green Procurement guideline that seeks to reduce the environmental footprint of the daily operations of the WCG, and influence the behaviour of suppliers to government.

The Green Procurement guideline will provide the general principles and guidelines for integrating environmental criteria into supply chain management decision-making. It also provides for a phased implementation through the issuing of specifications for selected products / service areas, with the initial six selected trial areas being:

- Paper and stationery;
- Lighting equipment;
- Office electronic equipment;
- Events greening;
- Cleaning products and services; and
- Waste services.

The inclusion of environmental considerations in provincial purchasing decisions is intended to encourage a change in the behaviour of provincial personnel and suppliers, and in so doing to stimulate the local recycling economy and promote innovation towards the development of products and services with a lower environmental footprint.

5.2.4 Stimulating the recycling economy

As most waste disposal facilities in the province are nearing the end of their life span, waste minimisation, including recycling initiatives, are critical to prolonging their use. Investigations into the recycling potential in the Western Cape draw attention to the huge volume of recyclables that are disposed of at already overstretched landfill sites, as well as the income potential and possible job creation opportunity to be derived from the effective recovery of recyclable materials. The Provincial Strategy to Stimulate the Recycling Economy (DEADP 2007h) stems from a drive to promote the Green Economy in the Western Cape, as well as the need to give effect to the National Waste Management Strategy and Waste Act which aims to minimise the generation of waste and promote waste recycling. One of the provincial objectives is to create opportunities to start recycling by facilitating arrangements between industry, municipal officials and communities. Another key focus area of the strategy was to stimulate the market for products made from recycled material by developing and implementing a "Buy Recycled" marketing campaign.

A Waste Minimisation Summit hosted by the Department in 2010 contributed to the establishment of the Western Cape Recycling Action Group (WCRAG). The main aim of the WCRAG is to address the key challenges in the recycling sector through facilitating partnerships between government and industry. One of the initiatives involves WCRAG support to municipalities who have difficulty in initiating recycling programmes. The WCRAG is also conducting a recycling survey in the Western Cape to inform future initiatives.

5.2.5 Evaluation of integrated waste management

An Integrated Waste Management Evaluation initiative was introduced in 2001 in the form of the Cleanest Town Competition with a primary focus on implementing the National Waste Management Strategy. The key elements were: reducing, recycling and reusing of waste materials. Over time the key focus areas of the competition have been changed to incorporate elements which are outside the waste management category. In addition, the name of the competition has been changed to the Greenest Municipality Competition and it now covers:

- Waste Management;
- Water Management;
- Energy Efficiency and conservation;
- Biodiversity Management, Coastal Management and Beautification;
- Air Quality Management; and
- Leadership, Institutional Arrangements, Compliance & Public participation.

The Integrated Waste Management Evaluation component of the Greenest Municipality Competition also now evaluates issues surrounding environmental protection, social upliftment and economic growth, and is reported on as part of the Greenest Municipality Evaluation Report.

The evaluation is an effective tool in encouraging municipalities to improve their waste management services. Furthermore, the competition provides a platform for municipalities to highlight their best practices related to waste management, energy efficiency and conservation, water management, landscaping and tree planting as well as leadership and governance.

5.3 High risk waste

5.3.1 Hazardous Waste Management Plan

The strategic goal of the Hazardous Waste Management Plan for the Western Cape Province (DEADP 2006) is: "*to ensure the safe and integrated management of hazardous waste in the Western Cape through integrated sustainable hazardous waste management planning*". The plan further states that the objectives are:

- Safe handling and disposal of hazardous waste
- Information management
- Effective compliance monitoring and enforcement
- Reduction of the generation of hazardous waste
- Provision of sufficient/adequate financial resources

5.3.2 Industrial waste management

An audit was conducted of 16 companies within the Consumer-Formulated Chemicals Sector in 2007. Information obtained from the survey provided insight into the chemical handling practices which exist in the various chemical sectors and suggested that although certain companies within a particular sector could be used as a benchmark in terms of hazardous waste management, safe handling of chemicals, appropriate storage arrangements and internal transferring of chemicals, a uniform approach did not exist.

The information further implied that even closer interaction from all tiers of government would be required to ensure compliance across the spectrum of companies constituting a sector. In response to this the Generic Integrated Waste Management Plan Guideline for the Consumer-formulated Chemical Sector of the Western Cape (DEADP 2012c) was compiled to assist with regards to the development of Industry Waste Management Plans. During 2013/2014, it is anticipated that Industry Integrated Waste Management Plans will be developed in the Consumer-formulated Chemical Sector.

5.3.3 Health care waste

Health care waste management is an area of great concern in South Africa, especially the prevalence of illegal dumping of health care waste and the co-disposal of health care waste with general household waste on unsuitable or un-permitted landfill sites. Furthermore, the general methods currently employed to destroy and dispose of health care waste in South Africa are in many instances unacceptable.

The Western Cape Health Care Waste Management Act, 2007 (Act No. 7 of 2007) was drafted to manage the risks posed by health care waste to communities and the environment and to realise their environmental rights in terms of the Constitution. Subsequent to the publication of the Western Cape Health Care Waste Management Act, however, the National Department of Environmental Affairs published the NEM:WA which repealed certain provisions of the Environment Conservation Act, 1989 (Act No. 73 van 1989). This necessitated minor amendments to the Western Cape Act in respect of terminology used and in order to prevent conflict or confusion. The amendments were promulgated as the Heath Care Waste Management Amendment Act, 2010 (Act No. 6 of 2010). In 2011, draft Western Cape Health Care Risk Waste (HCRW) Management Regulations were also published for public scrutiny.

The Health Care Waste Management Act and supporting draft regulations were developed through an extensive public participation process and provides for the effective management (handling, storage, collection, transportation, treatment and disposal) of health care waste in the Western Cape. This will be achieved by establishing a health care waste manifest system to track all HCRW from 'cradle to grave' in order to prevent incidences of the illegal dumping. The HCRW Legislation is now in effect as it was promulgated on 15 March 2013.

5.4 Waste-to-energy

The recovery and use of methane from waste disposal facilities can significantly reduce the release of greenhouse gases. Landfill methane can be collected or extracted from mature landfills by developing gas recovery systems, and it can then be used to generate electricity, as a fuel for nearby industrial purposes, or enriched and sold to gas suppliers. Even where practical harvesting of the methane is impossible or not feasible, flaring is preferred over direct venting to reduce the overall greenhouse gas release and fire hazards. Using such climate friendly municipal solid waste solutions can therefore yield energy, economic, environmental, and public health benefits.

It has been estimated that Vissershok and Coastal Park landfills each has the ability to generate 5MW of electricity off 13793 tonnes of methane generated per year (PDG 2004):

Table 3: Landfill gas potentials for Cape Town landfills (PDG 2004)

Landfill	Estimated peak Landfill Gas yield (Nm^3/yr)	Estimated methane (tonnes / annum)	Potential electricity generation (MW)
Belville South (old)	900	2 821	1
Belville South (new)	875	2 742	1
Vissershok	4 400	13 793	5-6
Coastal Park	4 400	13 793	5-6
Swartklip	1 800	5 643	2
Faure	2 300	7 210	2-3
Brackenfell	1 100	3 448	1

Coastal Park landfill is actively being considered by the City of Cape Town as a viable project for a landfill gas-to-energy project, and a Project Design Document has been submitted to the Department of Energy for recognition under the Clean Development Mechanism of the Kyoto Protocol.

5.5 Policy, tools and legislation

The Constitution provides the foundation for environmental regulation and policy in South Africa. The right to environmental protection and to live in an environment that is not harmful to health or well-being is set out in the Bill of Rights (section 24 of Chapter 2). This fundamental right underpins environmental policy and law, in particular the framework environmental legislation established by the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).

As a 'specific environmental management act' under NEMA, the NEM:WA provides a coherent and integrated legislative framework addressing all the steps in the integrated waste management hierarchy. As illustrated in Figure 8, the approach promoted in the NEM:WA, National Waste Management Strategy and Provincial Waste Management Plan builds on waste avoidance and reduction as foundation, and then promotes the adoption of reclamation prior to resorting to final disposal. The national application of the Act means that it must be enforced through all government structures.

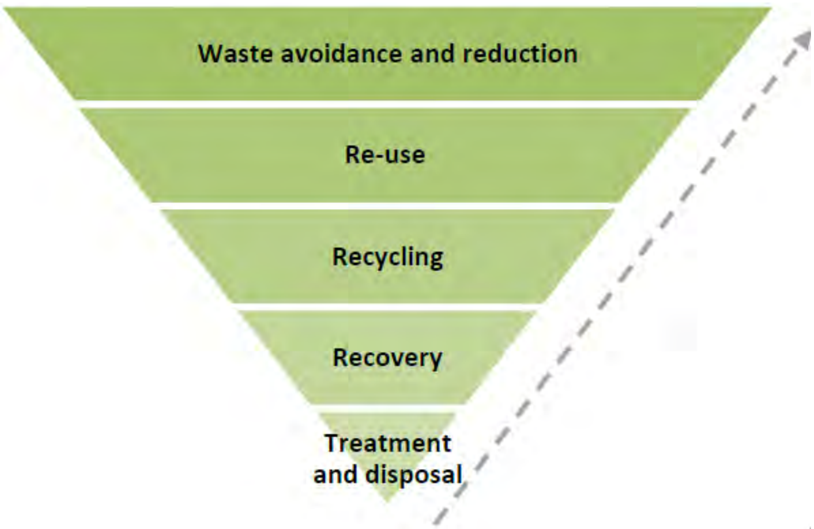


Figure 8: The waste management hierarchy (DEA 2011)

The Constitution assigns concurrent legislative competence with respect to the environment and pollution control (section 146) to national and provincial government, but exclusive legislative competence to local government in matters of cleansing and refuse removal, refuse dumps and solid waste disposal. The Constitution, however, allows national legislation to set national norms and standards relating to these matters in cases where national uniformity is required to deal effectively with the issue (DEA 2011). Norms and standards are therefore the foundation of the regulatory system established by the Waste Act.

The National Waste Management Strategy developed in 2011 (DEA 2011) is the central government policy that outlines priority initiatives to be developed by the three spheres of government. The initiatives include integrated waste management planning, a waste information system, waste minimisation, recycling, waste collection and transportation, waste treatment and waste disposal.

The strategy also defines short-term objectives, one of which is a responsibility placed on provincial governments namely the drafting of a Provincial Hazardous Waste Management Plan. To meet this obligation, the Western Cape Department of Environmental Affairs and Development Planning conducted a baseline analysis of hazardous waste management in the Western Cape (2002) and developed the first Hazardous Waste Management Plan for the Western Cape in 2006 (DEADP 2006).

