



Garden Route District Climate Change Adaptation Strategy

Reviewed Report

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Executive Summary

The Garden Route District Municipality recognises climate change as a threat to the environment, its residents, and to future development. Therefore, measures should be implemented to reduce or eliminate carbon emissions or enhance greenhouse gas sinks (mitigation) (Böckmann, 2015). However, due to lag times in the climate and biophysical systems, the positive impacts of past and current mitigation will only be noticeable in the next 25 years (Jiri, 2016). In the meanwhile, adaptation is regarded as inevitable and a necessary response to the changes that are projected to take place in the District. The Garden Route District Municipality has therefore prioritised the development of a Climate Change Adaptation Plan developed in 2014. This Garden Route District Climate Change Strategy builds on the original Adaptation Plan by providing more detail at a sector level on key Climate Change Vulnerabilities and Responses.

The Climate Change Adaption Strategy was developed with the assistance of the Local Government Climate Change Support (LGCCS) program (<http://www.letsrespondtoolkit.org/>); in partnership with the Western Cape Climate Change Municipal Support Programme. The LGCCS is led by the Department of Environmental Affairs and is part of the International Climate Initiative (IKI) and is supported by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

Through this program key climate change vulnerability indicators for the Garden Route District were identified. These indicators demonstrate areas that may be at high risk of climate change impacts.

A summary of the key vulnerability indicators is provided in the table below (DEA, 2017).

Table 1: Key Vulnerability indicators for Garden Route District Municipality

No	Sector	Name Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
10	Agriculture	Increased risks to livestock	Yes	High	Low
13	Biodiversity and Environment	Increased impacts on threatened ecosystems	Yes	High	Low
14	Biodiversity and Environment	Increased impacts on environment due to land-use change	Yes	High	Low
15	Biodiversity and Environment	Loss of Priority Wetlands and River ecosystems	Yes	High	Low
19	Coastal and Marine	Loss of land due to sea level rise	Yes	High	Low
20	Coastal and Marine	Increased damage to property from sea level rise	Yes	High	Low
30	Human Settlements, Infrastructure and Disaster Management	Increased impacts on traditional and informal dwellings	Yes	High	Low
32	Human Settlements, Infrastructure and Disaster Management	Increased migration to urban and peri-urban areas	Yes	High	Low

No	Sector	Name Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
33	Human Settlements, Infrastructure and Disaster Management	Increased risk of wildfires	Yes	High	Low
36	Water	Decreased water quality in ecosystem due to floods and droughts	Yes	High	Low
1	Air Quality	Increase in Air Pollution	Yes	High	Low
2	Air Quality	Increase in odour complaints	Yes	High	Low
3	Air Quality	Increase in Brown haze	Yes	High	Low

1 Climate Change Introduction

1.1 Climate change defined

Climate change is a natural phenomenon that takes place over geological time. However, over the past few decades the rate of climate change has been more rapid and the magnitude of global warming has increased dramatically (Warburton and Schulze, 2006; Warburton, 2012). This change has been attributed to increased anthropogenic greenhouse gas emissions (Koske and Ochieng, 2013). For example, the burning of coal to generate electricity, the burning of petrol in cars, some chemical processes in industries, and many farming activities all contribute to the increased concentration of greenhouse gasses in the atmosphere. Climate change adaptation can be defined as:

“The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation” (IPCC TAR, 2001).

Moser and Ekstrom’s (2010) definition of adaptation is also useful:

“Adaptation involves changes in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting non-climatic changes. Adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations, aim to meet more than climate change goals alone, and may or may not succeed in moderating harm or exploiting beneficial opportunities.”

This definition recognizes that adaptation to climate change takes place in a complex context where climate variability and change is only one of many stressors that require response. It also acknowledges that some adaptive responses help deal with current variability and others may be more transformative and sustainable; yet there is no defined separation between the two and they can, and in fact in many circumstances should, be linked.

Climate change is not just an increase in average global temperatures but changes in regional climate characteristics such as rainfall, relative humidity and severe weather extremes (Davis, 2011). Climate change can manifest as a shock or a stress (Ziervogel and Calder, 2003). Shocks are defined as discrete, extreme events (rapid onset) such as floods, while gradual change (slow onset) such as

long-term climate variability is classified as a stress (Ziervogel and Calder, 2003). The negative impacts of climate change “are already felt in many areas, including in relation to, *inter alia*, agriculture, and food security; biodiversity and ecosystems; water resources; human health; human settlements and migration patterns; and energy, transport and industry” (United Nations Women Watch, 2009, 1).

1.2 Climate Change Policy Context in South Africa

Climate change is a relatively new area of policy development in South Africa. As policies and structures are developed, it is necessary to ensure that they are evidence-based, coordinated and coherent. This section introduces international and national climate change policies and structures, which are listed below:

- The United Nations Framework Convention on Climate Change (UNFCCC). This international treaty provides guidance on setting agreements pertaining to the reduction of greenhouse gas emissions;
- The Paris Agreement, came into effect on 4 November 2016. This is the first agreement all countries have committed to and stipulates that all countries must reduce carbon emissions to limit global temperature increase to 1.5 degrees Celsius above pre-industrial levels;
- South Africa’s Nationally Determined Contributions came into effect after the Paris Agreement was signed. South Africa is therefore required to report on mitigation and adaptation efforts. Concerning mitigation, South Africa is to reduce emissions by a range between 398 and 614 million metric tons of carbon equivalent by 2025 and 2030. There are several instruments to ensure reduction in carbon emissions including car tax and company carbon budgets among other instruments. With reference to adaptation a National Adaptation Plan is currently being developed, and climate change is to be incorporated in all policy frameworks, institutional capacity is to be enhanced, vulnerability and adaptation monitoring systems are to be in place, vulnerability assessment and adaptation needs framework are to be developed and there needs to be communication of past investments in adaptation for education and awareness;
- The National Climate Change Response White Paper (NCCRWP) was adopted in 2011 and presents the South African Government’s vision for an effective climate change response in the long-term, to transition to a climate-resilient and lower-carbon economy and society;
- The National Development Plan, focuses on eliminating poverty and reducing inequality by 2030 and creating an environmentally sustainable country through mitigation and adaptation efforts;
- Long Term Mitigation Scenarios, outline different scenarios of mitigation action for South Africa;
- Long Term Adaptation Scenarios, consist of two phases. Phase one, was the identification of climate change trends and projections as well as impacts and responses for the main sectors. Phase two focussed on integrating issues such as climate information and early warning systems, disaster risk reduction, human settlements and food security.

1.3 Climate Change Impacts in South Africa

South Africa's temperature is expected to increase to 1.2° C by 2020, 2.4° C by 2050 and 4.2° C by 2080 (Kruger and Shongwe, 2004). Contrary to the global increase in rainfall, South Africa's rainfall is expected to decrease by 5.4% by 2020, 6.3% by 2050 and 9.5% by 2080 (Kruger and Shongwe, 2004). The frequency and intensity of climate extremes, *inter alia*, droughts, floods, storms and wild fires will increase (Davis, 2011; Böckmann, 2015). Climate change evidence indicates the changes in frequency and intensity of flood and prolonged drought events at small scales (Meyiwa *et al.*, 2014). Furthermore, the sea level will continue rising and ocean acidification will get worse (Böckmann, 2015). There are however uncertainties associated with climate projections because they are based on the potential rates of resource use in the future, and associated greenhouse gas emissions (Nicholson-Cole, 2005).

To assist with assessing the potential impacts from climate change, the country has been divided into six hydrological zones (Figure 1). These hydrological zones not only reflect water management areas but have been grouped according to common climatic and hydrological characteristics (Department of Environmental Affairs, 2013a). Based on a range of data and projections, four possible climate scenarios have been identified for South Africa:

- Warmer/wetter (with greater frequency in extreme rainfall events),
- Warmer/drier (with an increase in frequency of drought and somewhat increased frequency of extreme rainfall events),
- Hotter/wetter (with substantially greater frequency of extreme rainfall events), and,
- Hotter/drier (with a substantial increase in the frequency of drought events and greater frequency of extreme rainfall events).

Projections on rainfall have also been developed for each of the hydrological zones (Department of Environmental Affairs, 2013a). The following four climate change scenarios have been described for the Breede-Gouritz-Berg Hydrological Zone (the dominant zone in the Western Cape) in the Department of Environmental Affairs' Long Term Adaptation Scenarios Reports. These are:

- Warmer wetter scenario - Decreased rain in autumn & increased in winter & spring
- Hotter drier scenario - Decreased rain in all seasons & strongly decreased in west
- Hotter wetter scenario - Decreased rain in autumn & increased in winter & spring
- Warmer drier scenario - Decreased rain in all seasons & strongly decreased in west

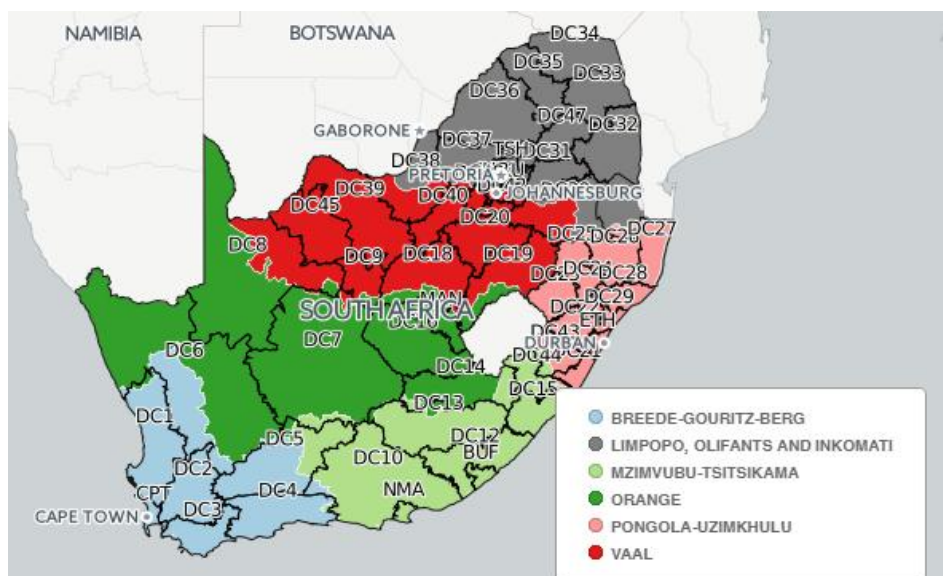


Figure 1: The hydrological zones of South Africa

2 Provincial Climate Change Context

The Western Cape has a well-developed climate change policy environment. In 2005, the Western Cape government carried out a study titled the “Status Quo, Vulnerability and Adaptation Assessment of the Physical and Socio-economic Effects of Climate Change in the Western Cape” and in the same year, the Western Cape government signed the Montreal Accord to protect the Ozone layer (Department of Environmental Affairs and Development Planning, Western Cape 2008). The Western Cape Climate Change Response Strategy and Action Plan was then developed in 2008 (Department of Environmental Affairs and Development Planning, Western Cape 2008; Coastal & Environmental Services 2011). The Climate Change Response Strategy and Action Plan placed a lot of emphasis on adaptation to allow for developmental priorities (Coastal & Environmental Services 2011). The Climate Change Strategy was then updated in 2014 to align with the National Climate Change Response Policy and is “geared to strategically direct and mainstream climate change actions and related issues throughout relevant Provincial transversal agendas” (Western Cape Government: Environmental Affairs and Development Planning, 2014).

The province experiences drought and flood events with significant adverse impacts (Pasquini, Cowling, and Ziervogel, 2013). Historically the province has been the most disaster prone in the country (Western Cape Government, 2015). Increased temperatures in the future are certain for the Western Cape (Western Cape Government, 2015). Rainfall projections are less certain, some projections reveal increased while others reveal decreased rainfall in the future, decreased rainfall has the most adverse impacts in comparison to increased rainfall (Western Cape Government, 2015).

Concerning wildfire, the frequency and intensity is expected to increase with climate change (Pasquini, Cowling, and Ziervogel, 2013). The frequency and intensity of extreme events is expected to increase as well (Department of Environmental Affairs and Development Planning, Western Cape, 2008).

The Table 2 below is a summary of the key climate change impacts in the province as outlined in the climate change strategy and action plan for the Western Cape.

Table 2: Climate change impacts for the Western Cape province

Change to climate variable	Vulnerability Details
Higher mean temperatures	<ul style="list-style-type: none"> Increased evaporation and decreased water balance; Increase wild fire danger (frequency and intensity).
Higher maximum temperatures, more hot days and more heat waves	<ul style="list-style-type: none"> Heat stress on humans and livestock; Increased incidence of heat-related illnesses; Increased incidence of death and serious illness, particularly in older age groups; Increased heat stress in livestock and wildlife; Decreased crop yields and rangeland productivity; Extended range and activity of some pests and disease vectors; Increased threat to infrastructure exceeding design specifications relating to temperature (e.g. traffic lights, road surfaces, electrical equipment, etc.); Increased electric cooling demand increasing pressure on already stretched energy supply reliability; Exacerbation of urban heat island effect.
Higher minimum temperatures, fewer cold days and frost days	<ul style="list-style-type: none"> Decreased risk of damage to some crops and increased risk to others such as deciduous fruits that rely on cooling period in autumn; Reduced heating energy demand; Extended range and activity of some pests and disease vectors; Reduced risk of cold-related deaths and illnesses.
General drying trend in western part of the country	<ul style="list-style-type: none"> Decreased average runoff, stream flow; Decreased water resources and potential increases in cost of water resources; Decreased water quality; Decrease in shoulder season length threatening the Western Cape fruit crops; Increased fire danger (drying factor); Impacts on rivers and wetland ecosystems.
Intensification of rainfall events	<ul style="list-style-type: none"> Increased flooding; Increased challenge to stormwater systems in urban settlements; Increased soil erosion; Increased river bank erosion and demands for protection structures; Increased pressure of disaster relief systems; Increased risk to human lives and health; Negative impact on agriculture such as lower productivity levels and loss of harvest.
Increased mean sea level and associated storm surges	<ul style="list-style-type: none"> Salt water intrusion into ground water and coastal wetlands; Increased storm surges leading to coastal flooding, coastal erosion and damage to coastal infrastructure; Increased impact on estuaries and associated impacts on fish and other marine species.

The provincial climate change strategy also lists a number of priority responses in each of the key sectors. These are summarised in Table 3 below:

Table 3: Priority Climate Change Adaptation Responses for the Western Cape Province

Adaptation Category	Adaptation Responses
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Adaptation Category	Adaptation Responses
Water Security and Efficiency	<ul style="list-style-type: none"> • Invasive alien vegetation clearing; • Prioritisation, valuation, mapping, protection, and restoration of ecological infrastructure in catchments; • Effective utilisation of irrigation water; • Resource nexus decision support; • Develop ecosystem goods and services (EGS) investment opportunities.
Biodiversity and Ecosystem Goods and Services	<ul style="list-style-type: none"> • Prioritisation, valuation, mapping, protection, and restoration of ecological infrastructure; • Landscape initiatives/biodiversity corridors and identification of requirements for climate change adaptation corridors; • Biodiversity stewardship; • Mainstreaming of conservation planning into decision making.
Coastal and Estuary Management	<ul style="list-style-type: none"> • Establishment of coastal hazard overlay zones and setback lines; • Research best practice regarding responding to repeated coastal inundation in high risk areas; • Protecting and rehabilitating existing dune fields as coastal buffers / ecological infrastructure; • Monitor possible linkages between climate change and fisheries industry; • Ensure Estuary Management Plans take cognisance of climate change.
Food Security	<ul style="list-style-type: none"> • Farming practices that are in harmony with nature, i.e. 'conservation farming'; • Climate smart agriculture; • Agricultural water technologies that reduce consumption and increase efficiency; • Research on climate resilient and alternative crops and livestock applicable to the Western Cape; • Addressing climate vulnerability through the Municipal Support Programme; • Assessing food security in the context of the resource nexus.
Managing the effects of increased temperature on human lives	<ul style="list-style-type: none"> • Societal adaptation to human health impacts from temperature increases associated with climate change.
Healthy Communities	<ul style="list-style-type: none"> • Monitoring health trends in relation to climate trends; • Research linkages between human health and climate change in the WC context. These include: Air quality, Water quality, Food security, Heat stress, Disease vectors

3 The Garden Route District Municipality

Garden Route District Municipality is one of five district municipalities within the Western Cape Province. The district is situated on the south-western portion of the province and comprises of the following seven local municipalities: Bitou, George, Hessequa, Kannaland, Knysna, Mossel Bay, and Oudtshoorn Local Municipality. The district municipal area has a total population of 574 266 less than 10% of the province's total population (Statistics South Africa, 2011). George local municipality is home to a great proportion of the district's population and Kannaland local municipality is home to the least proportion of the district's population. The district is the largest and most rural district in the Western Cape Province (Garden Route District Municipality, 2017b).

The Garden Route District is a place of exceptional natural beauty which offers a range of environmental goods and services that, to a large extent, underpin the economic activity in the area. This "sense of place" has resulted in the district being collectively termed "The Garden Route" and is a major tourism draw card. However the same things that form part of this tourism draw card, such as the lovely beaches, estuaries and rivers, pose a serious disaster risk to the area, particularly in the face of a changing climate. Over the past decade the district has been hit annually by climate related extreme events, resulting in a string of massive floods, coastal inundation, fires, and water crisis and drought.

3.1 Garden Route District Climate Overview

The historical climate monthly averages for the Garden Route District area have been calculated using the nearest weather data station to the Municipality, which is the measuring station at George. The graph below (Figure 512), shows that average temperatures peak in January and February, while rainfall is fairly consistent throughout the year, indicating that the Garden Route District area is a year-round rainfall area (Climate System Analysis Group, 2017b). The lowest average monthly rainfall historically occurs in June, which averages less than 38 mm (Climate System Analysis Group 2017b).

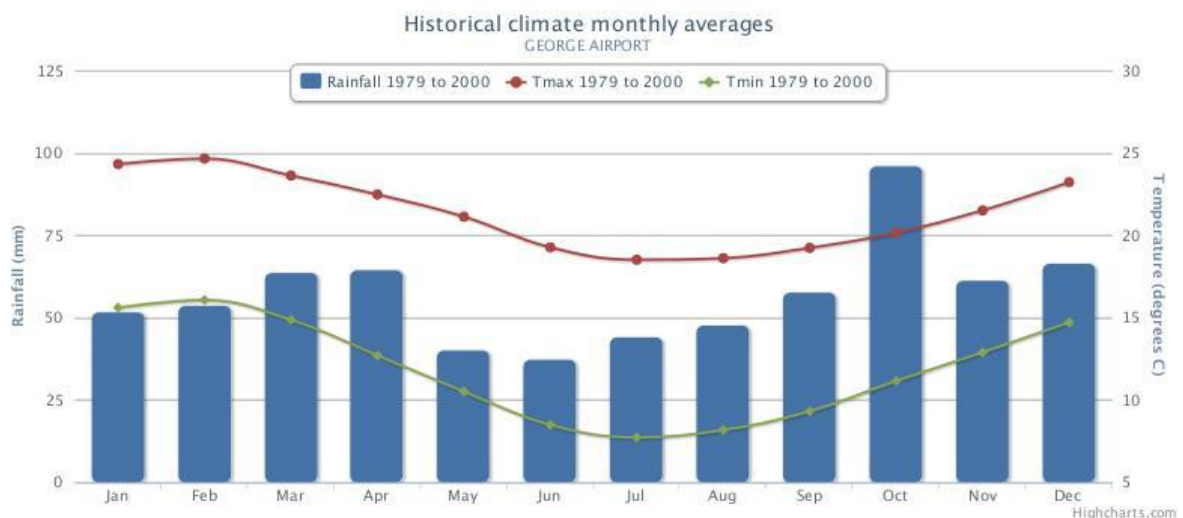


Figure 2: Historical Climate Monthly Averages for George (Climate System Analysis Group 2017b)

3.1.1 Rainfall

The Western Cape climate is classed as Mediterranean and as such is largely a winter rainfall region. Winter rainfall is the result of mid-latitude disturbances commonly known as cold fronts. While these frontal systems continually pass to the south of the country all year round, during winter their tracks move northwards and their influence on the regional climate is significant. Flood events are often associated with strong cold fronts or their closely related cousins, cut-off low pressure systems, which are more frequent during the transition seasons (i.e. spring and autumn).

The southern coastal areas, including the Garden Route district, experience rainfall almost all year around. This is a result of the onshore flow of moisture from the south (over the warm Agulhas Current), rising up the coastal mountains and producing summer rainfall. Additionally, moisture originating from the tropics is transported southwards towards the southern cape during the summer months, leading to occasional favourable conditions for rainfall. However the dominant strong rainfall events still occur in winter as a result of cold fronts passing across the country. It must be kept in mind that many local factors, such as topography, play a key role in the rainfall patterns of this region. This is evident when one looks at the spatial distribution of rainfall patterns across the region.

With the exception of the southeast and a small area in the west of the District Municipal Area, the Garden Route District Municipal Area (**Error! Reference source not found.3**) has relatively low levels of mean annual rainfall (average rainfall per year) (Western Cape Department of Agriculture 2017).

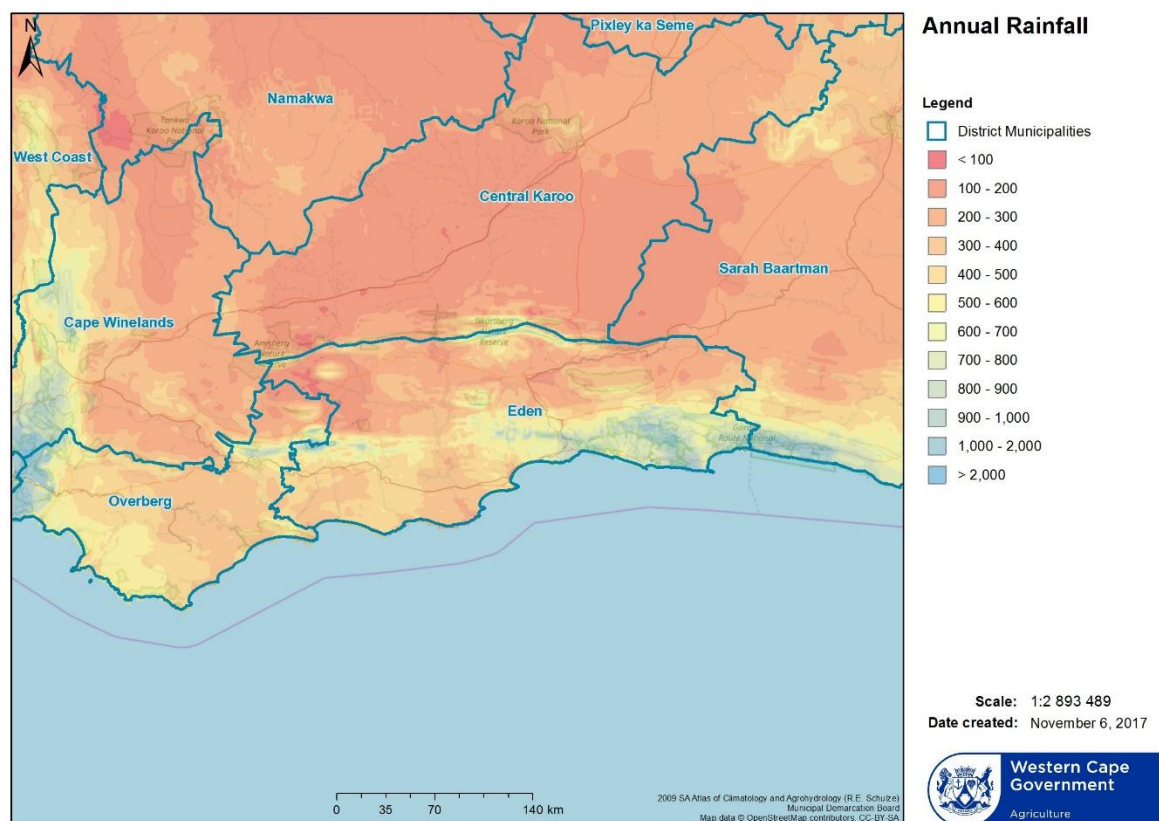


Figure 3: Mean Annual Rainfall in the District Municipal Area (Western Cape Department of Agriculture 2017)

If the mean annual rainfall is considered with the projected increases in average temperature, it is apparent that evaporation rates are expected to increase, which will increase water insecurity in the District Municipal Area, especially in the inland areas (Western Cape Department of Agriculture 2017).

3.1.2 Temperature

The Long Term Adaptation Scenarios Flagship Research Programme (LTAS) has forecast that climate change is predicted to increase temperatures and rainfall variability, while decreasing the total average rainfall in the west of South Africa (Department of Environmental Affairs 2013c). The predicted increases in mean average temperature (**Error! Reference source not found.4**), shows that the inland parts of the Garden Route District Municipal Area are projected to experience medium to high range warming, with the expectation of the Bo-Langkloof-Outeniqua SmartAgri Zone, which is projected to experience low to medium range warming (Western Cape Department of Agriculture, 2017). Meanwhile all the coastal parts of the District Municipal Area are projected to experience a low range of warming (Western Cape Department of Agriculture, 2017).

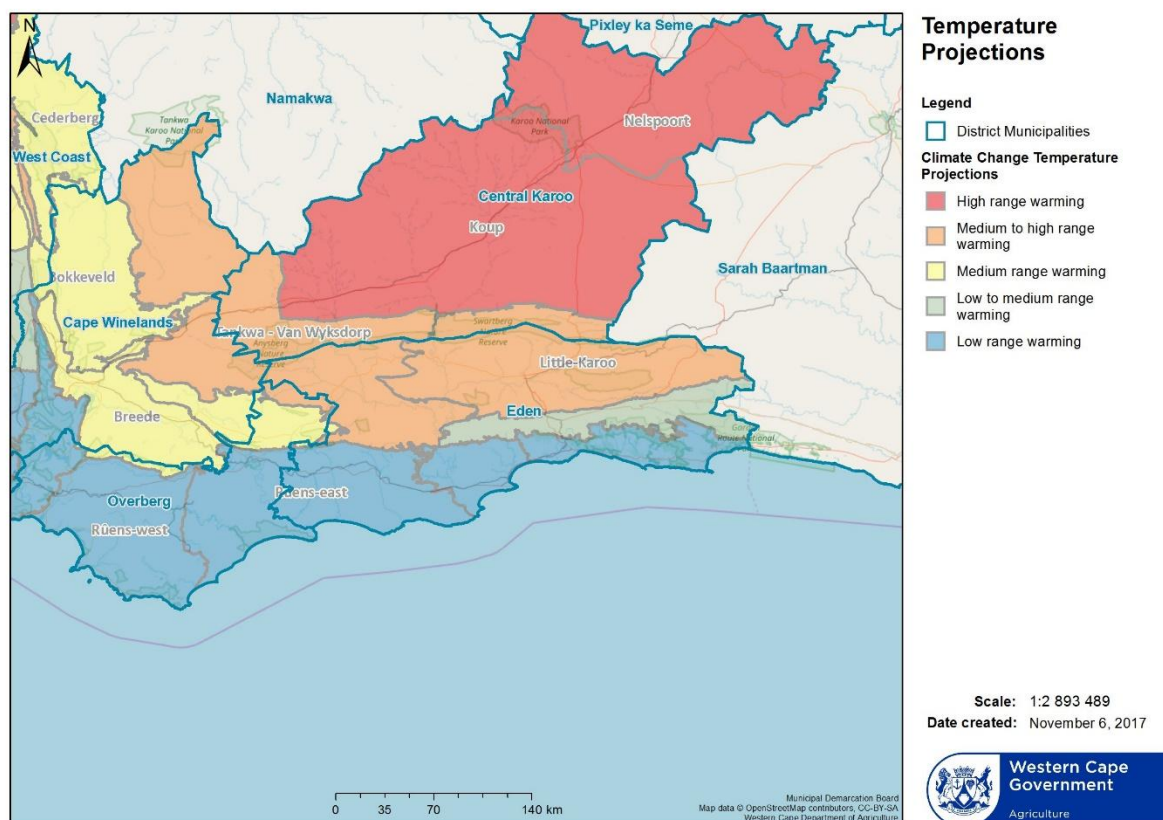


Figure 4: Temperature projections in the District Municipal Area (Western Cape Department of Agriculture 2017)

3.1.3 Future Climate Change Projections for the Garden Route District

Climate change is predicted to have an impact on rainfall patterns in South Africa. Future rainfall projections for the Garden Route District Municipality (using the measuring station at George) for the period 2020 to 2040 are made using the Representative Concentration Pathways (RCP) 4.5 greenhouse gas concentration trajectories (Climate System Analysis Group, 2017a). The bar chart (Figure 525) show the potential change in rainfall, with the blue bars indicating a potential increase in average rainfall and the red bars indicate a potential decrease in average rainfall (Climate System Analysis Group, 2017a). The grey lines represent the various models used for this projection. It is therefore projected across most of the models that Garden Route District could experience an increase in rainfall in the months of January, February, March, April, July, September, October and

December, and a decrease in rainfall during May, June, August and November (Climate System Analysis Group 2017a).