Other responses in the form of policies, tools and legislation across all scales applicable to this theme are listed in the summary Table 4:

Table 4: Summary of policy, tools and legislation related to integrated waste management

International Responses	1985	International Code of Conduct on the Distribution and Use of Pesticides
	1989	Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal
	1972	Principle 6 of the Stockholm Declaration
	1991	Convention on the Ban of the Import of Hazardous Waste into Africa
	1998	Convention on the Prior Informed Consent Procedure for certain Hazardous Chemicals and Pesticides in the International Trade
National Responses	1977	Occupational Health and Safety Act (63 of 1977)
	1994	Draft Hazardous Waste Management Policy
	1996	National Constitution
	1989	Environment Conservation Act (73 of 1989)
	1998	Minimum Requirements for Waste Disposal by Landfill
	1998	National Environmental Management Act (107 of 1998)
	2000	White Paper on Integrated Pollution Control
	2000	Polokwane Declaration
	2002	Mineral and Petroleum Resource Development Act (28 of 2002)
	2008	National Environmental Management: Waste Act (Act 59 of 2008)
	2011	Draft Standard for Assessment of Waste for Landfill Disposal
	2011	Draft Waste Classification and Management Regulations
	2011	Draft National Standard for Disposal of Waste to Landfill
	2011	National Waste Management Strategy
Provincial Responses	2002	Situational Analysis on Hazardous Waste Management in the Western Cape
	2002	Situational Analysis on General Waste Management in the Western Cape
	2006	Hazardous Waste Management Plan for the Western Cape Province
	2006	Recycling Economy Study
	2007	Waste Characterisation Study of 89 waste disposal facilities within the Western Cape Province
	2007	Western Cape Health Care Waste Management Act (No. 7 of 2007) (and Amendment Act of 2010)
	2008	Feasibility report for various approaches to separating household hazardous waste from the general waste stream within the Western Cape Province
	2009	Monitoring and Evaluation System of Integrated Waste Management Plans
	2012	Generic Integrated Waste Management Plan Guideline for the Consumer-formulated Chemical Sector of the Western Cape
	2012	Provincial Integrated Waste Management Plan
	2013	Health Care Risk Waste Management Regulations

Local Authority Responses		First generation Municipal Integrated Waste Management Plans

6 CONCLUSION

OUTLOOK: IMPROVING

The understanding of waste management in the Western Cape has improved significantly over the past decade, in concert with the introduction of the concept of integrated waste management in NEM:WA. The understanding is also slowly translating into a rigorous policy and regulatory regime that aims to protect everyone's constitutional right to a safe and healthy living environment.

Information and knowledge of the waste stream, waste management practices and waste processing facilities is still not perfect though, and determined efforts need to be made to improve the state of knowledge. It is also acknowledged that legislative compliance for waste disposal facilities is not very good, with many facilities operating without the necessary permits. The Province has committed to a steady improvement of the situation, with a target of a 20% increase in properly licensed facilities by 2014.

Of particular interest in the province are the inroads being made with regards to waste minimisation, especially the evidence coming through in the City of Cape Town. In fact, the Provincial target for waste diversion from landfills is set at 15% by 2016 against the 2010 waste generation baseline (DEADP 2012a).

At the same time though, it is noted with concern that the available landfill space for the province seems to be rapidly running out. On the one hand it must be viewed as a serious concern that will have immediate cost and environmental implications for the various levels of government, but on the other hand it should also be seen as a driver for the pro-active planning of sustainable integrated waste management solutions. If waste could be seen as a commodity rather than a liability, then both economic and environmental gains will be possible.

The findings of the Waste Management chapter can be summarised as an overall improving outlook. Table 5 contains a brief summary of the key pressures, impacts, challenges, progress and recommended critical areas for action.

Table 6 contains the anticipated changes or outlook for the future of Waste Management, based on the findings in this chapter. All of these aspects have been identified in the chapter, and should be referred to in more detail for a complete understanding of the dynamics associated with the Waste Management.

Table 5: Summary of key aspects identified in the chapter

Aspect	Summary of key points

Aspect	Summary of key points
Pressures	• Modernisation / consumerism • Means of disposal
Impacts	• Waste disposal site capacity • Contamination of land, air, water • Health issues
Challenges	• Waste not seen as a resource • Restricted information flows • Restrictive regulatory environment • Landfill space (insufficient planning)
Progress	• Up to 14% waste diversion in CoCT (i.e. Materials Recovery Facility and Green Waste initiatives) • Waste-to-Energy initiatives (e.g. landfills, biogas) • Integrated Provincial Waste Information System
Critical areas for action	• Remove regulatory constraints limiting appropriate reuse/industrial symbiosis • Transform traditional perceptions of waste and innovate around incentives for reduction of waste • Integrated Waste Management – ensure proper licensing of facilities and reporting of volumes and types of waste • Waste-to-Energy initiatives • Appropriate approach to removing organic material from waste stream

Table 6: Summary of the outlook for waste management based on the findings of the Western Cape State of Environment Outlook Report

Indicator	Quantification	Trend
Waste generation	Total: • 1 446 500 tonnes per annum in 2001 • 3 807 765 tonnes per annum in 2010 • 70% generated in CoCT, relative contribution falling • Mostly paper, plastic, organic waste and builder's rubble	Declining
Waste collection	91.7% of households have refuse removal services (88.8% in 2001)	Improving
Waste management	193 operational waste management facilities: • 92 general waste disposal • 54 drop-offs • 15 transfer stations • 13 materials recovery facilities • 6 planned/existing regional waste disposal sites	Improving

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BETTER TOGETHER.

State of Environment Outlook Report for the Western Cape Province

Environmental Outlook

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1 THE GOOD, THE BAD AND THE UGLY

The State of Environment Outlook Report provides information on the current level of local performance in terms of environmental sustainability thresholds. However, the report is also intended to provide a broad audience with an overview of the state of nine environmental themes. To aid with important issues being highlighted from the various themes and interlinked between themes a summary of the findings is presented below. Details on the state of each component are found in the different theme chapters and should be referred to for clarity and a holistic view of each theme.

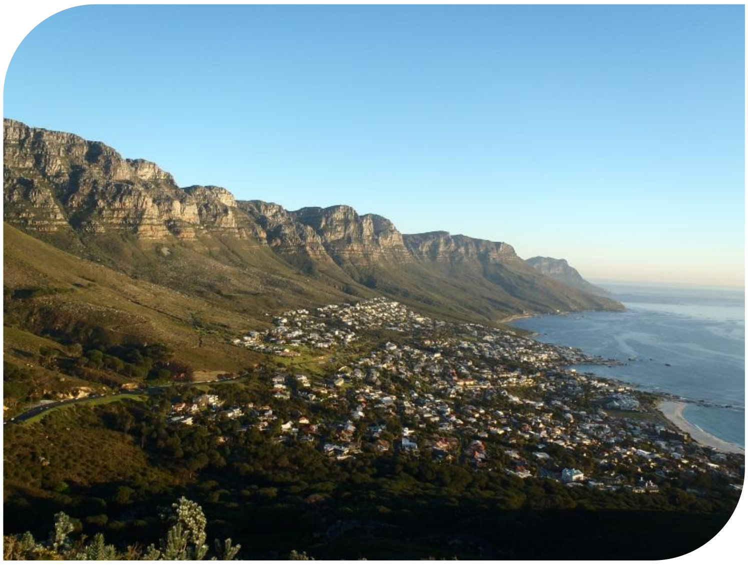
For each environmental theme, an outlook is given either as:

- **Improving** – implying that the environmental conditions are improving and societal responses are steering change in the right direction
- **Declining** – in cases where the indicators show a negative trend and/or the necessary societal response is not deemed to support environmental sustainability
- **Stable** – where indicators show neither a negative nor positive trend, and indications are that our responses to the concerns are generally positive

1.1 Land

OUTLOOK: DECLINING

Land is a resource that plays many different roles within a range of activities from mining, agriculture and urban development, to the way people move and the concept of 'sense of place'. The restructuring of landscapes inevitably has consequences on other environmental aspects – such as riparian environments, soil capacity, erosion and water pollution. Therefore land forms a context for much of the rest of the State of Environment Outlook.



Information on land transformation was found to be inadequate for definitive conclusions about the rate or impacts of transformation. Therefore, it is difficult to say if planning and decision-making around land-use has been positive, and that the resource is being used in the most effective manner. Although the predominant land cover in the province remains 'natural' (78%), agricultural cultivation has expanded since the previous report and now covers 19% of the land, with urban uses constituting around 1%. It was found that the approach to management and planning tends to be fragmented and reactively driven by land use rather than a clear understanding of soil potential matched to appropriate utilisation.

There is a need for integrated planning that takes cognisance of existing land capability and environmental thresholds, which necessarily has to be based on a comprehensive, consistent and current dataset on land cover and land uses. It is only once such comprehensive and recurring mapping is available, that better understanding of this resource can be gained and optimization be informed. Collaboration between entities that use or manage land resources needs to take place to ensure accurate, comprehensive mapping takes place on a frequent enough time basis to provide useful information on land use and land transformation.

1.2 Biodiversity & Ecosystem Health

OUTLOOK: DECLINING

The Western Cape is recognised globally for its high biodiversity and as a centre of endemism. Conservation of biodiversity and the preservation of ecosystem functioning, in the face of a growing economy, has therefore been a great focus area in the province. The tourism industry benefits from this great natural abundance. However, this is not the only economic benefit that biodiversity and ecosystem health has to offer. Aspects such as agriculture, ecological goods and services, and a green economy all require a balanced relationship with a functioning natural environment in order to thrive. Biodiversity and healthy ecosystems provide what is termed 'ecosystem goods and services'. Some of these goods and services include the cleansing of water and the atmosphere, natural carbon sinks, flood attenuation, provision of food (e.g. grazing potential), etc. Such services can be enhanced through planned green infrastructure. It is upon such goods and services that food security relies, in the form of both commercial and subsistence farming.

Green Infrastructure: a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas.

(European Union Definition)

The threat status of ecosystems in the Western Cape is a concern. There are 58 threatened terrestrial ecosystems in the province, of which 21 are critically endangered, 14 are endangered, and the remaining 23 are classified as vulnerable. Few of these are considered to be properly protected. In terms of individual species, 70% of all freshwater fish, 13% of plants, 10% of mammals, 5% of reptiles and 5% of birds are considered threatened. All vegetation types are considered to be highly fragmented.

The biggest threats to biodiversity and ecosystem health are ascribed to rapid urban expansion and agriculture (particularly cultivation), with invasive alien species having severe impacts in specific locations. The extent of protected areas is growing though. More effort should, however, be put into formal protection for Critical Biodiversity Areas.

1.3 Inland Water

OUTLOOK: DECLINING

Almost all human activities that require water result in the degradation of the resource and its associated ecosystems. This is a consequence of the modification of natural surface water resources by channel and flow alterations, nutrient loading and pollution. The most noticeable urban impact relates to the increase of impervious surfaces which alters the hydrology and geomorphology of streams and results in increases of runoff and pollution that reaches wetlands, rivers and ultimately the ocean, and limits recharge of groundwater sources.

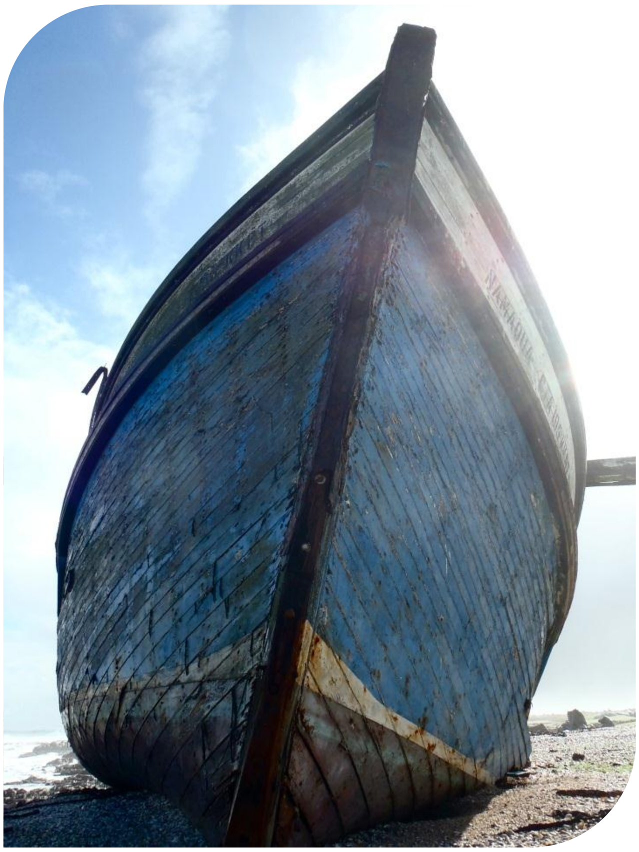
Climate change projections identify a progressive drying of the province towards the south-west. This will reduce surface runoff and slow down the recharge rate of groundwater aquifers. It implies a reduced water yield from both surface and groundwater sources. The water shortage is also likely to be exacerbated by the expected increase in temperature and resultant increased evaporation rates.