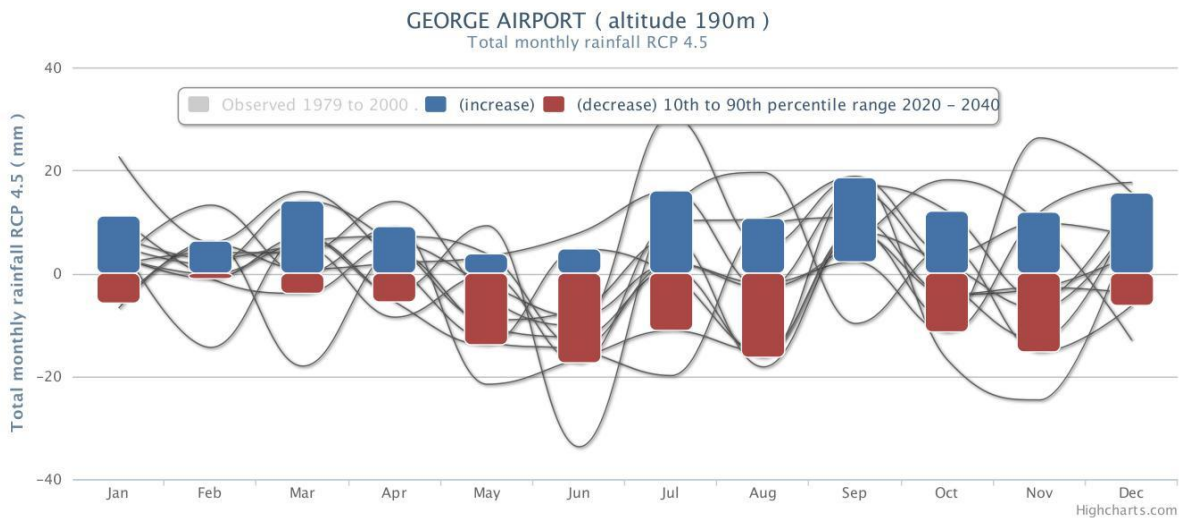


Figure 5: Rainfall Projections for George (Climate System Analysis Group, 2017a)

Climate change impacts for the Western Cape carry a high degree of uncertainty due to the complexity of the frontal systems and their interaction with the complex topography of the region. However there is a fairly confident message present in two strong climate drivers, which adds weight to some of the changes projected. The first is the shift in the South Atlantic High Pressure systems further south. Many models produce a similar shift south in the future and the result is to push the winter cold fronts further south, away from the country, during winter.

However, a counterpoint to this is the increase in atmospheric moisture due to a warmer climate. Orographic (mountain) rainfall is a significant component of rainfall in the mountainous regions of the Western Cape and the magnitude of such rainfall is often limited by the moisture content of the air flowing over the mountains. Increases in the moisture content could produce more orographic rainfall in mountain locations. The net result is a possible shift towards generally drier conditions but with wetter conditions in mountain locations (e.g. coastal region of the Garden Route district). Many river catchments include large portions of mountainous regions and hence the impact of climate change on river flows is likely to be complex and require a considerable modelling effort.

Finally, many projections suggest that changes in rainfall will occur through shifts in seasonality. Most distinctly, through decrease in peak winter rainfall but possible increases in the transition or “shoulder” seasons of autumn and winter. This shift agrees with the two large scale drivers discussed above as the shoulder season rainfall is often dominantly orographic while the core season rainfall is dominantly driven by strong cold frontal systems which, under climate change, could shift further from the continent.

There is some evidence that some of these changes are already being experienced which adds further weight to the evidence for general drying, seasonal shifts, and increased mountainous rainfall. Climate change is predicted to increase the number and severity of droughts, fires and floods in the Garden Route District area (Garden Route District Municipality 2014). To counter these risks, the Garden Route District Municipalities should conserve their water resources, wetlands and biodiversity, through updated land-use and settlement plans that take disaster risk management criteria into account, and by increasing public awareness regarding water conservation, droughts,

fires and floods (Garden Route District Municipality, 2014, 2017a). This is particularly pertinent given the recent devastating fires in and around the Garden Route as well as the severe ongoing drought in the Western Cape (Garden Route District Municipality, 2014, 2017a).

4 Major Climate Change Impacts of Extreme Concern within the Garden Route District

The district's vulnerability to climate change impacts is attributed to its physical location, topography and general climate conditions (Garden Route District Municipality, 2017a). In addition, increased vulnerability to climate change has been caused by rapid urbanisation and informal developments (Western Cape Government, 2013). Urbanisation has increased because of in migration of the youth from the Eastern Cape and the elderly to the coastal towns (Garden Route District Municipality, 2017b). However, housing delivery has not been able to keep up with the migration, hence the ongoing increase in informal dwellings in the District (Garden Route District Municipality, 2017b). Furthermore, the natural and scenic beauty of the District is a major tourist attraction that could be negatively affected by the impacts of climate change (Garden Route District Municipality, 2017a).

The following climate change impacts have already been observed in the District: increased average temperatures; shifts in seasonality; increased frequency of veld fires; increased magnitude and frequency of storm events accompanied by strong winds; more frequent and severe storm surges; and, increases in rainfall variability and the number of dry days (Garden Route District Municipality, 2014). In addition, sea level rise and associated hazards are a major concern for coastal areas within the District (Garden Route District Municipality, 2012). Sea level rise impacts are likely to include inter alia coastal erosion, flooding, destruction of infrastructure and salt water contamination of fresh water bodies (Western Cape Government, 2013).

Major climatic hazards in the District include: drought, floods and veld fires (Garden Route District Municipality 2014, 2017a). Climate change is expected to increase the frequency and severity of these hazards (Garden Route District Municipality, 2014). Additionally, financial losses in the District, due to these climate hazards, has already been high (Garden Route District Municipality, 2014) For example, it was estimated that the 2009/2010 drought cost the District R 300 million, while the cost of the 2011 floods was estimated to be R 350 million (Garden Route District Municipality, 2014). Furthermore, approximately 45% of the District's disaster relief budget is allocated to the repair and maintenance of road infrastructure after flood damage (Garden Route District Municipality 2014). Another 45% of the District's disaster relief budget is spent on fire-related disasters (Garden Route District Municipality, 2014).

4.1 Drought and Water Security

It is anticipated that climate change will result in higher temperatures, lower rainfall and increased rainfall variability in the Garden Route District (Garden Route District Municipality, 2014, 2017b). Furthermore, impacts such as more frequent and intense droughts, fires and floods are predicted to not only result in agricultural losses but also impact other sectors of the local economy as well (Garden Route District Municipality, 2014, 2017b, 2017a).

The Garden Route District Municipality falls mainly under the Breede-Gouritz/Berg Hydrological Zone (Figure 476), while small areas in the east fall within the Mzimvubu-Tsitsikama Hydrological Zone (Department of Environmental Affairs, 2013d). Under a warmer wetter scenario, the Breede-

Gouritz/Berg Hydrological Zone is predicted to experience an increase in rainfall in winter and spring, and a decrease in autumn (Department of Environmental Affairs 2013d). While under a hotter and drier scenario, the region will experience a decrease in rainfall in all seasons and a strong decrease in rainfall in the west of the Hydrological Zone (Department of Environmental Affairs, 2013d).

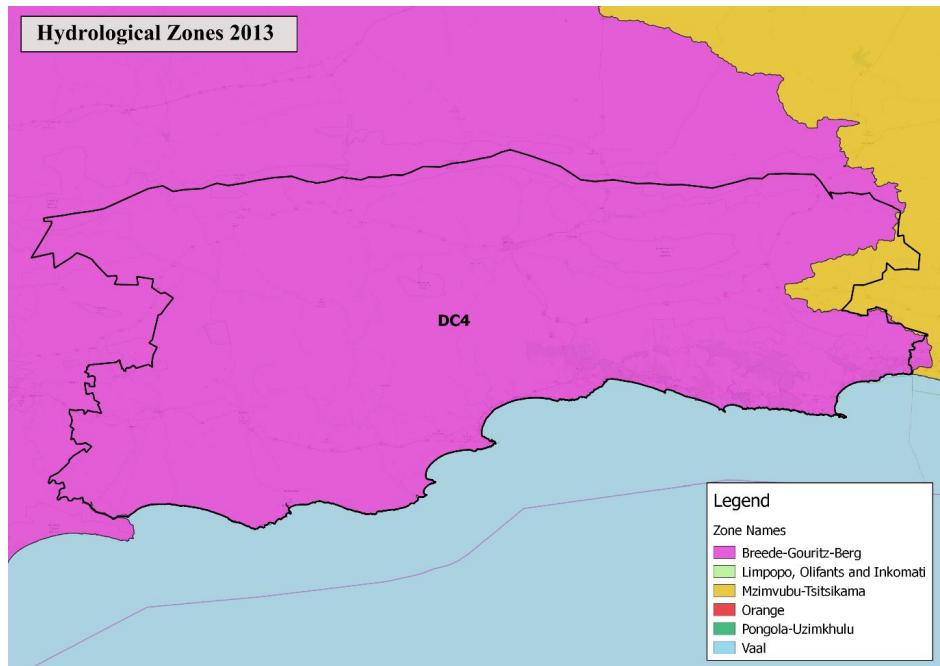


Figure 6: Hydrological Zone for the District Municipal Area (Department of Environmental Affairs 2013d)

Most of the Garden Route District falls under the Breede-Gouritz Water Management Area (Figure 487), while small parts in the east fall within the Mzimvubu-Tsitsikama water management area (Department of Environmental Affairs, 2013d).

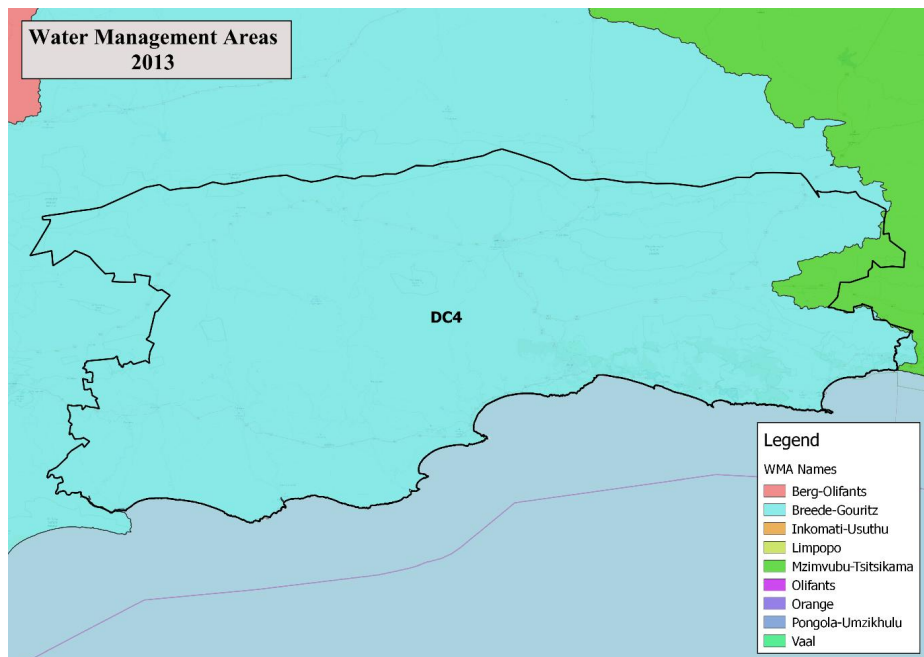


Figure 7: Water Management Area for the District Municipal Area (Department of Water Affairs 2013)

Within the Garden Route District area there are 24 main water resources (such as dams, lakes and estuaries), some of which are the: Stompdrift, Garden Route, Wolwedans, Tierkloof and Prinsrivier

Dams; Knysna and Sedgfield Lagoons; Groenvlei; Swartvlei; Rondevlei; and, the Touws River Estuary (Department of Water and Sanitation, 2016b). While these resources are spread throughout the Garden Route District area (Figure 498), they are mostly found in the south of the district (Department of Water and Sanitation, 2016b).

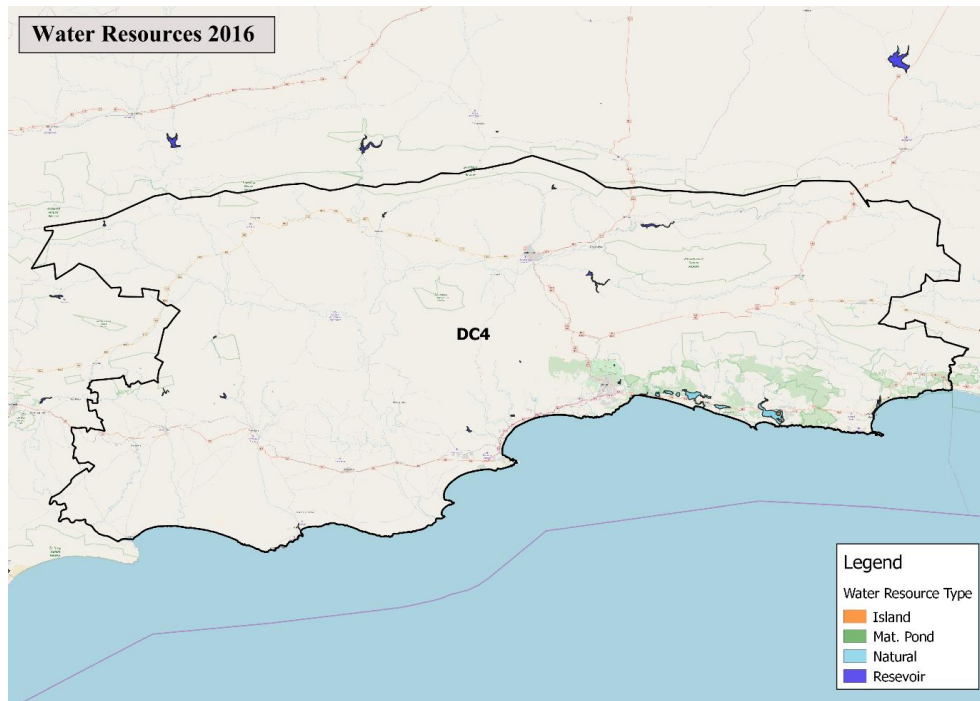


Figure 8: Water resources within the District Municipal Area (Department of Water and Sanitation 2016b)

4.1.1 Declining River States

The river quality within the Garden Route District area is mostly in a poor state, which means that many rivers are unable to contribute towards river ecosystem biodiversity targets (SANBI, 2011). The health of a river system is graded into one of several categories (SANBI 2011). These categories are listed in Text Box 11.

Text Box 1: Freshwater Ecosystem Priority Areas (FEPAs) classification for river ecosystem conditions

River conditions in South Africa have been classified according to the Freshwater Ecosystem Priority Areas (FEPAs) for river ecosystems (SANBI 2011). The different grades are provided below:

A = Unmodified, Natural

B = Largely Natural with Few Modifications

Ab = A or B Above

C = Moderately Modified

D = Largely Modified

E = Seriously Modified

F = Critically/Extremely Modified

Ef = E or F Above

Z = Tributary Condition Modelled as Not Intact, According to Natural Land Cover

Rivers that are unmodified or in their natural state are able to contribute towards river ecosystems biodiversity targets (SANBI 2011). In contrast, rivers that are categorised as 'largely modified' or worse are unable to contribute towards river ecosystems as they are not in a good state.

Several of the main rivers in the Garden Route District area (Figure 509) such as the Kammanassie, Olifants, Touws, and Wynands Rivers as well as sections of the Groot River are classified as 'largely modified' (SANBI 2011). Additionally, the Gourits River and sections of the Groot River are classified as 'moderately modified' (SANBI 2011). Furthermore, most tributaries are classified as either 'largely natural with few modifications' or 'tributary conditions modelled as not intact, according to natural land cover' (SANBI 2011).

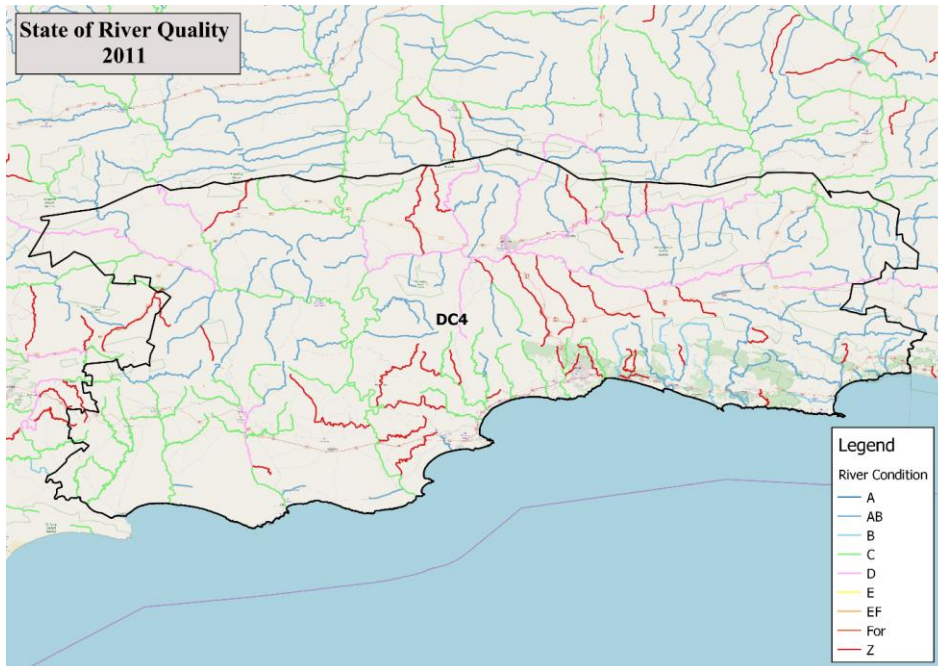


Figure 9: State of water quality in rivers in the District Municipal Area (SANBI 2011)

Water resources in any catchment are largely depended on rainfall. The Historical Climate Monthly Averages include long-term historical monthly average rainfall totals and monthly averaged minimum and maximum temperatures for a particular spot (Climate System Analysis Group, 2017b).

4.1.2 Increased Aquifer Vulnerability

Furthermore, there are several aquifers in the Garden Route District area that are already highly vulnerable to contamination by pollution, however more of the aquifers in the District Municipal Area have a medium vulnerability (Figure 1010) (Western Cape Department of Agriculture, 2017). Residents in some of the inland parts of the district already rely to varying degrees on groundwater and if these aquifers were to become polluted or over-utilised, water security in the district would diminish (Western Cape Government, 2016; Garden Route District Municipality, 2017a).

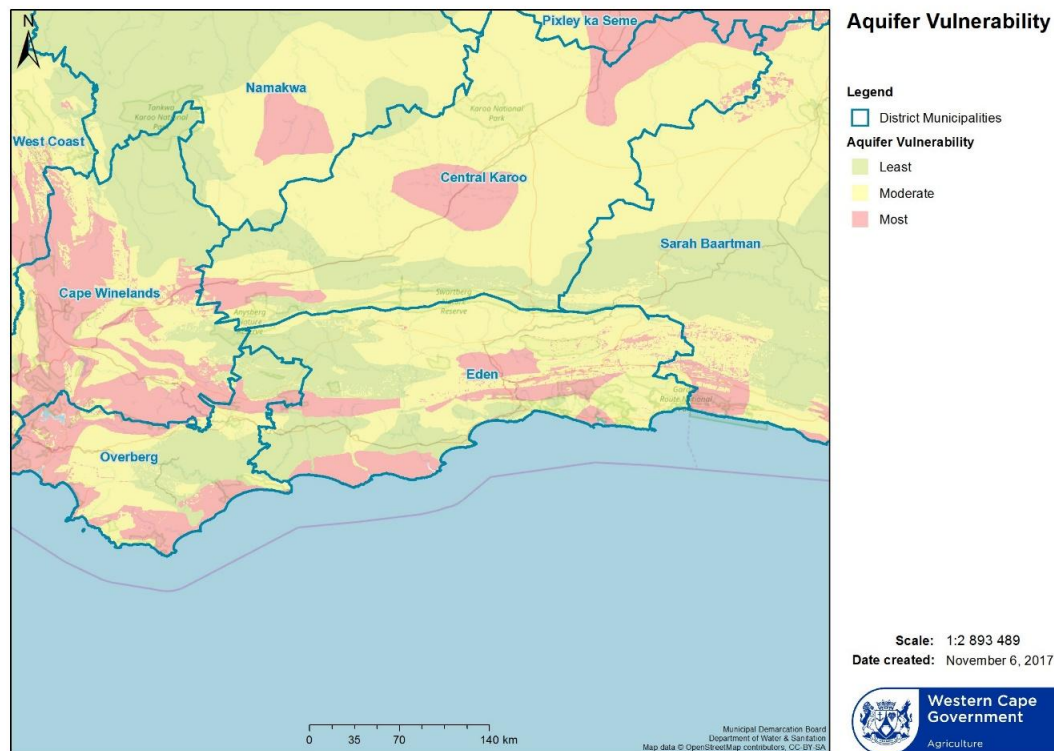


Figure 10: Aquifer vulnerability in the District Municipal Area (Western Cape Department of Agriculture 2017)

4.1.3 Decreased Groundwater Quality

The groundwater quality in the Garden Route District area, in 2012, was mostly in the lower categories of electrical connectivity (Figure 1111), however, groundwater in some western parts of the district already had very high levels of electrical connectivity (Western Cape Department of Agriculture, 2017). These electrical connectivity categories represent how salty the groundwater is, which is one way of measuring the water quality in the aquifers (Western Cape Department of Agriculture, 2017). The higher the level of salts in the water, the poorer the groundwater quality is (Western Cape Department of Agriculture, 2017).

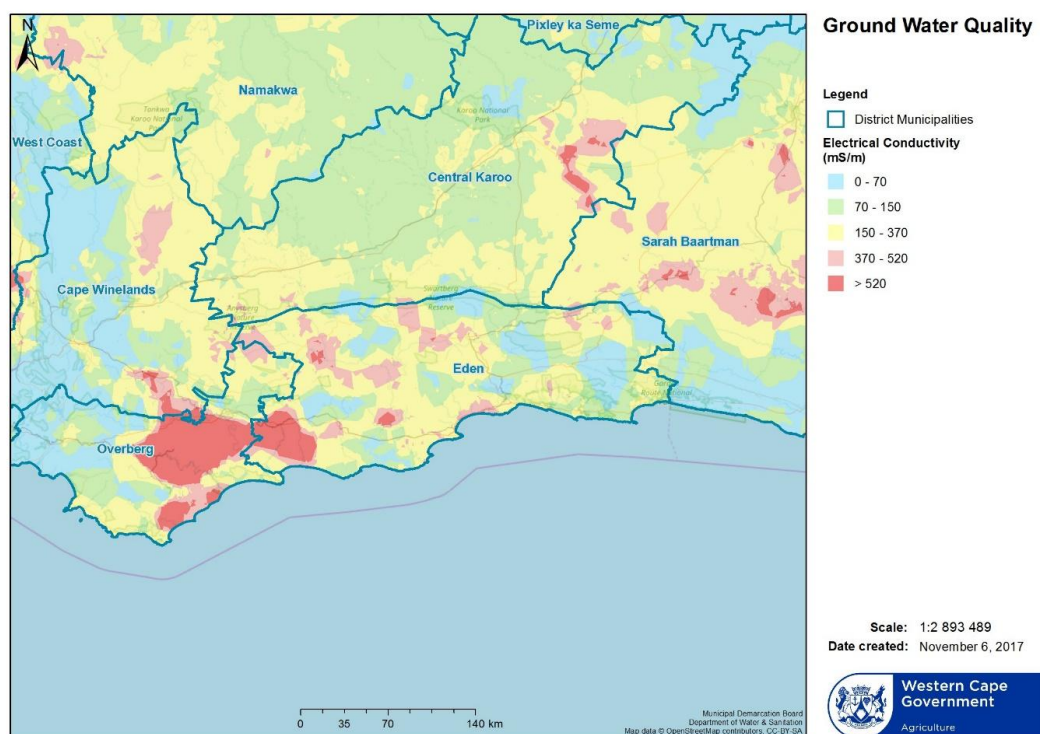


Figure 11: Groundwater quality in the District Municipal Area (Western Cape Department of Agriculture 2017)

4.1.4 Impact of Droughts on Agriculture

The predicted changes in average rainfall and temperature are forecast to reduce the areas that are suitable for viticulture or shift them to areas that are higher or cooler than current locations (Department of Environmental Affairs, 2013c). The reduction in rainfall (and runoff) is forecast to reduce the yields of fruit and vegetables, notably deciduous fruit and rain-fed wheat production in the Western Cape (Department of Environmental Affairs, 2013c). Furthermore, the production of fruit (such as apples and pears) and sugar cane will be increasingly vulnerable to damage from a predicted expansion of the areas affected by agricultural pests (Department of Environmental Affairs, 2013c).

By decreasing agricultural yields, climate change could also impact the agriculture sector by reducing profitability and job opportunities in the sector as well as increasing food security risks, especially amongst subsistence farmers and their dependents (Department of Environmental Affairs, 2013c; Garden Route District Municipality, 2014, 2017b). Indeed, the Garden Route District Municipality's 2017/2018 *Integrated Development Plan* has noted that climate change impacts could have dire consequences for the agriculture sector in the District Municipal Area (Garden Route District Municipality, 2017a).

4.1.5 Impact of Droughts on Water and Sanitation Services Provision

Linked to the rainfall and rivers in the Garden Route District area is its water and sanitation services. Specifically, a total of 12.31 % of households in the Garden Route District area do not receive their water from piped water schemes, which is lower than the national average of 21.82 % (Statistics South Africa, 2011). Furthermore, the percentage of the population with flush toilets in the Garden

Route District area is 84.31 % while the national average is 56.51 % (Statistics South Africa 2011). This indicates a good spread of sanitation access within the Garden Route District area.

Although the Garden Route District has high scores for the provision of water and sanitation services to households in the District Municipal Area, there is still room for improvement. Accordingly, the Garden Route District Municipality in its 2017/2018 *Integrated Development Plan* has identified the need for increased efficiency in the use of water and other natural resources while enabling environmentally sustainable developments (Garden Route District Municipality, 2017a). This is especially necessary given the ongoing drought in the Western Cape and the water supply issues in Knysna and surrounding areas.