Water quality in the watercourses of the Western Cape is generally still good, whilst the general state of ecosystem functioning in the watercourses is classified as fair. However, great variation is present along the length of rivers and streams as impacts vary along with land uses. The primary water use activity within the province is the agricultural sector, followed by settlements, forestry and aquaculture. The large quantities of water resources are required to meet the current demand and ensure economic growth, yet water is a limited resource. A provincial water resources reconciliation strategy has been developed to investigate and address the current negative water balance – i.e. more water demand than what can be supplied with existing water infrastructure. This negative balance is getting worse, and is a fundamental motivation for rating the state of water resources as 'declining'.

1.4 Oceans and Coasts

OUTLOOK: DECLINING

Based on monitoring done as part of the Blue Flag Beach certification scheme, coastal water quality seems to be good and improving over time. A decline in coastal water quality will lead to a reduction in the ability of coastal and marine environments to provide ecosystem goods and services such as waste assimilation and dilution of pollutants.



Estuarine environments are of concern. Typically, Western Cape estuaries are highly modified, and characterised by poor health and low levels of protection. This is concerning considering that all Western Cape estuaries, except those in the Eden District, are considered to be critically endangered ecosystems.

Over-exploitation of marine resources typically leads to the proliferation of specific marine species, at the cost of a naturally diverse and balanced ecology, and is one of the main threats facing marine ecosystems. According to the National Biodiversity Assessment 2011, critically endangered habitats are distributed along the West Coast nearshore, Eden and Overberg offshore areas, as well as the continental shelf edge. Endangered areas are concentrated between Langebaan in the northwest and Cape Agulhas in the southeast, while vulnerable coastal and benthic habitats stretch from Cape Town to the Knysna area, often for vast distances offshore.

Transformation of threatened ecosystems in the coastal belt continues unabated, and leads to alteration of natural coastal dynamics, the introduction of alien invasive species and decreased resilience to the impacts of climate change. The transformation leads to increasingly acute impacts related to dynamic coastal processes such as mobile sand dunes, beach regression, coastal erosion, and declining stocks that locals rely on as a means of subsistence and livelihoods. Over time, this is exacerbated by climate change induced increased intensity, frequency and duration of extreme events as well as decreased ecosystem resilience.

In response to the threats, the Western Cape has prepared a Western Cape Provincial Plan of Action for Reducing Land-based Pollution to the Marine Environment, and it hosts the CAPE Estuaries Programme. Coastal Management Plans are in process for Eden and the West Coast, and in existence for the City of Cape Town. Coastal set-back lines have been determined for the Overberg and City of Cape Town, and processes are underway to delineate them for the West Coast and Eden. Estuary management plans are in process for 30% of the estuaries in the province.

1.5 Human Settlements

OUTLOOK: IMPROVING

As with most developing regions, the Western Cape is rapidly urbanising, and its population is growing rapidly. Both the population growth and urbanisation can be attributed to the migration of people from rural areas and other provinces in search of work opportunities or a perception of better quality of life. By implication, both Provincial and Local Government face increasing pressure to provide adequate shelter and basic services for all.

Service delivery is generally quite good, and shown to keep pace with the increases in demand. 99% of households have access to piped water, and over 93% of households have access to electricity. Access to water-borne sanitation has improved to nearly 90%. Many of those not formally serviced use pit latrines or bucket systems. More than 91% of households are reached by municipal waste removal services. The Western Cape ranks second best in terms of Blue Drop (potable water quality) certification, and best in terms of Green Drop (wastewater treatment systems) certification.

Transportation systems are well developed, although heavily skewed towards road-based transport, private vehicles and road-based freight movement. Rural transport networks are as well established as they might be. Interventions and strategies aimed at transforming the provincial transportation network to more efficient and effective forms are evident but further work is required to shift the trend towards use of public transport. The envisaged end state is an integrated system consisting of different modes of transport with different levels of coverage, but which serves the needs of commuters and special purpose trips alike, whilst reducing the impact on the environment.

The housing backlog is a concern throughout the province with over 400 000 units required, most of which are within the City of Cape Town. In an effort to ensure housing provision that alleviates suffering and improves livelihoods to as many people as possible within the shortest possible timeframes, a number of strategies have been employed. One such strategy is that of incremental delivery, where provision of services are phased, with the long term roll-out of housing as final outcome.

The importance of alleviating the housing backlog has been highlighted in numerous reports, as the solution to a vast range of human health, livelihood and environmental health issues. It can also be seen as an opportunity to create jobs, and invest in sustainable communities for the future benefit of the city as it continues to grow through urbanisation and as an economy.

1.6 Air Quality

OUTLOOK: STABLE

Although some uncertainty exists regarding the extent and severity of air pollution in the province due to the lack of long-term records, the monitoring that is being done indicates that ambient air quality is in a good state. The main source of air pollution arises from transportation, especially from urban traffic congestion. Indoor air pollution also persists in low income or informal settlements where the burning of coal, paraffin and biomass for purposes of heating or cooking contribute to exceptionally high levels of indoor air pollution, despite a high percentage of households having access to electricity. Other sources include industrial sources, dust and agricultural crop spraying. Concerted efforts have been made to improve monitoring and reporting, and as such have begun to form the baseline of air quality information for the area. Sustained effort will need to be placed on ensuring this is continued in an appropriate spatial and temporal context to inform meaningful decision making and management in the future.

In order to ensure this is possible, funding at municipal level will need to be made available. This will require that air quality management be planned for at the IDP level. To aid this process a provincial needs assessment has been undertaken, which includes a map of communities that have been affected by air pollution. This should be used as the baseline when identifying problem areas, and required monitoring, mitigation or corrective action, and reporting requirements.

1.7 Climate Change

OUTLOOK: DECLINING

Overall, the Western Cape Government and other stakeholders appear to be responding to the potential impacts of climate change, albeit only in terms of strategic and systematic adjustments rather than large scale practical change. Carbon dioxide equivalent (CO_2e) emissions for 2009 were calculated at 41 303 482 tonnes.

The GHG emissions contribute to global human-induced changes to the climate, which will have a bearing on future human health, biodiversity, agricultural productivity, marine resources and social resilience. Broadly speaking, it is expected that in the Western Cape minimum temperatures in late summer and late winter will be warmer, very hot days will become more frequent, and rainfall could decline. Sea levels will also rise slightly, which, when combined with extreme weather can lead to severe coastal flooding and increased damage.

Overall, the Western Cape appears to be responding well to climate change. This can be attributed to the swift development of policy and strategies around this topic. Strategic provincial strategies have been adopted for climate change responses, and targets for emission reductions have been specified in the Climate Change Strategy and Action Plan. The Provincial Strategic Objectives Work Groups have taken up the energy and emissions reductions targets. Municipal Support Programmes are in place to give direction to municipalities in the development of Climate Adaptation Plans and Sustainable Energy Plans and the City of Cape Town is well advanced in terms of climate change responses and the transition to a green economy and sustainable society. A foundation for the transformation of the energy economy has also been laid in the form of a provincial Energy Consumption and CO_2 Emissions Database.

Information on social and economic interventions with relevance to climate change is limited due to the distributed nature of the projects and integration with several other sectoral themes. Information sharing and critical analysis of desired objectives and the best possible implementation plans need to be undertaken continually to ensure effective adaptation and alleviation of vulnerability to climate change induced impacts.

Provincial carbon footprinting will also need to be refined, especially in terms of emissions from land use change (such as agriculture). This will aid with the comparison of the province with other provinces, and over time to assess trends.

1.8 Energy

OUTLOOK: STABLE/DECLINING

The Western Cape houses the Koeberg nuclear power station, two Open Cycle Gas Turbine peaking power stations, the Darling and Klipheuwel Wind Farms, oil refineries, as well as natural gas refineries. However, coal-based electricity is sourced from the national electricity grid to satisfy the bulk of the electricity consumption in the province. As a consequence, the nature of the energy use in the province results in significant greenhouse gas emissions (especially from coal-based electricity and transportation), air pollution (transport and domestic fuel burning), pollution of water resources , threats to biodiversity (infrastructure development and pollution) and land use (visual impacts and extent of land taken up).

There is great potential for wind and solar power energy resources in the Western Cape although these haven't been exploited to any significant extent. The market is only now slowly shifting away from conventional technologies to more renewable options. The province is set to host 4 Solar PV and 4 wind farm projects under the IPP programme.

Energy consumption in the province has grown from 247 742 000 GigaJoule (GJ) in 2004 to 270 887 000 GJ in 2009 (excluding aviation and marine figures). It should be noted that various data uncertainties remain and there is no consistent collection and analysis of data, but the overall trend can be taken as indicative. 52% of energy consumption in the province is consumed within the transport sector, followed by industry at 34%.

The Western Cape Department of Environmental Affairs and Development Planning published a White Paper on Sustainable Energy for the Western Cape Province, and developed a Strategic Environmental Assessment for the placement of wind energy facilities. Also on the horizon is the development of a 'Green Economy' focussed manufacturing and industrial hub in the vicinity of Atlantis, as well as investment in gas infrastructure in the Saldanha Bay node. There is also a strong focus on promoting the use of renewable energy and public transport in the transport sector.

1.9 Waste Management

OUTLOOK: IMPROVING

Waste management, and in particular airspace availability in landfill sites, has been a widely publicised problem for the Western Cape over the past few years. While great strides have been made with strategies to avoid waste being landfilled many challenges and opportunities still lie ahead.

Solid waste in the Western Cape in 2010 amounted to some 3 807 765 tonnes per annum. As expected, the City of Cape Town represents the bulk (approximately 70%) of the total waste generated in the province, with the Cape Winelands and Eden Districts ranking a distant second and third. Effective waste reduction strategies in the City of Cape Town are slowly reducing the Metro's share. During the past decade the rate of formal waste removal services has kept pace with population growth, and indeed improved throughout the province. In the City of Cape Town the rate of formal waste removal remained at 94% despite in-migration and population growth.

One of the greatest challenges is the insufficient information and lack of understanding of waste flow in the province. Many studies have been undertaken to characterise the types and quantities of solid waste being landfilled but a lack of communication, integrated planning and funding makes it difficult to manage waste in an integrated way.

Perhaps the greatest opportunities that is yet to be realised is the acknowledgement of waste as a resource by industry. Waste that is currently being disposed of at landfills holds potential to be utilised for the production of a host of goods and energy. Some private companies have begun to make use of waste; however this is limited and mostly orientated around the recycling industry. Industrial symbiosis needs to take place to ensure optimisation of the use of resources, and there needs to be a shift towards closed cycle waste management where all by-products are used and nothing is landfilled, and full cost accounting for the use of natural resources is present.