Directly linked to water and sanitation services in the Garden Route District area are the Blue and Green Drop scores. Blue Drop scores rate the quality of drinking water, while Green drop scores rate the quality of wastewater. Blue Drop scores rate the quality of drinking water supplied by water service providers. The Blue Drop score can be understood using the following scale: 90 – 100 % = 'Excellent situation'; 75 - <90 % = 'Good status'; 50 - <75 % = 'Average performance'; 33 - <50 % = 'Very poor performance'; and, 0 - <33 % = 'Critical status' (Department of Water Affairs 2011a). There is no 2014 Blue Drop score for the Garden Route District Municipality, rather there is a Blue Drop score for each local municipality within the Garden Route District Municipality (Department of Water and Sanitation 2014).

The 2014 Blue Drop scores of each local municipality within the Garden Route District are as follows: The George Local Municipality scored 82.77 %; the Mossel Bay Local Municipality scored 78.76 %; the Knysna Local Municipality scored 61.62 %; the Bitou Local Municipality scored 90.43 %; the Oudtshoorn Local Municipality scored 51.29 %; the Hessequa Local Municipality scored 55.18 %; and the Kannaland Local Municipality scored 31.66 % (Department of Water and Sanitation 2014).

The Green Drop score rates the quality of wastewater management in municipalities. The Garden Route District currently has 37 wastewater treatment works that are operated at the local municipality level, because a regional wastewater treatment scheme does not exist within the District (Garden Route District Municipality 2017a). The Green Drop score can be understood using the following scale: 90 – 100 % = 'Excellent situation'; 80 - <90 % = 'Good status'; 50 - <80 % = 'Average performance'; 30 - <50 % = 'Very poor performance'; and, 0 - <30 % = 'Critical state' (Department of Water and Sanitation 2016a).

The 2011 Green Drop scores of each local municipality within the Garden Route District Municipality are as follows: The George Local Municipality scored 84.90 %; the Mossel Bay Local Municipality scored 79.20 %; the Knysna Local Municipality scored 78.73 %; the Bitou Local Municipality scored 98.82 %; the Oudtshoorn Local Municipality scored 69.95 %; the Hessequa Local Municipality scored 47.86 %; and the Kannaland Local Municipality scored 50.27 % (Department of Water and Sanitation 2013). These Green Drop scores indicates that the wastewater services in most of the local municipalities within the Garden Route District are being managed according to the expectations of the Department of Water and Sanitation as assessed by the Green Drop score.

4.2 Increasingly Frequent and Intense Fire Events

Veld fires occur mainly between November and February, however, in Knysna they occur throughout the year (Western Cape Government 2013). Increases in the frequency and intensity of veld fires have had negative impacts in the agricultural, forestry and tourism sectors (Garden Route District Municipality 2014). The risk of veld fires is high for most of the Garden Route District Area, however, there are areas of extremely high veld fire risk in the south and low veld fire risk in many parts in the north and west of the District (Figure 4612) (Department of Agriculture, Forestry and Fisheries, 2010). There are also several areas of medium veld fire risk spread throughout the District (Department of Agriculture, Forestry and Fisheries, 2010).

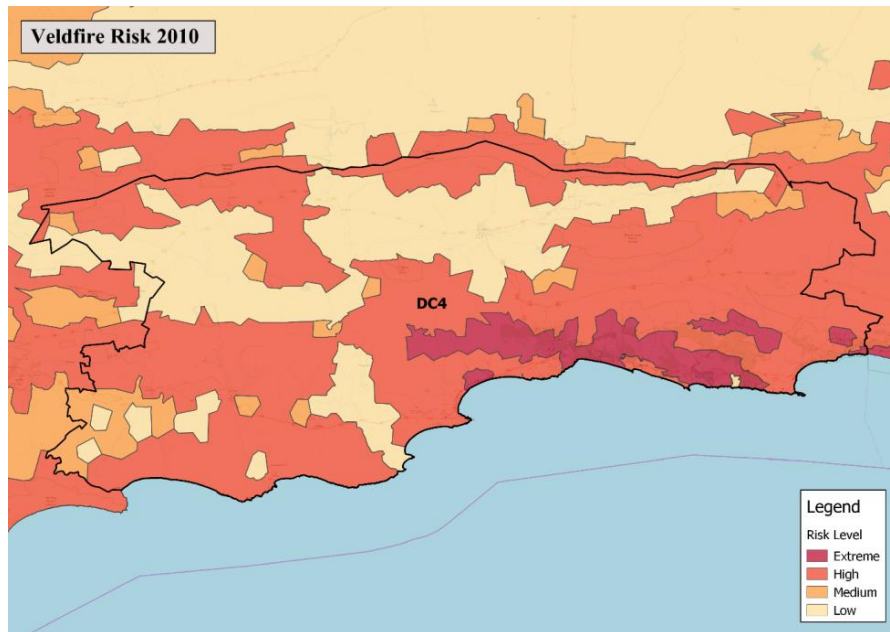


Figure 12: Veld fire risk for the District Municipal Area (Department of Agriculture, Forestry and Fisheries 2010)

The disastrous June 2017 Garden Route fires provided a wake-up call about the deleterious effects of climate change in South Africa, and in many ways is a watershed regarding future approaches and preparedness for these disasters, as well as for the ensuing rehabilitation and rebuilding of the damaged environment.

4.3 Impacts of Climate Change on Human Health

Climate change has been deemed the “greatest global health opportunity of the 21st century” (Watts *et al.*, 2015) and the impacts of climate change on human health are featuring more prominently in global discussion. Considerations of climate change and health at the regional level, particularly in Africa, are limited (Baker *et al.*, 2012; Pasquini *et al.*, 2013). Climate change is a cross-cutting concern of many sectors, especially health, and developing locally appropriate regional health strategies is often challenging for governments of low- and middle-income countries (LMICs), particularly as there is a plethora of information available from a global perspective, which may not be applicable to, or translated for, local conditions.

Climate change impacts affect the social and environmental determinants of health which include clean air, secure shelter, safe drinking water, and sufficient food (World Health Organization, 2017). Below are some general climate change manifestations and their associated impacts on human health.

- Natural disasters - The frequency and severity of natural disasters has increased. Natural disasters destroy health facilities and homes. People may be forced to vacate their properties leading to increased risk to a wide range of health effects including communicable diseases and mental disorders (World Health Organization, 2017).
- Increased storm events - These affect the supply of fresh water consequently increasing the risk of diarrhoeal diseases (World Health Organization, 2017).
- Floods - The frequency and intensity of floods has increased. Floods pollute water supplies and increase the risk of water borne diseases. In addition, people lose their life's as a result of drowning or physical injuries, property is damaged and the supply of health services is disrupted (World Health Organization 2017). Climate change will also impact the distribution and causes of several communicable diseases including cold-influenza and dry-meningococcal meningitis among others (Singh and Kistnasamy, 2014).
- Changes in climate conditions also affect vector-borne diseases that are transported through organisms such as snails, insects and other cold-blooded animals (World Health Organization, 2017). With climate change the transmission season will lengthen and the geographic range of some vector borne diseases will change (World Health Organization, 2017).
- Increased temperatures and variable rainfall are likely to reduce agricultural yields consequently increasing the prevalence of malnutrition and hunger as a result of food insecurity (World Health Organization, 2017).
- Increased heat stress leads to death which can be attributed to cardiovascular and respiratory diseases (World Health Organization, 2017).
- Increased air pollution and increased occupational health problems (World Health Organization, 2017).
- Approximately 9.86 % of the Garden Route District Municipal Area's households are involved in agricultural activities (Statistics South Africa 2011). People, who work outdoors, like those involved in agricultural activities, are especially vulnerable to the impacts of extreme weather conditions. Moreover, climate change is forecast to exacerbate the frequency and severity of extreme weather events (Department of Environmental Affairs, 2013c). Consequently, predicted impacts for households involved in agriculture include reduced agricultural yields and water security as well as increased food insecurity.

The main disaster risks that are likely to affect human health in the Garden Route District area are wild fires, drought, severe storms and floods (Garden Route District Municipality, 2014). It is predicted that these disasters will be exacerbated by climate change (Garden Route District Municipality, 2014). Figure 13 depicts the main climate change and health risk factors for the Western Cape as identified in a study conducted by the University of Cape Town and the Western Cape Government (UCT and Western Cape Government, 2018)

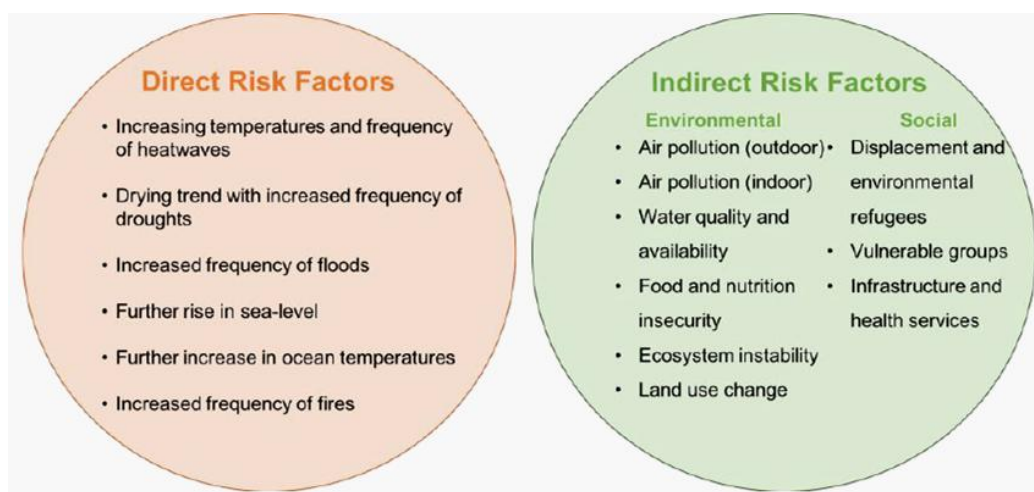


Figure 13: The climate change and health risk factors for the Western Cape (UCT, Western Cape Government, 2018).

Regarding direct risk factors, the long-term projection (to 2100) of a hotter and drier future for the Western Cape with further increases in sea-level rise and more extreme events such as heat waves, droughts, floods and fires presents several health challenges requiring adaptation strategies. This is particularly the case for vulnerable populations. Specifically, climate variability in the Western Cape will result in both direct and indirect risk factors that will need to be addressed. Suggested interventions from the global sphere are presented in the interventions section below. Climate change-related risk factors for human health that are not directly the result of climate or extreme weather events but are rather indirect risks include issues that we have grouped within two broad areas: environmental (e.g. air pollution) and social (e.g. environmental refugees). Often an indirect risk factor might span both areas. Any adaptation strategy for addressing health impacts of climate change in the Western Cape will need to include addressing these risk factors so as not to undermine the efforts of the strategies.

The WHO estimates that globally, climate change is projected to account for an additional 250 000 deaths annually between 2030 and 2050 (WHO, 2017). Although the risk factors identified play a key role in increasing the health impacts from climate change, there are several climate change-specific health impacts that may be directly or indirectly climate-related that the Garden Route District Municipalities should be considering in climate change adaptation strategies. Figure 14 provides a summary of the main health outcomes of projected climatic risk factors for the Western Cape.

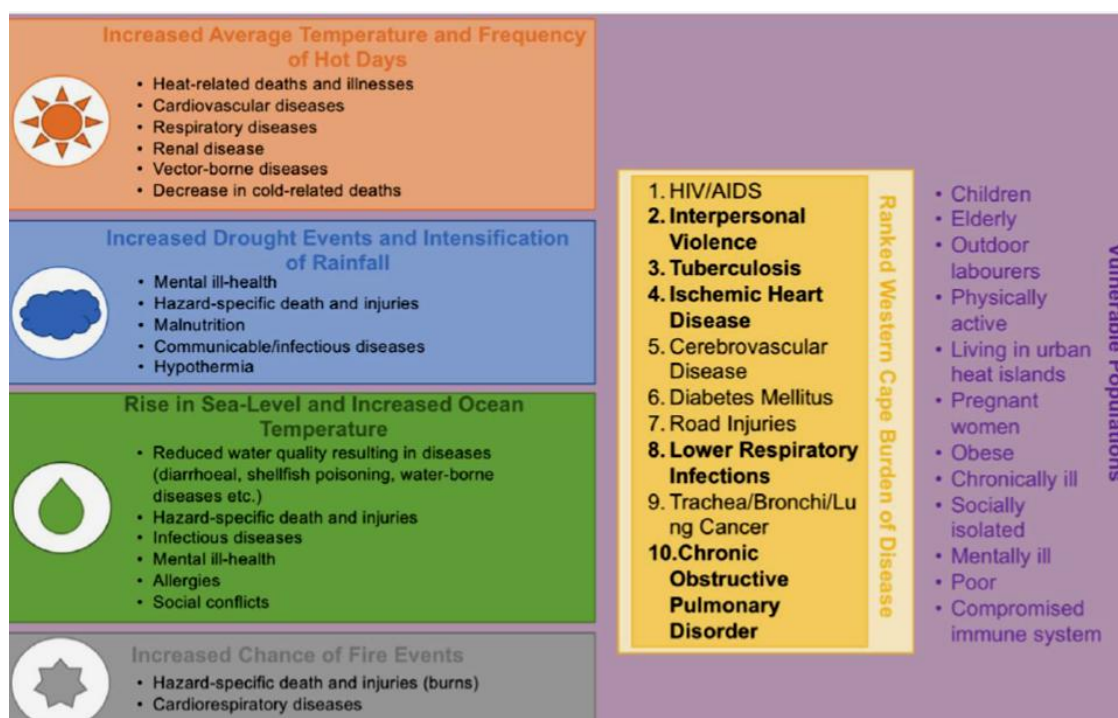


Figure 14: The main projected climate change and health risk factors for the Western Cape (UCT, Western Cape Government, 2018).

The findings from the University of Cape Town (UCT) and Western Cape Government report (2018) identified some key climate change research gaps for the Western Cape, as showed in Figure 15 below.

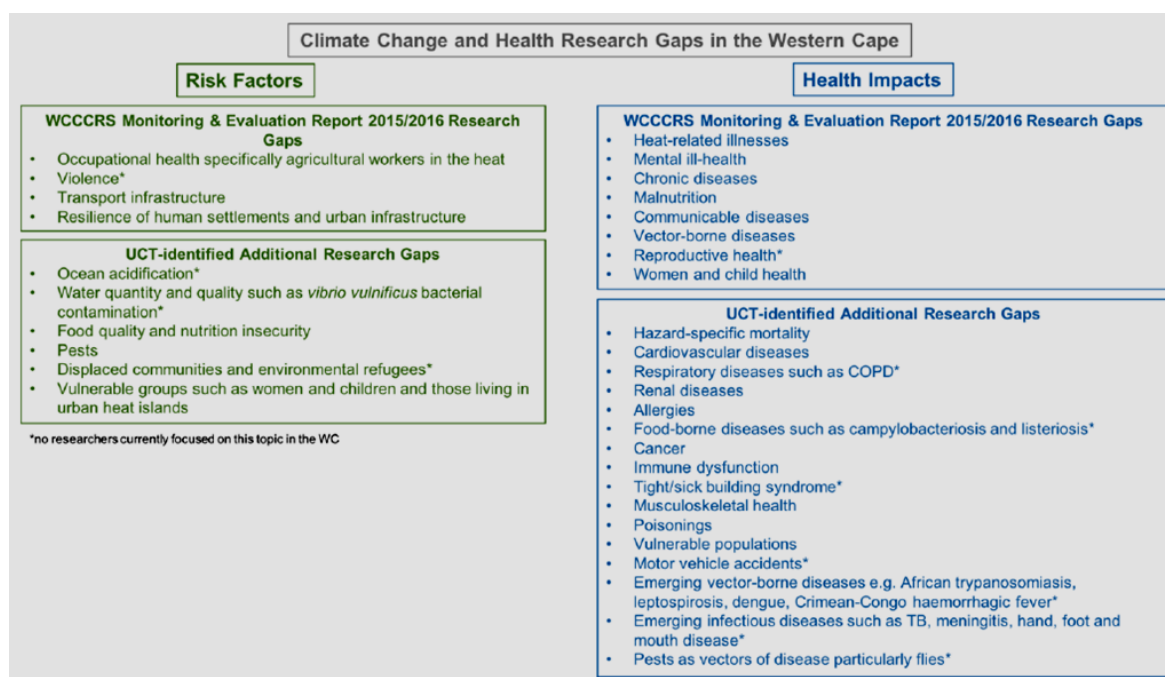


Figure 15: Climate change and health research gaps for the Western Cape (UCT, Western Cape Government, 2018).

It is strongly recommended that the Garden Route District Municipalities implement, and/or strengthen, a database capturing all implementation projects. Additional funding mechanisms for climate change and health research should be made available at a strategic level in order for successful adaptation and mitigation implementation plans at a local level. Table 4 provides some examples and ideas of implementation projects which could be suitable for the specific Garden Route District area.

Table 4: Examples of adaptation and mitigation projects that could be implemented within the Garden Route District

Health Impact	Example of Potential Adaptation and Mitigation Projects
Vector-borne diseases	Research on climate and water temperature rises and potential disease manifestations
Water quality related diseases	Temperature increases, evaporation, algal overgrowth, nitrification, decreased wetland purification functioning, drought and related increased dust particles in water sources,
Heat related diseases	Heat stress in the vulnerable, skin cancer, heat stroke in farm labourers/people working outside,
Allergies	Drought and increased dust particles,

4.3.1 Key Climate Change and Health Actions

In order to adapt to increasing climate change pressures and impacts, the scaling-up of existing Municipal Health interventions that are addressing the social determinants of health is essential. Basic public health programmes need to be strengthened or implemented in order to increase resilience to the health hazards of climate change, such as:

- access to safe drinking water improved sanitation,
- management of vector-borne diseases,
- food security,
- control of malaria and cholera outbreaks,
- hygiene awareness and education,
- improved housing,
- access to safe fuels,
- air quality management,

The Garden Route Climate Change Adaptation Strategy are rooted in the key elements of an environmental health approach to climate change. The following actions are proposed to increase the districts health resilience to climate change:

○ Climate Change and Health Steering Committees

Municipal Health Sections need to establish Municipal Health Climate Change Adaptation Committees (MHCCAC's), with the important task of steering the implementation of key activities, including inter-sectoral interventions. Under the umbrella of the MHCCAC's, various working groups may be established to address specific area or issue-based concerns.

- **Capacity building interventions**

Public participation is essential for a successful climate change adaptation strategy. An important foundation for public participation is communities that is highly informed about the process and consequences of climate change, and that identifies and agrees with the key adaptation actions.

- **Public Awareness strategy**

The implementation of long-term and comprehensive communications strategies to raise public awareness of climate change impacts, and the advantages of early attention to adaptation are critical. Such education campaigns should inform and encourage citizens to adapt their actions and behaviours to minimise environmental damage. It should also prepare individuals to cope with, for example, heat stress, improved ventilation and an increase in the frequency of disasters or service disruptions. Such campaigns may include encouragement of a culture of disaster preparedness and the measures to be taken on very hot days.

- **Monitoring and Surveillance**

Health impact resilience to climate change should include a review of public health monitoring and surveillance systems to increase the ability to detect climate change and health trends at an early stage. The early detection of trends in disease is vital to facilitate early intervention. Every effort must be made to integrate monitoring and surveillance systems across sectors, for example, health, environment, agriculture and human settlements.

- **District Vulnerability Assessments**

To identify high-risk locations and groups, it is important that detailed vulnerability assessments be undertaken that are focusing specifically on health related aspects and impacts. Knowledge of such groups and locations will steer climate change adaptation toward those in greatest need, and will inform the strengthening of the health system and the management of risks. The negative impacts of climate change on the socio-economic standing of the most vulnerable communities, and the consequences in terms of food security and the nutritional status of individuals within these communities threatens to further undermine their resistance to diseases such as HIV/AIDS and tuberculosis. Women, as primary care-givers, are put under additional strain looking after sick and elderly household members whilst maintaining a household. This leaves them less time to earn a livelihood putting cyclical pressure on them as they often neglect their own health in prioritising the health of others. In densely populated urban areas, air pollution resulting primarily from the burning of fossil fuels may have serious health effects. Whilst South Africa's air quality is generally good, stagnant air episodes in cities can create extremely poor air quality conditions and there are indications that climate change may increase the number and intensity of such events.

- **Research and Development**

Long-term climate change and health research programmes must be initiated to ensure that decisions and planning are evidence-based, and that adaptations implemented are the most cost-effective and efficient. Information and knowledge of linkages between diseases and climate change

must be strengthened through education. More and more climate change research still needs to be conducted especially on impacts of health.

- **Health Impact Assessments**

Environmental Health impact assessment (HIA) procedures must be adopted. HIA is often seen as a component of environmental impact assessments. HIA has a role to play in avoiding further contributions to climate change (for example avoidable emissions), as well as the negative downstream health consequences. HIA processes may also be used to identify health co-benefit opportunities contained within the development policies and programmes of non-health sectors. For example, housing design and construction may hold opportunities to keep dwellings cooler in hotter or warmer in winter – hence avoiding additional energy use to keep warm.

- **Inter-Sectoral Action for Climate Change and Health**

The emergence of climate change, and the need to adapt to it, has added increasing urgency to the efforts on inter-sectoral approaches taken in order for strategies to become more effective, efficient, and sustainable than would have been achieved by the health sector acting alone e.g. liaising with the Department of Human Settlements, as well as relevant provincial and local government authorities to ensure that housing meets the minimum health requirements in terms of the National Building Regulations and Building Standards Act (RSA, 1977), may dramatically improve public health and reduce vulnerability to climate change.

- **Health System Readiness**

Health system readiness is crucial to ensure outbreak response teams' readiness to act rapidly to prevent further spread in case of disease outbreaks resulting from extreme weather events. The links between weather and disease are well established – for instance, studies have shown a strong association between extreme weather events such as droughts and flooding and the incidence of water borne diseases such as cholera.

- **Model and Pilot Climate Change and Health Adaptation Projects**

The on-going review of development policies to identify climate change and health protection opportunities will need to occur at all spheres of government, while human settlement planning and design, as well as disaster preparedness may perhaps best be considered at provincial or local level. Furthermore, direct physical temperature stresses pose particular risks for children, the elderly and socio-economically vulnerable communities. South African data from the past four decades indicates an increase in the number of hotter days and nights and therefore an increased risk of casualties from heat stress.

- Climate change considerations must be integrated into health sector plans to:
 - Develop and roll-out public awareness campaigns on the health risks of high temperatures and appropriate responses including improved ventilation and promotion

of behaviours that minimise exposure to high temperatures, namely “avoidance behaviour”;

- Design and implement “Drought vs Health” action plans including plans in respect of climate-sensitive disease surveillance and control, safe water and improved sanitation;
- Strengthen information and knowledge of linkages between disease and climate change through research;
- Develop a health data-capturing system(GIS);
- Strengthen the awareness programme on malaria and cholera outbreaks;
- Reduce the incidence of respiratory diseases and improve air quality through reducing ambient particulate matter, ozone, and sulphur dioxide concentrations by legislative and other measures to ensure full compliance with National Ambient Air Quality Standards by 2020;
- Recognising that the nutritional status of individuals is key to building resilience to environmental health threats, ensure that food security and sound nutritional policies form part of an integrated approach to health adaptation strategies.

- **Key Focus Activities of the Garden Route District Municipality’s Health Section**

- Strengthening the local epidemic preparedness and response(Outbreak Response Teams) teams through regular engagements;
- Design and production of educational material on diarrhoeal diseases and meningococcal meningitis to increase community awareness;
- Resuscitate a Water, Sanitation and Hygiene committee strategy to plan and coordinate key activities toward the prevention and control of sanitation and water-related diseases;
- Strengthen programmes and activities related to improved industrial and household waste management for the prevention of disease, including health education and awareness;
- Improving surveillance and reporting of cases toward early detection and case management of key diseases. This includes the development and distribution of case management guidelines; conduct of health education programmes; collaboration with stakeholders such as the National Institute for Communicable Diseases (NICD) and Department of Agriculture Forestry and Fishers (DAFF);
- Finalization of a monitoring and evaluation plan which highlights global warming as one of the environmental factor that has a negative impact on the prevention of communicable diseases. There will be indicators that will assist the programme in monitoring the progress on the prevention and control of communicable diseases in the region (this excludes HIV, TB and EPI);
- Other factors that contribute to infectious diseases must also be addressed for example, the Local Government is responsible for proper water and sanitation system, the Department of Housing is responsible for proper housing in the community.

The Garden Route District Municipality’s Health Section shall participate in key regional and national events and mechanisms, to facilitate sharing of experiences, successes and failures with regard to adaptation to the consequences of climate change. These may include those offered through

4.4 Invasive Alien Species and Climate Change

Over the past few decades globalisation has increased the movement of people and goods around the world, leading to a rise in the number of invasive alien species (IAS) introduced to areas outside their natural ranges. A 2017 study in the journal *Nature Communications* found that over one third of all introductions in the past 200 years occurred after 1970 and the rate of introductions is showing no sign of slowing down. Invasive alien species are an animal, plant or other organism that is introduced by humans, either intentionally or accidentally, into places outside its natural range. Some alien species – classed as ‘invasive’ – become established and negatively impact native biodiversity, as well as ecosystem services on which humans depend. Invasive alien species are negatively impacting on the Garden Route District’s indigenous biodiversity, ecosystem services or human well-being.

IAS are compounded by climate change, which facilitates the spread and establishment of many alien species and creates new opportunities for them to become invasive. Extreme climatic events resulting from climate change, such as storms, floods and droughts can transport IAS to new areas and decrease the resistance of habitats to invasions. Alien invasive vegetation species’ germination rates are also increased due to increasingly frequent fire events due to a drying climate. Climate change is also opening up new pathways of introduction of IAS. Climate change can cause IAS to have the ability to expand rapidly to higher latitudes and altitudes as the climate warms, out-pacing native species. Alien species that are regularly introduced by humans but have so far failed to establish may succeed in doing so thanks to climate change, creating new sets of invaders. Some habitats, such as temperate forests and freshwater systems that currently have thermal barriers limiting the establishment of IAS will become more suitable for alien species as the climate changes. The increase and geographic redistribution of IAS will have diverse societal and environmental impacts. Biological invasions are a major threat to food security and livelihoods, with developing countries being the most susceptible.

IAS reduces the resilience of natural habitats, making them more vulnerable to the impacts of climate change. For example, some grasses and trees that have become IAS can significantly alter fire regimes, especially in areas that are becoming warmer and drier. This increases the frequency and severity of wildfires and puts habitats, urban areas and human life at risk. IAS can also impact agricultural systems, by reducing crop and animal health.

4.4.1 Adaptation Strategies towards Alien Invasive Species Control

It is essential that IAS be incorporated into climate change policies. This includes bio-security measures to prevent the introduction of IAS to new regions as a result of climate change, and rapid response measures to monitor and eradicate alien species that may become invasive due to climate change.

As the impacts of IAS are increasingly compounded by a changing climate, policy responses addressing these issues need to take into account the links between the two issues. Climate change

policies can incorporate IAS, by including IAS prevention and control, and by ensuring that measures to address climate change do not increase the threat of IAS. For example, indigenous tree species should be used for carbon sequestration or erosion control rather than introduced species. Climate change should also be explicitly incorporated into risk assessments of IAS, to help identify those alien species that could become a threat in the future.

Ecosystems need to be prioritised according to their vulnerability to climate change and IAS, making it possible to establish measures that will prevent IAS introduction. This should include establishing effective bio-security measures to manage priority pathways of introduction, supported by early warning and rapid eradication to tackle alien species before they become invasive. To improve ecosystem resilience to a changing climate, ecosystems that are already threatened by IAS need to be prioritised for IAS control or eradication. Those alien species that are likely to become invasive due to climate change ('sleepers') need to be identified and eradicated or controlled before they spread and become invasive.