Industrial symbiosis is the sharing of services, utility, and by-product resources among industries in order to add value, reduce costs and improve the environment.

2 EMERGING TRENDS

As population numbers increase, so does the need for utilisation of natural resources, both in terms of consumptive and non-consumptive uses. This leads to increased impacts on the environment and on living conditions, and consequently also an increased need for proper management of pressures and impacts.

The effectiveness of environmental management actions is determined by two things i.e. whether the right aspects are being managed (i.e. what matters most), and whether the management actions are responding appropriately and in time to contextual changes (proactively responding to trends). In this respect, a list of key issues or focus areas that are of most relevance to environmental governance in the Western Cape is distilled from the findings of the different theme chapters. The figure below (Figure 1) provides an overview of the key issues that have been identified in this manner, ranked according to relative impact or influence, and in terms of how much certainty exists about the topic or trend. This provides an indication of which of the important areas for intervention may yield the highest benefits in terms of minimising impacts. Recognising our areas of uncertainty especially in areas of high impact requires our focussed attention on improved monitoring and research to understand these systems better. This exercise was undertaken by the report authors who used the technical chapters and expert knowledge to inform the debates and represents their opinions. This is shared here to stimulate debate and thought about the priority areas and actions required to move towards a more sustainable region.

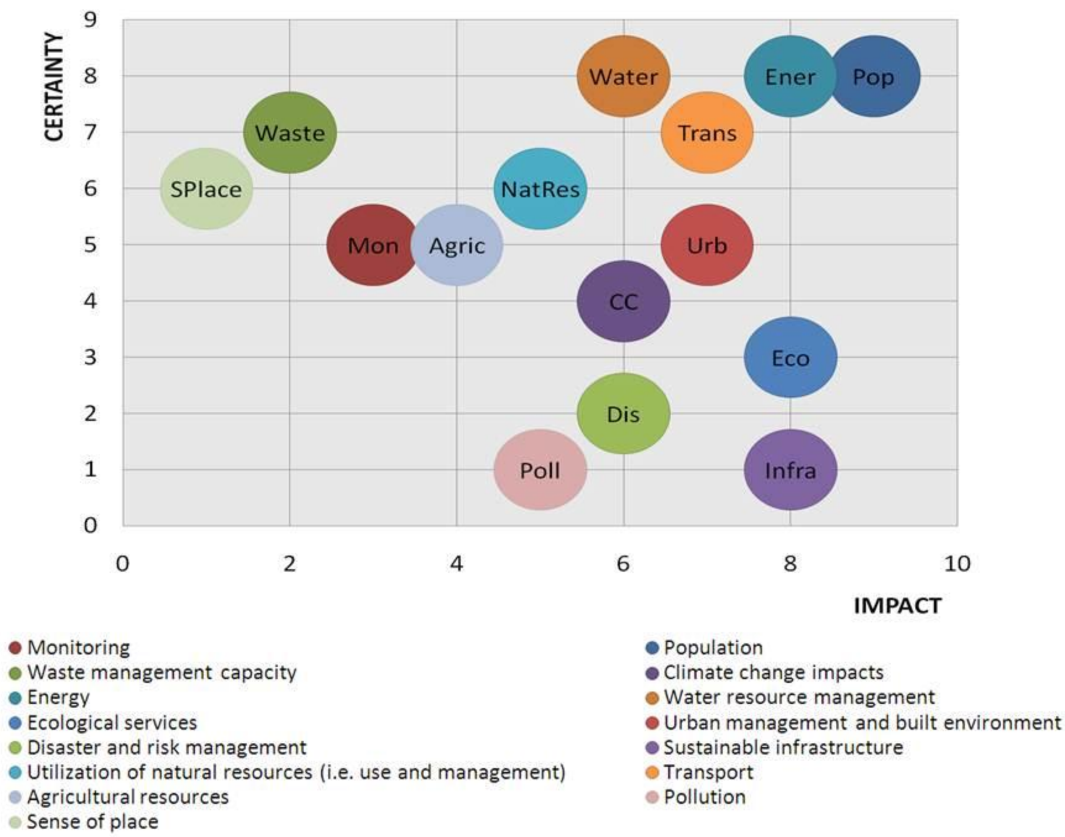


Figure 1: Relative importance of cross cutting themes of importance, based on level of certainty and impact

From the arrangement of issues in Figure 1, some inferences can be made. Firstly, population, energy, transportation and water resource management are considered the aspects with a significant influence over the state of the environment, but also as aspects that are very well understood in terms of their current nature and future development.

The population of the Western Cape has been rapidly increasing over the past few years. The consequence of this growth is increasing pressure on natural resources and the need for service provision. Population growth is therefore displayed with the highest level of certainty and highest impact on the figure. Closest to this is the need for diverse and sustainable energy sources, to sustain the growing population and economic development. As a function of the efficiency of resource use, energy supply and demand furthermore determines to a great extent the environmental footprint of the Western Cape.

Improved transport networks are also considered a critical foundation for sustained economic growth, but the nature of transportation networks will need drastic overhaul if the resource efficiency of the economy and society in general is to be improved. Public transport has also been identified as a major requirement to ensure the sustainable growth, efficiency and reduced impact on the natural environment of nodal areas. As water is a limited resource and basic necessity for all life, the management of water resource availability and quality is seen as an issue of high importance, with disastrous impacts if not managed appropriately. Overall, it is important that the growing demand for resources is managed in line with what is available, whilst making provisions for future generations.

Secondly, urban management and the built environment, climate change impacts, ecological services, sustainable infrastructure, disaster risk management and pollution are considered aspects that have a lot of influence over the state of the environment, but which are either not well understood, well quantified or indeterminate in terms of whether they are likely to change for the better or worse in future. The high level of uncertainty is derived from limited or inconsistent monitoring; leading to high levels of uncertainty.

Urban management and the built environment are strongly linked to the growing population, growing economy, and the increasing need for sustainable infrastructure which is characterised by being high-performing, resilient, cost-effective, resource-efficient and environment-friendly. This encompasses the need for improved transport networks, sustainable energy solutions, and pollution reduction. Interestingly, urbanisation is also a threat to land of high agricultural potential in some areas. It is therefore displayed with a medium to high level of certainty, yet a potential high level of impact that could be either positive or negative

Sustainable infrastructure refers to engineered systems that provide the smallest possible strain on resources while ensuring the provision of water, energy, transport, sanitation, information sharing, etc. This is essential to ensure the daily requirements of more than half of the world's population living in cities today. With rapid population growth placing a strain on available and vulnerable resources (water, energy and materials), the need for high-performing, resilient, cost-effective, resource-efficient and environment-friendly infrastructure is being recognized globally as a key component of future urban sustainability.

University of Colorado, 2013

based on the future shifts in growth of the province, and the development of sustainable urban nodes.

Climate change is considered an uncertainty, since the exact nature of the climatic shifts and their associated effects are still only partially understood. This means that adaptation responses are challenging and need to be localised. On-going scientific research, modelling and verification needs to inform Provincial strategies in terms of micro-climatic changes and alterations of the rainfall patterns, as well as anticipated responses from natural systems.

Natural resources and the provision of goods and services are essential for economic growth (e.g. manufacturing industry), subsistence, ecological functioning, and adaptation to climate change, amongst other things. Of these, the availability and quality of natural resources and goods and services has the greatest impact. Ecosystem services strongly influence the successes and failures of agricultural sector which, in turn, is vital for national food security and the export industry. Similarly, it determines the integrity of the tourism industry that is greatly reliant on the quality of the natural environment. However, understanding of where thresholds of overexploitation or degradation of ecosystems lie is still limited.

Sense of place and waste management are both displayed with a high level of certainty, and low impact. This implies that for both issues there is a fair understanding of the nature of the issue, but direct responses to them will have limited impact. For waste management, for instance, it is clear that the accumulation and disposal of waste is unsustainable and that waste minimisation and re-use needs to be implemented. However, rationalisation of the waste management systems will have limited overall effect as they are, in turn, determined by aspects such as efficiencies in energy use and transportation systems.

Monitoring of environmental features and pressures on the environment is quite important, as without monitoring, an understanding of how well the environment is being managed, and what should be done to rectify the situation (if anything at all), will be limited.

Monitoring on its own will have a limited effect though, as only once it is applied to inform better decision making and shifts in policy and environmental governance, will it help to shift the state of the environment into a more positive dimension.

The issues presented in Figure 1 are discussed in more detail, in the sub-sections below. These discussions include the interrelated nature of all aspects, and the influence that any changes in the environment will potentially yield to all related aspects, whether it is positive or negative. Each aspect is considered in terms of how society needs to respond to the issues, but importantly also in terms of what will happen should responses not be adequate.

2.1 Population

Of all the issues that are identified through this State of Environment Report population growth is the most certain, i.e. the growth is certain to continue, and the aspect with the most impact on the overall environmental system. Environmental policy and decision-making must recognise the increasing pressures that population dynamics will place on natural resources. These pressures will manifest as a need for increased utilisation or exploitation of biophysical resources as well as an increasing volume of waste or by-products that are disposed of in the environment.

2.2 Climate change

Human induced accelerated climate change will result in higher average temperatures in the Western Cape, higher extreme temperatures and likely a drying trend. This will impact on broad resource management strategies as the misalignment between resource availability and demand increases. It will also affect decision-making and livelihoods on a fine scale due to microclimatic shifts that will influence agricultural productivity, crop suitability, irrigation practices and pest populations, and consequently also food security, social harmony and social-ecological resilience.

2.3 Energy

A growing appetite for energy and expansion in the primary supply of energy is a certainty. This will go hand-in-hand with changes to energy supply infrastructure and shifts in the type of energy applied in different applications. The impact on the environment will be significant, especially in terms of the potential conflict between sensitive biophysical resources and sources of energy.

Four aspects need to be addressed at a strategic, political and macro-economic level:

- A shift from near complete reliance on 'dirty' fossil fuels to primary energy sources and energy carriers with lower GHG emissions, as well as an increasing contribution from renewable energy sources.

- Improvements in the efficiency of energy use, especially in terms of domestic energy use, transportation and the built environment as a whole.
- Access to appropriate energy types and sources relative to the application, such as micro-generation solutions for rural settlements versus bulk supply to energy intensive industries.
- Facilitation of the development of renewable energy generation facilities, balanced with the need for protection of natural resource quality and sense of place.

2.4 Urban management and sustainable infrastructure

It is generally known that internationally our cities and urban settlements are inefficient in design and operation. It is also certain that urban growth will continue as migration from rural areas persists. Reform of our urban spaces will have positive impacts on environmental resources, through improved efficiency of resource use, improved social cohesion, more functional spatial patterns and greater valuing of ecological infrastructure with low capital and maintenance costs.

The biggest transformation is possibly in terms of rectification of spatial patterns. Improvement in residential densities and correction of spatial disjuncture will enable the roll-out of efficient urban services such as public transport, waste reduction strategies and innovative energy supply systems. The efficiency of energy use will improve as the energy intensity of urban operation drops.

Control over urban encroachment into natural systems will also ensure that natural biophysical features are integrated into the urban system as ecological infrastructure (e.g. stormwater management) and biological controls (e.g. pest control or microclimatic mediation). Natural systems that are shown to be under stress include watercourses, estuaries, the coastline and remaining intact habitats.

2.5 Pollution

The consumption of goods within modern society necessarily creates both by-products and waste, which increase along with population growth and improvements in socio-economic welfare. The Western Cape can be certain that social conditions will increase the need for disposal of waste products in the environment unless interventions can be instituted that will divert waste from the waste streams. This applies to all forms of waste, including solid waste, water and air pollutants – although water pollution is elaborated on under water resource management.

How well society will respond to the need for reduced waste and less pollution is not clear, and therefore monitoring and management will be required in the following fields:

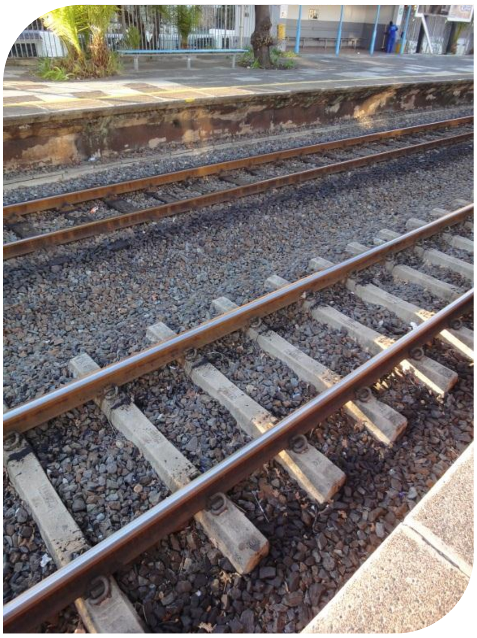
- Indoor air pollution
- Water pollution of agricultural origin
- Coastal and marine water quality
- Contamination originating from industrial areas and facilities
- Pollution from solid waste disposal facilities

- Urban water pollution
- The control of pollution from informal settlements
- Risks to groundwater

Waste management is a field in which significant gains are possible should the current perception of waste as a liability be converted into one that views waste as a potential resource. This transformation will require management of the entire waste stream, with improved public awareness of the issue, improved capacity of waste management facilities, improved waste stream monitoring data and improved regulatory control. The diversion of waste out of the waste stream should be a general objective, although urgent intervention is required to alleviate the existing strain and capacity limitations on waste disposal facilities.

Waste management facilities must also be planned, designed, operated and regulated in a manner that ensures the containment of environmental impacts, and optimisation of resource recovery from the facilities. This extends to innovative interventions such as the conversion of waste to energy through recovery of landfill gas or production of biogas, or the facilitation of waste exchange (also known as industrial symbiosis) amongst industries.

2.6 Transport



Transformation in the transportation system will have a major impact on increasing the efficiency of energy use in the province, alleviation of the Cape Town smog problem, and improving social cohesion, integration and well-being. Several large-scale interventions are possible, and although completely necessary, will require active intervention at a strategic level.

Two significant modal shifts are required in the Western Cape – a shift towards rail-based freight transport rather than road based, and a dramatic increase in the coverage and uptake of public transport. Both will relieve congestion on the road network, obviate the need for expansive road upgrades and improve the efficiency of energy use. Modal shifts will also create the opportunity to use less carbon intensive energy sources such as renewable energy or natural gas. Reliable public transport systems will also serve to improve social welfare through improved access to employment opportunities, lower relative costs of transportation and better social integration.

In addition to efficient and reliable public transport, the Provincial Land Transport Framework (2011) advocates the enhancement of sustainability aspects into the overall transportation network, including the provision of non-motorised transport services (e.g. cycling lanes and pedestrian walkways) and infrastructure, providing transport services for people with special needs, public transport provision in rural areas and ongoing maintenance of infrastructure. The implementation of an Integrated Rapid Transport System in the City of Cape Town is already underway and it aims to integrate numerous modes of transport, including conventional and feeder bus services, minibus taxis, metered taxis, road based services as well as transport facilities and infrastructure such as pedestrian walkways, bicycle access, Metrorail park and ride services.

2.7 Agriculture and food security

Food security is a growing concern for all sectors of society. Growing demand will necessitate the expansion or intensification of current agricultural production and a shift to high value crops. Although the overall impact on the environment can be managed to a large extent, some uncertainty exists in terms of whether appropriate protection has been provided to prime agricultural land, how productivity will be affected by climatic variability, and whether the quality of the natural resource base (water, soil and ecosystems) can be maintained. This concern relates to both large scale rural agricultural areas, as well as small scale farming in urban contexts. Urban farming plays a significant role in facilitating food security, livelihoods and social resilience in vulnerable communities.

An additional aspect to consider is issues related to land reform and restitution, however, progress is being made in rural transformation and land reform. Despite this, social unrest in the early part of 2013 is indicative of severe inequalities and levels of conflict still present in the agricultural sector that need resolution.

2.8 Management of natural resources, biodiversity and ecosystem services

The maintenance of functional ecosystems and sustainable utilisation of natural resources are essential for human health and well-being. Natural processes are fundamental for balance and stability in the environment that we live in, and often go unnoticed and under-valued.

From the assessment of natural resources in the different theme chapters of the State of Environment Outlook report, it becomes clear that although large natural areas are protected and significant resources are directed at conserving biodiversity, ecosystems remain under threat. Specific aspects that raise concern, and that will determine the direction of change in natural resource quality, are:

- Declining ecosystem health in particular risk categories such as estuaries and threatened ecosystems
- Persistence and impacts of invasive alien species
- Uncertainty with regards to marine ecosystem integrity
- Illegal harvesting of natural resources
- The state and effectiveness of marine protected areas
- Impacts from emerging fields such as wind and solar energy, natural gas extraction and rare earth minerals mining
- Poor protection for many of the threatened species and ecosystems or CBAs

- The numbers of threatened species
- Coastal transformation
- Land transformation

2.9 Water resource management

The water resource supply-demand balance in the Western Cape is currently negative, with more demand for water than what can be supplied from conventional surface water sources. This means that more efficient water use is imperative, and a reduced impact on the state of environmental resources is possible through more effective integrated catchment management and co-ordination between decision-makers and water users.

Urgency exists for the implementation of an ecological reserve for all river, wetland and estuarine systems. Also required is the determination of resource quality objectives for all significant water resources of the province's WMAs and relevant catchment management agencies, as has taken place in the Olifants/Doorn Water Management Area.

Alien vegetation and alien fish management is also an essential management action required in order to realise sustainable management of the water resources of the province. Invasive species are, next to human activities, arguably the most significant impacts on state and availability of water resources.

2.10 Disaster and risk management

Human concentrations, land transformation and natural hazards combine to expose communities to environmental risks. These risks include risks from natural disasters such as flooding or sea level rise, as well as consequences of human activities such as fires in informal settlements and outbreaks of disease. The risks are hard to predict and difficult to quantify, but their impact on human lives and livelihoods can be significant. Managing the risk through control over exposure and community vulnerability will improve overall social resilience and consequently also the capacity of communities to invest in the maintenance of natural resources.

2.11 Monitoring

Monitoring of change in the environment will have an indirect impact on the state of environmental conditions, as it is essential for informing environmental management decisions and actions. Monitoring, and specifically monitoring of the baseline indicators reported on in this State of Environment Outlook report, will put both authorities and public entities in a position to make more informed and therefore better decisions on environmental matters.

Some information on the state of environmental resources is currently being collected and made freely available. However, particular aspects that require either updated information or improved systems of collection for monitoring data include: information on land cover and transformation; information on waste; and better coverage by air quality monitoring points.

2.12 Sense of place

The Western Cape is known for its beauty, as a centre of endemism, hot spot for biodiversity, and a renowned tourist destination. Its rich history, colourful culture and friendly, diverse community further distinguish the province. As such, it attracts scores of foreigners, residents from other provinces and rural families to its city, resulting in a rapidly growing metropolitan community.

While this adds to the flavour of the province and economic potential with a diversity of available skills, it does pose a potential shift for the sense of place, as a whole and by individuals or groups specifically. The risks originate from particular lifestyle trends such as lifestyle estates or boutique agriculture, as well as new technologies and infrastructure requirements such as wind or solar farms and expanded public transport. It is important to ensure that the value derived from the unique and internationally valued natural resources of the Western Cape is not compromised in an unsustainable manner for short term gain, or unequally in favour of particular sectors of society.

3 RESPONDING TO ENVIRONMENTAL CHANGE

The disaggregated evaluation of the state of environmental themes and consideration of which components of environmental management matter most, serve to consolidate guidance on which key themes or actions will make the most difference in advancing the Western Cape on the road to sustainability. If addressed with the necessary urgency and commitment of resources, these actions will ensure that the direction of development remains true to the sustainability ideal, and that investment in environmental management will result in continuous returns over the longer term.

By virtue of shifting towards more sustainable ideals, the proposed priority actions support the National Green Economy targets, as outlined in the New Growth Path: Green Economy Accord (2011). The intention of this Accord is to implement wide-ranging commitments and mobilise the private sector, organised labour, communities and government in a strong partnership to promote the green economy. This serves as a platform for creating five million new jobs by 2020 across the country. Above all, this strategy makes use of the enormous spending on climate change induced technologies to create local industrial capacity, local jobs and local technological innovation.

Priority actions can be categorised in five themes, namely the built environment & infrastructure, strengthening of ecosystem services, reduction of wastage, good governance and building of resilient communities. The proposed priority actions for each category are addressed in the sub-sections that follow.

3.1 Sustainable built environment & infrastructure

Many advances can be made in the built environment that would lessen the impact on the natural environment in terms of efficiency of resource use and pollution. This sector not only lends itself to improvements in energy, water and waste efficiencies, but improvements in building performance can benefit the human occupants in terms of cost of living and working and in terms of health.

Key actions required to either kick off radical long-term changes or to maintain momentum of existing initiatives include:

- Removing obstacles to innovative green urban development and off-grid infrastructure;
- Stimulating large-scale changes to energy and transport systems (support renewable energy development, waste to energy initiatives and decoupling from restrictive dependencies);
- Identify new funding mechanisms;
- An integrated planning approach that aligns development actions and removes duplication or conflicts of action; and
- A push for renewable energy development within the province.

3.2 Actively strengthen ecosystem services

The provincial economy, and indeed much of the unique environment that attracts people to the Western Cape, is dependent on a functioning ecological system. It is imperative that efforts be directed at maintaining the integrity of the natural systems. In this regard, sensitive or critical natural elements have to be protected, and the slow deterioration of the overall system hindered. Key interventions are:

- Active protection and enhancement of natural resources that provide ecological goods and services, with specific focus on improving the living conditions of the poor;
- Protection for Critical Biodiversity Areas and adoption of biodiversity planning into local Spatial Development Frameworks;
- Restoration of degraded riverine habitat and corridors (e.g. Berg River Improvement Plan)
- Actively develop green infrastructure; and
- Implementation of coastal management plans to protect sensitive marine and estuarine ecosystems, and improve the understanding and management of coastal dynamics and marine ecosystems.

3.3 Curb wastage of resources

Improving the efficiency of resource use will benefit the planet in two ways – it will reduce the amount of resources extracted as well as the amount of waste material being disposed of in the environment. Most of the improvements in efficiency will result in systematic cost savings, and should therefore be prioritised as win-win interventions. The recommended key actions include:

- Increasing options for water reuse and curbing of reticulation water losses;
- Active support for conservation agriculture where it relates to use of water – i.e. more '*crop per drop*';
- Actions and strategies for addressing energy intensity and dependencies;
- Removing the regulatory constraints that currently inhibit reuse of waste and industrial symbiosis;
- Transforming traditional perceptions of waste so that waste may be viewed as a resource and not a liability; and
- Incentives for reduction of waste, including an appropriate approach to removing organic material from waste stream.