4.5 Increasing Coastal Erosion and Estuarine System Health Risks

The coastal zone in South Africa includes the inshore, offshore and estuarine ecosystems. It is a continually changing area where land and ocean meet, and includes beaches, rocky shores, estuaries, wetlands and the ocean near the coast (Nelson 2013; Provincial Government of the Western Cape 2005). A coastal zone extends seaward up to the boundary of the exclusive economic zone, which is 200 nautical miles (roughly 370 km) out to sea, and inland up to one kilometre after the high-water mark (Republic of South Africa 2014).

Climate change is predicted to result in several changes to South Africa's coastal zone (Department of Environmental Affairs 2013e, 2012). It is forecast that climate change will:

1. increase impacts on marine and benthic ecosystems
2. increase impacts on estuary ecosystems
3. increase impacts on coastal livelihoods, and
4. increase impacts on infrastructure and property due to sea level rise.

These impacts are expected to affect all coastal district municipalities in South Africa (Department of Environmental Affairs 2013e).

Furthermore, the 'Agulhas Hard Inner Shelf' is categorised as endangered ecosystem types (South African National Biodiversity Institute 2011a). There are also numerous ecosystem types in the Garden Route District Municipal Area that are categorised as vulnerable (South African National Biodiversity Institute 2011a). Some of these threatened ecosystems are partially being conserved in marine protected areas.

The Garden Route District currently has three marine protected areas entirely within its coastal zone: Robberg Marine Protected Area, Goukamma Marine Protected Area and Stilbaai Marine Protected Area (Department of Environmental Affairs 2017). It also has a small part of the Tsitsikamma Marine Protected Area, which was the first marine protected area in South Africa (Department of Environmental Affairs 2017; WWF SA 2017).

However, the expanse of marine protected areas off the coast of the Garden Route District Municipal Area is set to grow. In 2016, through its participation in the Operation Phakisa Initiative, the Department of Environmental Affairs published draft notices and regulations to declare 22 new marine protected areas in South Africa's coastal zone (Department of Environmental Affairs, 2016). In the coastal zone of the Garden Route District area it is proposed that the offshore Southwest Indian Seamount Marine Protected Area be created (Republic of South Africa, 2016d).

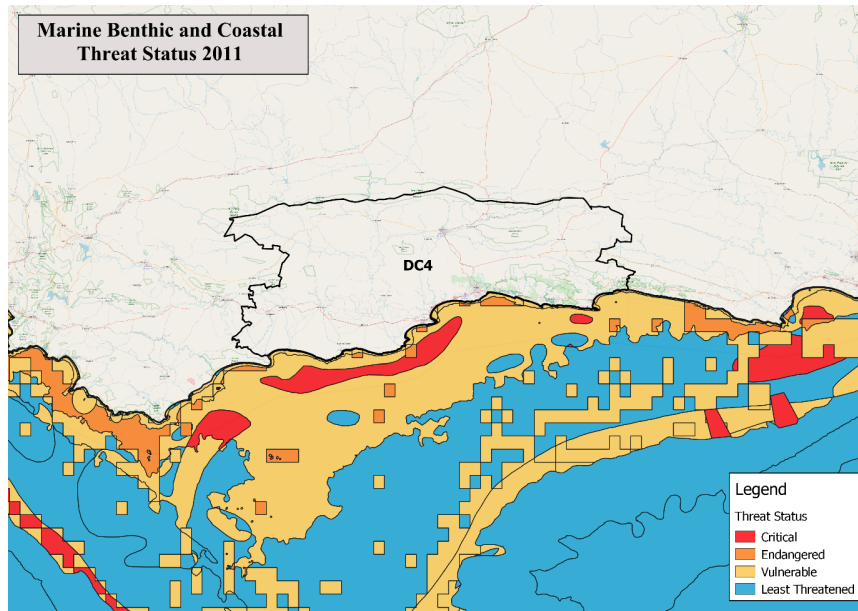


Figure 16: Threatened marine, benthic and coastal ecosystems in the District Municipal Area's coastal zone (South African National Biodiversity Institute 2011)

There are 22 estuarine systems wholly in the Garden Route District Municipal Area (Figure 3917) and two (the Breede and Bloukrans estuaries) that mark the borders of the Garden Route District Municipal Area (South African National Biodiversity Institute and CSIR 2012). The health condition of the estuaries in the Garden Route District Municipal Area is varied. The Bloukrans, Sout (Oos) and Keurbooms estuaries are classified as 'unmodified, natural' (South African National Biodiversity Institute and CSIR 2012). The Groot (Wes), Matjies, Noetsie, Knysna, Goukamma, Swartvlei, Wilderness, Kaaimans, Gwaing, Maalgate, Blinde, Duiwenhoks and Breede estuaries are all classified as 'largely natural with few modifications' (South African National Biodiversity Institute and CSIR 2012). The Piesang, Klein Brak, Gourits and Goukou (Kaffirkui) estuaries are classified as 'moderately modified' (South African National Biodiversity Institute and CSIR 2012). The Hartenbos estuary is classified as 'largely modified' and the Groot Brak estuary is classified as 'seriously modified' (South African National Biodiversity Institute and CSIR 2012). There are no estuaries in the Garden Route District Municipal Area that are classified as 'critically/extremely modified' (South African National Biodiversity Institute and CSIR 2012). According to the *Garden Route District Municipality Integrated Development Plan 2017/2018 - 2021/2022*, the Garden Route District Municipality has allocated funding for three years, starting in the 2017/2018 municipal financial year, for the implementation of a coastal management and estuaries plan (Garden Route District Municipality 2017a).

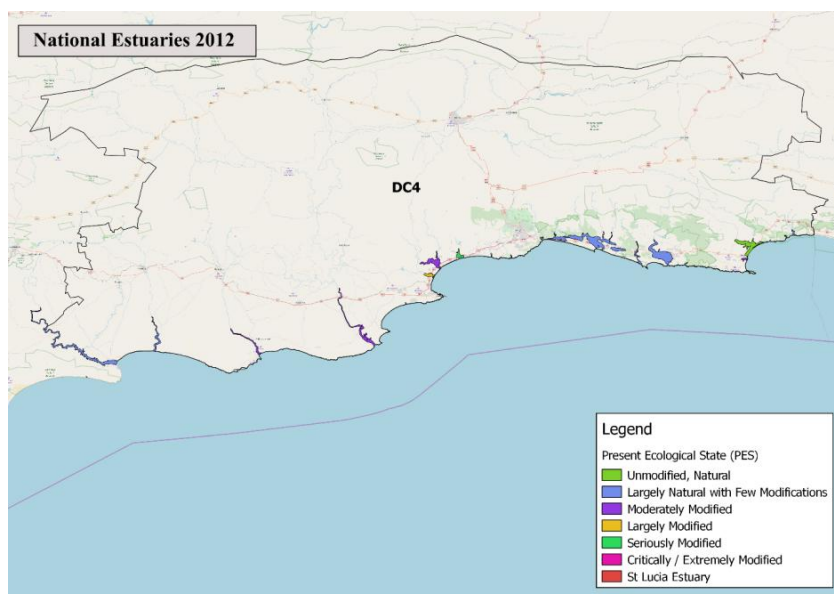


Figure 17: Estuaries in the District Municipal Area (South African National Biodiversity Institute and CSIR 2012)

In South Africa, 43 % estuary ecosystems are threatened (Department of Environmental Affairs 2012). Estuary ecosystems are experiencing increasing pressure from human related activities that are decreasing the quantity and quality of available estuarian ecosystem services (Department of Environmental Affairs 2012). These pressures are caused by: the activities that happen in and around the estuary; changes to the quantity and quality of fresh water entering the estuary; and, poor land use practises and degradation higher up in the catchment (Department of Environmental Affairs 2012). Estuary ecosystems are also impacted by: artificially breaching the mouths of estuaries; pollution; and the expected impacts of climate change, especially escalating sea level rise, coastal erosion, and increased coastal storm frequency and intensity (Palmer, van der Elst, and Parak 2011; Department of Environmental Affairs 2013e).

Climate change is expected to reduce the diversity and quantity of fishes and other biota in estuarine ecosystems (as well as inshore and offshore ecosystems) through changes to: land and sea surface temperatures; frequency and distribution of precipitation; water runoff patterns; increased coastal storm frequency and intensity; oxygen levels; and wind (Department of Environmental Affairs 2013e). Sea level rise may also cause salt water intrusions into estuarine and agricultural lands which can lead to a reduction in their ecosystem services (Atkinson and Clark 2005).

Climate change may also have a negative effect on coastal livelihoods (Department of Environmental Affairs 2013e). Predicted increases in the severity and frequency of storms and sea level rise may reduce the number of feasible fishing days and cause damage to shore-based infrastructure (e.g. harbours and launch sites) and fishing boats (Department of Environmental Affairs 2013e).

With regards to impacts from sea level rise, the *Long-Term Adaptation Scenarios* specifically considers all land under 5.5 metres (m) above the current mean sea level to be part of the coastal zone (Department of Environmental Affairs 2013f). The reason for this is that 5.5 m is the maximum estimated height of land that could be affected by the predicted increases in storm surges, sea level rise and tidal fluctuations by the year 2100 (Department of Environmental Affairs 2013f).

Within the Garden Route District Municipal Area (Figure 4018), 54 square kilometres (km²) in Knysna Local Municipality, 35 km² in the Mossel Bay Local Municipality, 30 km² in the Hessequa Local Municipality, 20 km² in the Bitou Local Municipality and 12 km² in the George Local Municipality are

estimated to be below a 5.5 m elevation (Department of Environmental Affairs 2013b). At 151 km² in total, the Garden Route District Municipal Area contains a relatively large amount of coastal land with less than a 5.5 m elevation (Department of Environmental Affairs 2013b). These areas under a 5.5 m elevation are at risk of being negatively affected by the predicted increases in storm surges, sea level rise and tidal fluctuations, due to climate change (Department of Environmental Affairs 2013b).

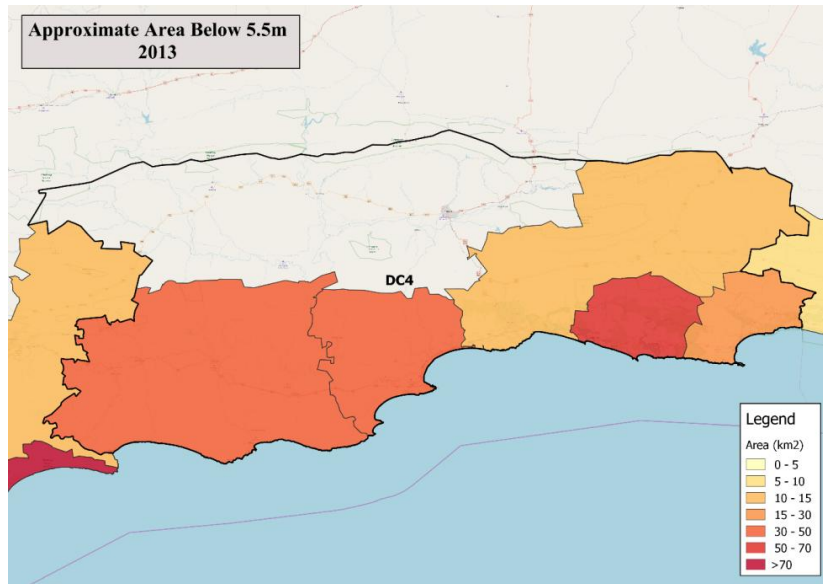


Figure 18: Approximate area below 5.5m in the District Municipal Area (Department of Environmental Affairs 2013f)

In addition to the predicted effects of climate change, the coastal zone in South Africa is susceptible to anthropogenic impacts such as ecosystem overuse (e.g. overfishing) and degradation, increased pollution, and the increased nutrient runoff from coastal developments leading to eutrophication of wetlands, estuaries, etc. (Department of Environmental Affairs 2013e). The anthropogenic and climate change impacts have already negatively affected biodiversity and ecosystems services in the coastal zone (and across South Africa) and are expected to worsen these issues unless climate change adaptation and mitigation responses are developed and implemented (Department of Environmental Affairs 2013e).

The National Environmental Management: Integrated Coastal Management Amendment Act, No 36 of 2014 requires that every coastal district municipality has a Coastal Management Programme (Republic of South Africa 2014). In 2012, the Garden Route District Municipality released their Coastal Management Programme (Garden Route District Municipality 2012, 2017a). In addition to three years of funding for the implementation of a coastal management and estuaries plan in the Garden Route District Municipal Area, The Garden Route District Municipality has also put forward a project to annually review “Garden Route’s Coastal Management Plan and District Environmental Framework” during the 2017/2018 to 2021/2022 time period (Garden Route District Municipality 2017a).

4.6 Climate Change and Energy Provision

Tourism along the Garden Route results in particular energy management and waste challenges, as infrastructure and supply has to cope with large tourism season-driven peaks. This would mean that distribution infrastructure has to be able to cope with a seasonal peak demand that is far higher

than the yearly average demand. The report provides a brief energy picture for Garden Route District Municipality and highlights key areas or issues for attention.

Table 5: The Garden Route District energy picture (Department of Energy (2010; 2011).

Key Sustainable Energy Indicator	Unit of Measure	District Value 2009	Provincial Value 2009	National Value 2009
Energy consumption per capita	GJ/capita	52	64	53
GHG emissions per capita	tCO ₂ e/capita	7.3	8.0	7.7
Energy per GDP (R' mill)	GJ/GDP	1,626	1,428	1,094
GHG emissions per GDP (R' mill)	tCO ₂ e/GDP	231	178	159

The district has an average annual carbon emissions level of 7.3 tonnes per person; higher than the global average of 4 tonnes per capita, but on a close par with provincial average and the national average of 8.0 and 7.7 tonnes per capita respectively. This carbon footprint is substantially higher within industrial towns compared to non-industrialised towns. However, when looking at the of energy consumed per unit of economic output and as well greenhouse gas emissions per unit of economic value, then the area can be seen to be a relatively high user of energy and carbon emitter.