3.4 Good governance

The National Development Plan 2030 makes it unequivocally clear that good governance is necessary for sustainable and equitable social and economic transformation. Two essential government responsibilities identified through the course of the State of Environment evaluations are information gathering and integrated planning. These need to be implemented through:

- Proper licensing of waste management facilities and reliable reporting of volumes and types of waste;
- Improving the extent of and co-ordinating air quality monitoring;
- Update information on land cover;
- Gather information on private sector initiatives in the waste, air quality, energy and climate change adaptation fields; and
- Enhanced systems for integrated planning and implementation, especially in terms of biodiversity and ecosystem vulnerability.
- Ensure environmental sector plans are up to date and incorporated into IDP priorities.

One method of measuring the inclusivity of environmental matters within planning at municipal level is to track the inclusion of environmental sector plans in IDPs. Figure 2 and Figure 3 illustrate which district and municipal environmental sector plans are completed and up to date (shown as green rings), and those that are not (as red rings). Each ring represents a different legally required plan e.g. Integrated Waste Management Plan, Air Quality Management Plan etc. The diagram therefore shows that there is significant work to be done to ensure all required plans are in place to mainstream environmental issues into municipal planning and governance structures.

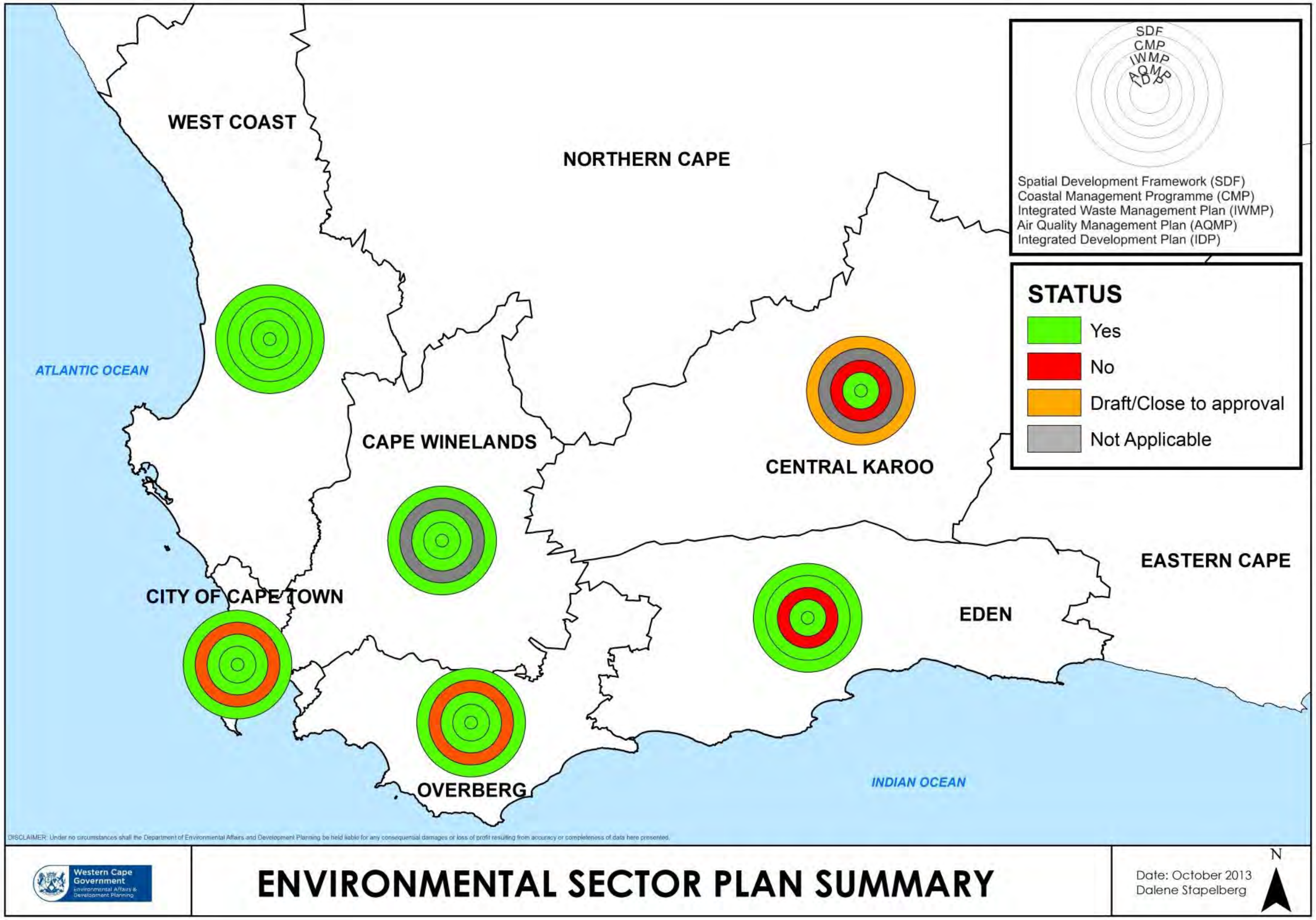


Figure 2: Status of District and Metropolitan Municipalities' environmental sector plans

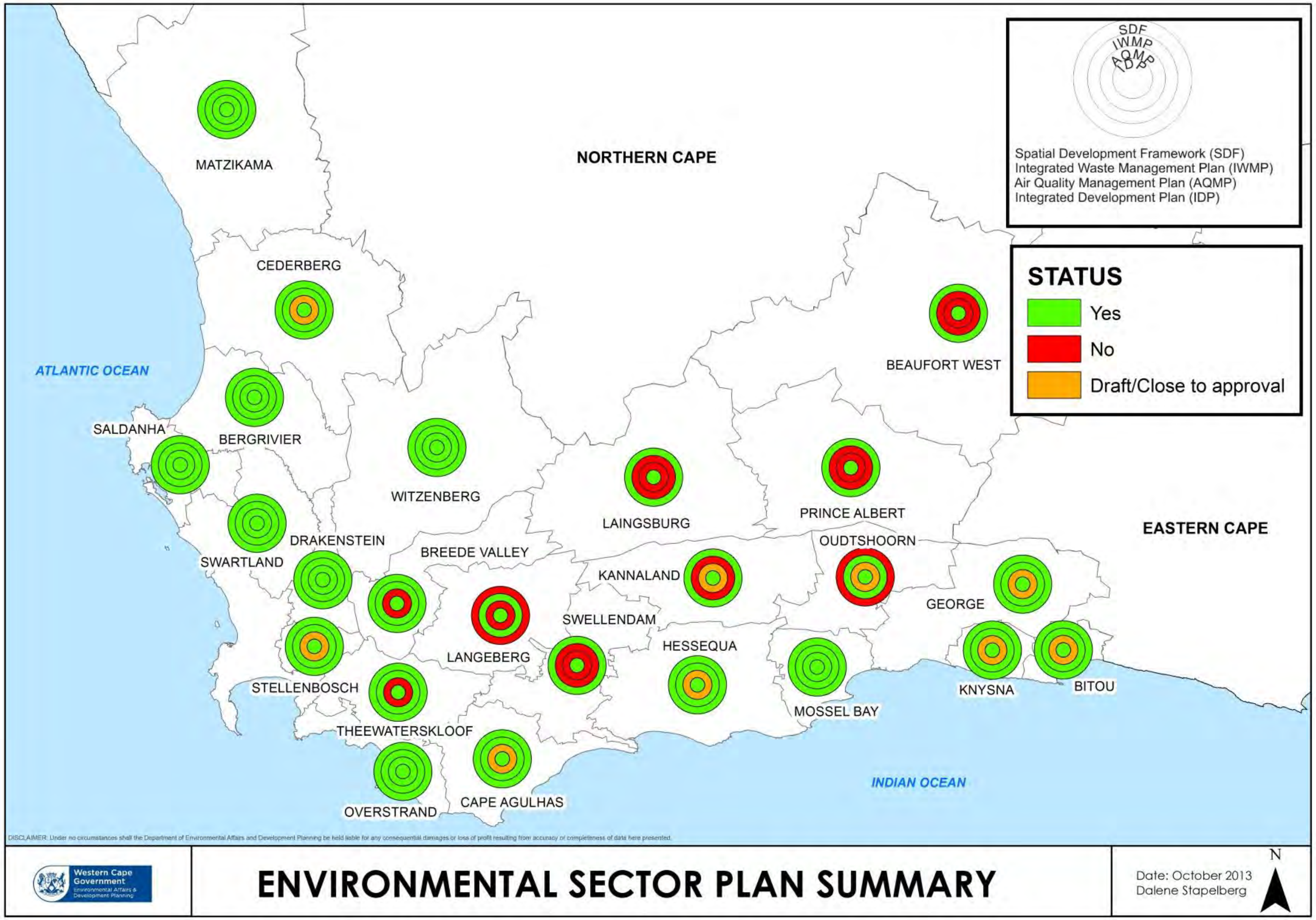


Figure 3: Status of Western Cape local Municipalities' environmental sector plans

3.5 Build resilient communities who can earn a living

Sustainable development is as much dependant on maintaining human welfare as it is on not exceeding the capacity of natural systems. The trick seems to be in finding developmental strategies and solutions that can satisfy both requirements, or at least benefit either without compromising the other. Specifically in the Western Cape, the most urgent human welfare focussed actions to be implemented are:

- Large scale adoption and support of conservation agriculture;
- Sustainable coastal livelihoods programmes;
- Active support for Green Economy development; and
- The developing and implementation of local climate change adaptation plans.

4 ENVIRONMENTAL GOVERNANCE AND POLICY ALIGNMENT

4.1 Policy alignment

When considering the focus areas for policy and action as identified through the State of Environment Outlook analysis, against policy directives from various strategic planning initiatives relevant to the Western Cape, a high level of convergence emerges. Alignments or synergies of policy directives can be seen at National and Provincial levels, in the form of government plans for the future of the country, its people and the environment. These directives have typically been defined through an analysis of gaps, challenges and areas identified for growth and improvement. The evidence of convergent strategic direction further elucidates thinking around the key priorities for action which will lead to a holistic improvement in the state of the environment and level of sustainability in development.

Respectively, Figure 4 and Figure 5 show national and provincial policy directives related to future planning and development in summarised form. Directives related to themes also identified in the Western Cape State of Environment Outlook Report 2013 have been highlighted in blue, to bring out the convergence of thinking on key priorities.

As is evident, most policy convergence lies in stimulating development that is based on resource use efficiency, ecosystem health, functional and well planned human settlements, good governance and regulation, as well as a good education system. Resource use efficiency incorporates the efficient and effective use of all natural resources, including water, energy, land, soil, biodiversity, fauna and flora, air and marine resources. Specific environmental themes include a response to climate change, a transformed transportation system, green growth and development, and a focus on agriculture and food security.

2030 National Development Plan

- **Twenty year Plan**
- **Objectives and actions**
  - **Economy and employment**
  - Economic infrastructure
  - **Environmental sustainability and resilience**
  - An integrated and inclusive rural economy
  - Positioning South Africa in the region and the world
  - **Transforming human settlements**
  - Improving education, training and innovation
  - Promoting health care for all
  - Social protection
  - Building safer communities
  - Building a capable and developmental state
  - Fighting corruption
  - Nation building and social cohesion

2020 New Growth Plan

- **Ten year framework**
- **Jobs drivers**
  - **Infrastructure**
  - Main economic sectors
  - Seizing the potential of new economies
  - **Investing in social capital and public services**
  - **Spatial development**
- **Key sectors**
  - **Infrastructure**
  - **Agricultural value chain**
  - Mining value chain
  - **Green economy**
  - Manufacturing sectors in IPAP
  - **Tourism and certain high-level services**

2014 National Strategy for Sustainable Development

- **Five year revolving strategy, action plan and interventions**
- **Strategic priorities**
  - **Enhancing systems for integrated planning and implementation**
  - **Sustaining our ecosystems and using natural resources efficiently**
  - **Towards a green economy**
  - **Building sustainable communities**
  - **Responding effectively to climate change**

Figure 4: National policy directives

ONE CAPE 2040

- **Thirty year Plan**
- **Vision & priority actions**
- High skills, connected and collaborative & innovation driven
  - **Resource efficient & resilient**
  - An inclusive and competitive economy
  - High employment rate & growing incomes
  - **Improved quality of life overcoming legacy issues**
  - **Responsive to environmental risks**
- **Priority actions**
  - **Transition from a dirty to a clean economy is paramount**
  - **Safe and efficient public transport and embracing of non-motorised transport**
  - **Energy security from renewable sources**
  - **Upgrading low income rental stock, gap housing and private-sector driven integrative efforts**
  - Consciously empowered community leaders are required
  - **Enhance municipal service delivery in poor settlements**

2014 Provincial Strategic Objectives

- **PSO1: Increasing opportunities for growth and jobs**
- **PSO2:** Improving education outcomes
- **PSO3: Increasing access to safe and efficient transport**
- **PSO4: Increasing wellness**
- **PSO5:** Increasing safety
- **PSO6: Developing integrated and sustainable human settlements**
- **PSO7: Mainstreaming sustainability and optimising resource-use efficiency**
- **PSO8:** Increasing social cohesion
- **PSO9: Reducing and alleviating poverty.**
- **PSO10: Integrating service delivery for maximum impact.**
- **PSO11: Creating opportunities for growth and development in rural areas.**
- **PSO12:** Building the best run provincial government in the world

2013 State of Environment Outlook Report

- **Strategic priorities**
  - **Green Built Environment – infrastructure, services, human settlement (innovate)**
  - **Actively strengthen ecological goods and services to enhance resilience & limit impact on the poor**
  - **Enhance Systems for Integrated Planning and Implementation incorporating biodiversity & ecosystem vulnerability**
  - **Good governance- environmental monitoring, waste management, integrated planning**
  - **Build resilient communities who can earn a living- conservation agriculture, coastal livelihoods, Green Economy**
  - **Responding Effectively to Climate Change**

Figure 5: Provincial policy and the State of Environment Outlook

4.2 Who is responsible to drive change?

No amount of prioritization or policy formulation will effect change unless specific entities take responsibility to implement the recommended actions. Many of the identified trends for the Western Cape cut across disciplines, and as such there are convergences of policy that should be tackled from an interdisciplinary approach in order to ensure effective results without duplicated efforts by various parties. In order to achieve such an integrated and co-ordinated approach to implementing change, a strong focus on governance, policy alignment and service delivery will be required.

Nevertheless, the specific entities that will need to contribute action can be identified. Figure 6 is a high level and general depiction of the shared responsibilities, but more importantly, shows the connection of government, local communities, NGOs, CBOs, PBOs, and the private sector. Each of these groups is fundamental in ensuring positive shifts within the Western Cape, and the continued ecological health and synergy of the natural environment, economic growth of the province, and a sustainable future.

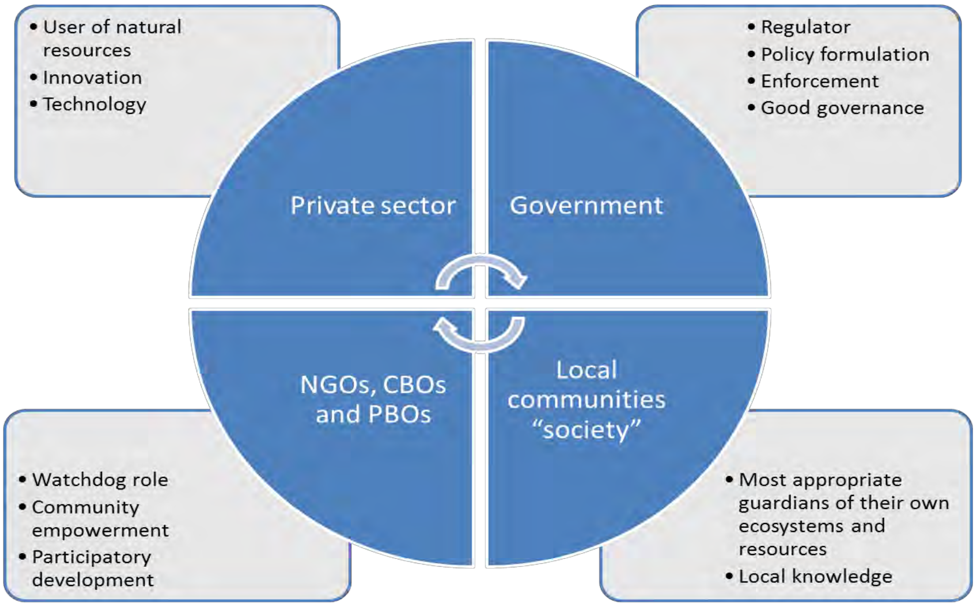


Figure 6: The roles of various bodies in the implementation of priority actions for change

While national and provincial policy acts as an overarching guide to all processes, it is important that a focal point is created for implementation. The Municipal System Act (Act 32 of 2000) provides the opportunity to utilise the Integrated Development Plan process at local government level as the focal point to ensure local action for these key issues. Local Authorities are at the "coal-face" of environmental sustainability, because they have tremendous influence over infrastructure development, the effectiveness of resource use, spatial development patterns, human welfare and the protection of ecosystem goods and services. Although environmental management is a mandate and responsibility placed on Local Authorities by the Constitution, it is often argued that the environmental function is not adequately funded. This is indeed one of the aspects that will be monitored more closely in the next State of Environment reporting period. Government spend on environmental matters is currently not clearly ring-fenced or tracked, and is in fact for the most part allocated as non-environmental budget items – such as procuring efficient light bulbs. It is proposed that systems be put in place that can track any environmentally responsible spending as part of the Provincial Economic Review and Outlook reporting system.

Environmental management is nearly always more a matter of responsible execution of the day-to-day activities of municipalities rather than an add-on. The Municipal System Act requires that municipal tasks must be undertaken in harmony with the natural environment and for the social and economic upliftment of communities. The implementation of an integrated, resource efficient public transport system, for example, is as much related to sustainability and environmental responsibility as it is to social welfare and the building of functional urban areas.

What is important is that clear direction is provided as to how change need to be made, by whom and by when, and that it is shown how everyday execution of governance mandates can realize environmental sustainability. This needs to be an iterative process that is continually reviewed and adjusted when needed. It is important that there is free flow of communication at all levels, and that such processes are not undertaken in isolation.

4.3 Monitoring requirements

The State of Environment Outlook Report is but one example of a consolidation of monitoring data with the aim of informing decision-making and policy formulation. Unfortunately the quality of the reporting, and therefore the quality of the decision-making support, is dependent on the quality of the data that is available. Preferably, datasets that cover all relevant data points and with consistent long term records should be available, but in reality such sets are rare. Often the collection of data is subject to contextual constraints such as financial and human resource constraints, technical challenges, or is only available for short periods due to discontinued monitoring stations or changes to observation programmes.

As a consequence, the State of Environment Outlook Report is based on a selection of critical indicators that are specifically selected because of their potential as proxies for more complete data sets. In some cases these indicators continue reporting lines that were started in the previous State of Environment Report for the Western Cape, but in others are intended as baseline indicators that offer an opportunity for future iterations of the report to compare future states to the current state.

4.3.1 Land cover

One of the fundamental shortcomings of environmental data in the Western Cape is the lack of a recent, comprehensive and systematically classified land cover dataset. The current information on land cover dates from a national dataset of 2001, with a limited update done by SANBI in 2009. Here and there, sector-specific datasets are found, such as information on agricultural activities that is in the process of being updated, but on the whole it is not possible to compare historic land cover information with current patterns.

A need therefore exists for a provincial land cover dataset with a classification that is comparable to the 2001/2009 data in order to map transformation and inform spatial decision making.

4.3.2 Waste management & air quality

Monitoring of environmental conditions that have material impact on human health is fundamental to their proper management. Waste management and air quality are two aspects that need constant monitoring. Long term monitoring data provides authorities with information on which to base planning decisions, whereas real-time information will make rapid response to pollution incidents possible.

4.3.2.1 Waste management

Information on the size and composition of waste streams is hard to obtain in the Western Cape, and indeed throughout South Africa. Most of the data on waste generation and disposal is based on estimates and assumptions rather than hard measurements, and is therefore rather uncertain. For example, the actual waste volumes in the Western Cape can be 12.5% higher or lower than the best estimations show.

Although municipal information flows are improving rapidly, much still needs to be done to improve information of waste that is diverted from the waste stream and to include information on private initiatives in the overall knowledge base. Also, information about waste from industrial sources often goes unreported due to commercial sensitivity or confidentiality, and it is consequently difficult to understand the impacts of the waste flowing from and between such facilities.

Several initiatives aimed at improving the state of waste information are underway. This includes an Integrated Pollutant and Waste Information System based on mandatory registration and reporting by holders of waste, improvements in the recording of waste volumes at waste management facilities, and implementation of the monitoring and reporting requirements of recent Health Care Risk Waste legislation.

4.3.2.2 Air quality

Monitoring of ambient air quality and air pollution incidents has improved over time, with a network of monitoring stations across the province. The stations are run by the Western Cape Government, local authorities and private facilities, and build up to a good dataset of atmospheric pollutant levels. Admittedly, more stations are required, as is improved maintenance of existing stations, especially in terms of the Provincial oversight function. Few long term Provincial monitoring records exist, since in most cases monitoring stations have only been in their current locations for short periods. Longer term records are available from local authorities and private facilities.

Real-time information on air pollution incidents is required if effective rapid response to such events is to be accomplished. This necessarily requires fully functioning monitoring stations at high risk locations, real-time data dissemination and a response protocol that can be put in practice at any time.

4.3.3 Water resources

Information on wetlands is currently limited to delineations and classifications done by SANBI on a national scale. A need exists to verify the mapping and ecological classifications on a finer scale in order to improve the accuracy of the data. In conjunction, River Health monitoring must be continued and possibly improved, in order to advance understanding of wetlands and watercourses that show negative trends.

Groundwater information is found to be skewed towards a limited number of monitoring points and therefore requires much wider investigation and monitoring work to provide a holistic representation of the resource availability and quality.

4.3.4 Biodiversity and ecosystems

It is known that the value of ecosystem goods and services are not recognised in microeconomic policy and everyday market prices. This means that the benefits derived from natural resources are undervalued within the market system, and consequently neglected, leading to biodiversity loss and impacts on human well-being.

For this reason, dedicated systems of measurement, monitoring and reporting on the state of natural capital – natural processes, genetic resources, productive ecosystems, etc. – are required. These systems need to:

- Quantitatively measure biodiversity and ecosystem values;
- Understand biophysical tipping points at various scales and measure how close we are to them; and
- Report on the economic value of ecosystem services relative to macro- and microeconomic processes.

Ecosystem valuations can draw on State of Environment reporting, but needs to inform the selection of indicators for the reporting process and add value to the reporting system by ensuring consistent monitoring and regular feedback to relevant economic planning forums.

4.3.5 Marine resources

Scientific understanding of marine ecosystem dynamics and resource levels is still limited. This is particularly problematic in the Western Cape due to the rich and complex nature of the local coastline. When this lack of knowledge is combined with capacity constraints experienced by the institutions and authorities responsible for monitoring and assessment of marine resources, a dangerous situation is created where poor decision making and unsustainable exploitation occurs.

One particular aspect that is of concern is the lack of consistent and co-ordinated monitoring. Part of the problem lies in the fact that numerous scientific and academic institutions vie with National and Provincial authorities for research opportunities and funding, whilst few entities are willing to accept responsibility for administration and active protection of the coastal and marine environment. Intertidal and estuarine systems are of particular concern due to overlapping spheres of responsibility and weakly defined boundaries.

As the chapter on Oceans and Coasts show, the current state of marine ecology is a concern along much of the Western Cape coastline, and therefore improved information on the drivers of change, the state of the marine system, as well as the impacts of changes to the system will be crucial for future coastal decision-making and planning.

4.3.6 Responses

A general shortcoming of monitoring and reporting systems relating to State of Environment information is the lack of consistent reporting on interventions aimed at addressing pressures on the environment or reacting to changes in environmental conditions. Much of the information on responses to environmental change is based on incidental reporting or disaggregated data, and therefore does not give an accurate picture of what is taking place in the province in terms of aspects such as:

- Integrated waste management and waste reduction;
- Climate change adaptation and mitigation, especially in terms of private sector responses; and
- Energy efficiency interventions on local authority level and in private facilities

5 CONCLUDING STATEMENTS

The Western Cape is custodian of a rich, varied and highly valued natural environment. This natural environment sustains the livelihoods of everyone in the province, whether through the provision of foodstuffs or as building blocks for the diverse economy. This overview of the state of the environment shows that although the natural systems are still broadly functional and generally sustaining the current levels of social development and economic activity, sustainability of natural resource use is still to be achieved. More needs to be done to protect critically sensitive or important environmental features, and the ability of the region to adapt to impacts from climate change is uncertain.

The overall outlook for all our natural resources is declining. Table 1, contains a summary of all the environmental indicators reported on in the State of Environment Outlook Report. Where "insufficient historical data" is cited, it often implies that the comparative dataset necessary for trend analysis is not available, but that the general environmental state is stable.

Worryingly, most biophysical themes show declining trends. Energy is considered relatively stable but in need of revision, and there is a slightly more positive outlook for waste management and human settlement indicators. A radical shift in the modus operandi is required throughout the province to respond to these findings. Moving forward service delivery and economic growth must be **resource efficient, low carbon and enhance societal resilience** if we are to find a more balanced approach to using our limited resources.

Table 1: Summary of environmental indicators reported on in the State of Environment Outlook Report

Land	Key points	Trend	
Land cover	• 4th largest province (10.6% of total) in South Africa • 78% natural • 22% transformed o 18.7% agriculture o 1% urban o 0.7% forestry o 0.7% degraded	***Declining***	
Land capability	• No high capability soils- vulnerable agriculture requiring high inputs	***No change***	
Land transformation	• Intensification of urbanisation sprawl • 1.6% more agriculture	***Declining***	
Biodiversity & Ecosystem Health	**Key points**	**Trend**	
Alien invasive species	• 291 invasive plant species • Primary threat to indigenous fish	***Declining***	

Biodiversity Priority Areas	• Progress on expansion of conserved areas but only 2.3% of expansion qualifies as formal protection	High concern	
Protected areas	• Since 2002: o 311,197ha formally protected (Only 2.4% of which are Critical Biodiversity Areas) o 4,861ha biodiversity agreements • 27,077ha conserved with no legal protection	Improving	
Habitat fragmentation	• The province contains 15 of the 17 highly fragmented vegetation types in the country	Insufficient historical data	
Vegetation types	• Existing mapping is from the South African National Biodiversity Institute (SANBI)	No change	
Threat status	• Threatened species: o **70% of freshwater fish** (16 of 23 indigenous species under threat) o **13% of plants** (13,489 species total – 1,709 Threatened + 296 Critically Endangered + 575 Endangered + 801 Vulnerable; 68% of National Threatened species total; 2,984 additional species of concern; 21 species Extinct; 1,695 endemic to Western Cape) o 10% of mammals o 5% of reptiles o 5% of birds o **Marine fish and invertebrates** – information not available, cartilaginous fishes are assumed most threatened with 4 of 35 species Critically Endangered • Threatened terrestrial ecosystems: o 21 critically endangered o 14 endangered o 23 vulnerable	Insufficient historical data	
Centres of endemism	• 96% of threatened species are endemic	High concern	
Inland Water	**Key points**	**Trend**	
Water availability	• Water resource balance (2005): o Supply 2522 million cumec o Demand 2637 million cumec o Current deficit of 115 million cumec (was 90 in 2000)	Declining	
Fitness for use	• River Health Water Quality assessment: o Overall – relatively good shape o 21% natural o 36% good o 34% fair o 9 % poor	Insufficient historical data	
Freshwater ecosystem health	• River Health Ecostatus: o 6% natural o 30% good o 48% fair	Insufficient historical data	

	o 14% poor		
Oceans & Coasts	**Key points**	**Trend**	
Coastal water quality	• Blue Flag Beaches monitoring shows acceptable state	*Improving*	
Estuary health	• Poor health, highly modified, poorly protected and highly threatened (Eden District is the exception to this	*High concern*	
Conservation areas	• 8 marine protected areas • Mixed results in terms of management	*Improving*	
Marine area threats	• Critically endangered marine habitats: o West Coast nearshore o Eden and Overberg offshore areas o Continental shelf edge • Endangered habitats: o Langebaan o Cape Agulhas	*High concern*	
Transformation	• Loss of threatened ecosystems along 14% of the coastline between 2001 and 2009	*Declining*	
Human Settlements	**Key points**	**Trend**	
Housing	• Informal dwellings constitute 18.2% of households in 2011 (up from 16.7% in 2001) • Housing shortage of 400 000 units	*Backlog increasing*	
Access to basic services	• 99.1% piped water (up 0.8% from 2001) • 93.4% electricity (up 5.3% from 2001) • 90.5% sanitation services (up 2.2% from 2001) • 91.1% refuse removal (up 2.3% from 2001)	*Improving*	
Access to transportation	• Well developed, but historic patterns dominate • New forms of public transport taking off	*Improving*	
Open space provision	• Insufficient and often inappropriate	*Insufficient data*	
Air Quality	**Quantification**	**Trend**	
Atmospheric pollutants	• Particulate matter (PM_{10}) – below threshold but shows steady increase • Nitrogen oxides (NO, NO_x) – acceptable but problems at certain locations • Sulphur dioxide (SO_2) – below threshold • Green House Gases (GHG) – levels increasing	*Insufficient data*	
District breakdown	• City of Cape Town – higher concentrations of all parameters o General problem in the form of smog ('brown haze') – linked to vehicle emissions o Cape Flats – high PM_{10} and volatile organic	*No change*	

	compounds (VOC) – due to domestic fuel burning, traffic and industry • Cape Winelands – high particulate matter (PM) and NO_2, linked to fugitive agricultural spraying • Central Karoo – transportation related emissions • Eden emissions – concentrations at PetroSA, Oudtshoorn (tanneries and abattoirs) • Overberg – has highest per capita vehicle ownership, indicating potential issues over time • West Coast – concentrated emissions from industries using coal, red oxide dust from iron ore handling at the Saldanha port, mines (e.g. dust from lime production, Matzikama), and aqua/mariculture industries (e.g. St. Helena Bay fishmeal production)		
Climate Change	**Key points**	**Trend**	
Projected change	• 1°C warming by late 2030s, warmer minimum and maximum • Highly uncertain, but possibly drying towards the west, and shorter rainy season, stronger winds, and approximate 5cm sea level rise over 25 years	***Declining***	

Carbon footprint	• Total emissions (contribution to greenhouse effect measured in carbon dioxide equivalent (CO_2e) emissions):
	  o 41,303,482 tonnes CO_2e (2009) (compared to ~17,000,000 tonnes CO_2e in 2001)
	  o 53% of provincial total due to electricity consumption
	• Carbon intensity:
	  o Emissions relative to population size - 8 tonnes per capita in 2009 compared to 5.8 tonnes per capita in 2001
	  o 178 tonnes per million Rand contribution of Gross Domestic Product (GDP) (2009
	• GHG contributions:
	  o 36% from industry, 28% from transport
	  o City of Cape Town 57% of total, West Coast District 22%
		Limited historical data	

Energy	**Key points**	**Trend**	
Energy generation	• Oribi/Oryx oil field (2% of RSA liquid fuels) • PetroSA coal/gas-to-liquid plant • 2x open cycle gas turbines (2 084MW) • 2x gas turbines (207 MW) • Koeberg nuclear reactor (1 800MW) • Palmiet pumped storage (580MW) • 4x solar, 4x wind farms planned under the Independent Power Producers (IPP) process • Eskom Sere wind farm under construction	***Improving***	

Energy use	• Total excluding marine and aviation:
	  o 247 742 000 GJ in 2004
	  o 270 887 000 GJ in 2009
	• 52% used by transport (previously 35%)
	• Mostly coal based electricity and liquid fuels
	• CoCT consumes 60%, West Coast 24%
		Declining	

Energy intensity	• 64 GJ/capita • 8t CO_2e/capita • Even higher intensity per unit of GDP • West Coast 6x higher intensity than provincial average (industries) • Central Karoo relatively high due to overland transport	***Concern***	
Domestic energy use	• Households electrified: o 83.5% in 2005 o 93.4% in 2011 • Decreasing % of households using electricity for heating • Energy other than electricity: o 7% for lighting o 13% for cooking o 21% for heating	***Improving***	
Waste Management	**Key points**	**Trend**	
Waste generation	• Total: o 1,446,500 tonnes per annum in 2001 o 3,807,765 tonnes per annum in 2010 • 70% generated in CoCT, but relative contribution falling • Mostly paper, plastic, organic waste and builder's rubble	***Declining***	
Waste collection	• 94% of households have refuse removal services (82% in 2001)	***Improving***	
Waste management	• 193 operational waste management facilities: o 92 general waste disposal o 54 drop-offs o 15 transfer stations o 13 materials recovery facilities o 6 planned/existing regional waste disposal sites	***Improving***	

The Western Cape Province is focussed on exploiting the opportunities of the global Green Economy in order to use responsible, equitable and sustainable economic development. The intention is to reduce the environmental footprint of the province and improve the socio-economic realities of its citizens through a shift towards a more sustainable and eco-friendly Green Economy, that benefits the local community.

Whilst State of Environment reporting is to become a regular reporting tool for tracking our resource utilisation trends, it is critical for us to focus on undertaking all activities within government and private sector in a more resource optimal manner on a day to day basis. Large scale conservation or environmental management interventions will not shift the pattern which has been identified within the province, nationally and globally. It is our actions, our services, our consumer patterns which will influence the trends. Day-to-day private, business and government decisions and implementation will cumulatively change how we use or abuse our environment and the change needs to start with each of us today.

So let us start making it better together.

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