4.6.1 The Garden Route Energy Emissions by Fuel Type

Identifying fuel types responsible for emissions within the district enables more effective strategic planning around sustainable fuel use. Liquid fuel (diesel and petrol) represents more than half of all energy used within the district, with electricity consumption at about a third of the amount (Figure 19). Electricity contributes to 66% of GHG emissions. This is because electricity is fossil-fuel based; largely from coal-fired power stations. By contrast, petrol and diesel contribute 25% towards emissions.

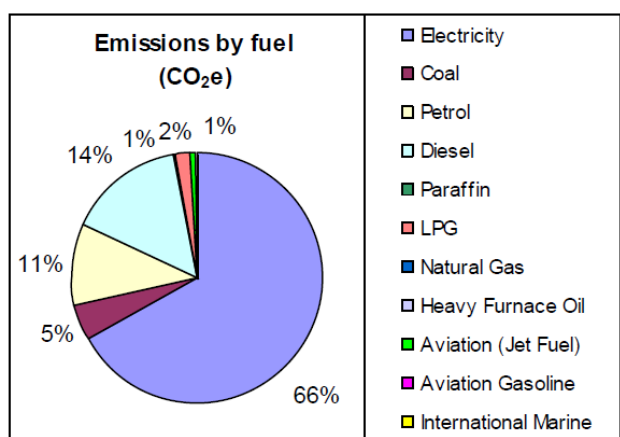


Figure 19: Energy-related emissions by fuel type in the Garden Route District

4.6.2 The Garden Route Energy Emissions by Sector

The transport sector accounts for the largest proportion of energy consumption in the district (54%), followed by the industrial sector at 27% (Figure 20). The high use of energy in the industrial sector can be attributed to PetroSA in Mossel Bay and the fact that the Western Cape's second-largest town (George) is located in the Garden Route District. The residential sector accounts for 12% of energy consumption in the district.

Understanding sectoral contributions to district emissions enables effective management for reducing sectoral carbon emissions. Sector carbon emissions in Garden Route point to the high impact of the industrial, transport, and residential sectors. There is an opportunity for the district to embark on energy efficiency projects aimed at reducing sectoral carbon emissions. Targets in reducing sectoral emissions can be included in the district and municipal Integrated Development Plans.

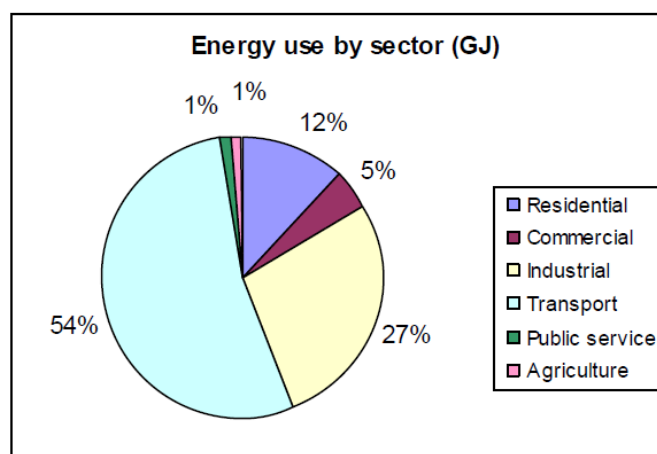


Figure 20: The energy use by sector within the Garden Route District

4.6.3 Local Government Energy Use in the Garden Route District

Street and traffic lights make up the majority of total energy consumption in the district (Figure 21). There are opportunities for municipalities to upgrade streetlights and traffic lights – such as the use of light emitting diode (LED) signals at traffic intersections. This has a significant potential for savings on energy use, financial savings and reduced emissions. The water and waste water treatment plants as well as vehicle fleet energy use is underreported, as 5 of the 7 local municipalities in this district were unable to report on either or both of these figures. There is a scope to improve the efficiency of water treatment. Substantial energy savings within building and facilities sector can also be achieved. It is suspected that waste water and water treatment will contribute a much higher percentage of the pie chart, as South Africa's largest desalination plant, which is very energy intensive when in use, is situated in the Garden Route District in Mossel Bay. Unfortunately no data was available on waste water and water treatment works energy use in Mossel Bay.

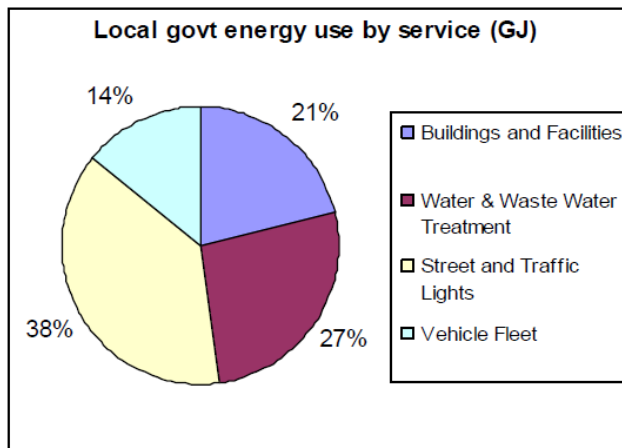


Figure 21: The local government energy use by sector (GJ) within the Garden Route District

While the energy consumption in this district is small and it represents a very small part of the total provincial consumption (8% of the provincial total), important saving opportunities exist within the built environment as well as the industrial sector. The Garden Route District experiences the highest level of energy poverty of all the districts/metros. It's per capita energy and waste GHG emissions footprint is in line with the provincial average, but this masks a large range; from 3 tonnes per capita in Kannaland and Oudtshoorn, and 5 in George (the largest town after Cape Town), to 8 in Mossel Bay (a heavy industrial area). Garden Route has the second-highest vehicle ownership, which, combined with the high energy poverty, may indicate large wealth inequality. Liquid fuel represents the largest amount of energy consumed in the district, while electricity use is the cause of the most GHG emissions. Industry uses about half of the district's electricity, with the residential sector consuming a third. The following are key energy issues within the Garden Route District Department of Environmental Affairs and Development Planning (2013):

- Heavy industry is situated in the Garden Route District (e.g. in Mossel Bay).
- A national road runs through the district, which increases liquid fuel use that is outside the management control of local municipalities.
- South Africa's largest desalination plant is situated in Mossel Bay. Though not used often, it is very energy intensive when in use.
- The district has the highest energy poverty level in the Western Cape, when based on the percentage of non-electric fuels used for space heating and cooking.
- Peak tourist season offers energy management challenges. LPG use for cooking may be encouraged in the tourism sector to decrease electricity peak load demand.

4.7 Climate Change and Air Quality Management

4.8 Climate Change and Waste Management

5 Economic Impact of Climate Change

Depending on underlying assumptions, studies of the economic impacts of a doubling in atmospheric carbon dioxide (CO₂) from pre-industrial levels conclude that this would have a slightly negative to moderately positive aggregate effect (i.e., total impacts across all regions) on the agricultural sector. This aggregate effect hides substantial regional differences, with benefits mostly predicted in the developed world and strongly negative impacts for populations poorly connected to regional and global trading systems.

A number of other sectors will be affected by climate change, including the livestock, forestry and fisheries industries. Other sectors sensitive to climate change also include the energy, insurance, tourism and recreation industries. The aggregate impact of climate change on most of these sectors is highly uncertain.

- **Background:**

The 2017/ 2018 Garden Route wildfire disasters had a severe impact on the regional economy, with much of the consequences not immediately apparent, only to play out and manifest in the medium to long term. In order to obtain a complete overview of what exactly the impact of the respective fires and droughts were on the economy, Garden Route Rebuild Initiative Business fund in collaboration with the GRDM commission a study to determine the existing and potential impact of the disasters, as well as to identify projects or initiatives to mitigate the consequences.

- **Objective:**

The objective is to determine what the total damage of the Garden Route fires and droughts were and where steps by both the authorities and private sector can be taken to mitigate losses and improve the regional economy.

- **Study area to include:**

To include the following wild fire disasters:

- Hessequa fires
 - Riversdale/ Still Bay fires (May 2017);
 - Vermaaklikheid fires (October 2018)
- Knysna/ Plettenberg Bay fires (June 2017)
- George fires (October 2018)

- **Droughts:**

Over the last 12 years the district has been experiencing drought conditions, peaking over the period 2009/2010 in the coastal areas and presently over the Klein Karoo areas including Calitzdorp and Ladismith in the Kannaland Municipal area. This drought condition has led to de-population of some of the rural areas as well as the creation of more poverty pockets. This aim is to firstly identify the areas directly affected as well as the knock-on effect that the drought has had on the local economy over the last 12 – 15 years.

- Relevant sectors

- Environmental (jobs lost, damage to natural infrastructure such as catchments, projected invasive plants regrowth, erosion, loss of biodiversity, land care, developmental options)
- Agriculture (jobs, capacity, production, fences, fodder, grazing, infrastructure, developmental options)
- Forestry (private and state, present and future feasibility, value chain, developmental options)
- Tourism and conservation (SANParks, Cape Nature, private entities e.g. guest houses)
- Property market
- Municipal infrastructure (damage to infrastructure, costs related to the fires, developmental options)
- National infrastructure (SANRAL roads and reserves)
- Other relevant sectors

6 Garden Route Climate Change Vulnerability

Climate change has been identified as a key issue for the Garden Route District Municipality (Garden Route District Municipality 2017a, 2016, 2014). Following the publication of the *Western Cape Climate Change Response Strategy* in 2014, the Garden Route District Municipality developed the *Garden Route District Climate Change Adaptation Plan* in 2014 (Garden Route District Municipality 2016, 2014).

While the *Garden Route District Climate Change Adaptation Plan of 2014* primarily focused on adapting to climate change, this reviewed *Garden Route District Climate Change Strategy* also focused on the inclusion of climate change adaptation hazards as well as a vulnerability assessment. Table 6 below indicates the key climate change hazards identified for the Garden Route District:

Table 6: List of Key Climate Change Hazards in the Garden Route District

Climate Change Hazard	Vulnerable areas
Temperature dependant vulnerability:	Water; Agriculture; Environment
Extended Dry Spell periods (longer periods between rainfall events and more intense rainfall events – this does vary between areas within EDM due to different landscapes and location)	i. Water ii. Agriculture iii. Communities/Society iv. Tourism
Fire Risks (there are fire regimes that are needed i.e. Fynbos, but this focussed on unwanted fires)	i. Community/Society ii. Human Settlements iii. Environment
Increased intensity of Storm Events	i. Infrastructure ii. Humans settlements – Built environment, planning, location iii. Communities/Society – safety, emergency response
Coastal areas (Storm Surge and Sea-level rise)	i. Infrastructure ii. Coastal areas, Built environment, natural barriers, dunes, ecosystem services iii. Human settlements

6.1 Garden Route Climate Change Vulnerability Assessment

A Garden Route Climate Change Vulnerability Assessment was conducted through the Local Government Climate Change Support (LGCCS) program (<http://www.letsrespondtoolkit.org/>) in partnership with the Western Cape Climate Change Municipal Support Programme. The LGCCS is an initiative of the National Department of Environmental Affairs and the International Climate Initiative (IKI) and is supported by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The assessment outlines the key climate change vulnerabilities and responses to address these vulnerabilities for Garden Route District Municipality.

The three primary objectives of the LGCCSP are to:

- Perform a desktop analysis of the municipality to provide context on change vulnerabilities and responses;
- Undertake district municipal specific engagements to draft climate change vulnerabilities and responses;
- Facilitate capacity building and knowledge-transfer throughout the program to enhance implementation of prioritised climate change adaptation options.

Through the LGCCSP, a Climate Change Vulnerability Assessment Toolkit was developed to assist municipalities to identify and prioritise climate change indicators to facilitate the assessment of adaptive capacity. The LGCCS Toolkit was applied to the Garden Route District Municipality to assist with the development of its Climate Change Response Plan.

6.2 Vulnerability Assessment Results

A Garden Route District workshop was held with key environmental stakeholders of the seven Category-B Municipalities in the district, where the focus was specifically on the identification and review of key climate change vulnerabilities for the area. The process included the identification of context specific climate change indicators, assessing exposure, sensitivity and adaptive capacity. Participants also developed priority climate change responses. The following section provides a summary of the Vulnerability Assessment conducted for the Garden Route District Municipality.

6.2.1 Agriculture

Table 7: Agriculture Vulnerability Indicator Table Garden Route District Municipality

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
1	Change in grain (maize, wheat & barley) production	Areas towards the west of RSA are likely to become less suitable for grain production.	Do you grow or have potential to grow grains in your area?	Yes	Mostly in the coastal areas of the District (e.g. Heidelberg). Hops – dried and used exclusively in beer brewing industry. Fodder is mostly for dairy farms.	How important is grain to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	Medium	Wheat is of medium priority in the District and is grown mostly to the east of the District Municipal Area. Hop production may decline over time due to climate change. There will be more sunlight but less moisture to assist with the production of hops.	Medium	Department of Water Affairs and Water User Association. The Western Cape Climate Change Implementation Plan for Agriculture highlights that conservation agriculture has been introduced to wheat farmers throughout the Western Cape which has assisted with production. Farmers and labourers DAFF and WC DA DRDLR

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
2	Change in Sorghum production	Sorghum yields are projected to increase in parts of western KZN, inland areas of the Eastern Cape and the eastern Free State, with some areas in the north registering losses compared with present climatic conditions.	Do you grow or have potential to grow Sorghum in your area?	No	Not suitable because of weather conditions.	How important is sorghum to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	Low			
3	Change in Soya Bean Production	Areas in the east of RSA lost to potential production, with an expansion of suitable areas inland towards the central/west or RSA.	Do you grow or have potential to grow Soya Bean in your area?	Yes	Mainly in coastal areas (e.g. Plettenberg Bayenberg Bay, Knysna, and George). 1-1.5 tons yielded per hectare in these areas.	How important is soya bean to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	Low	Soya is a low priority crop.		Department of Water Affairs and water user's association Farmers and labourers DAFF and WC DA DRDLR

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
4	Change in Sugarcane Production	Increase in <10% in many parts of the present cane growing areas, but by up to 30% in new growth areas further inland.	Do you grow or have potential to grow Sugarcane in your area?	Yes	Between 30-50 tons per hectare (George and Knysna).	How important is sugarcane to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	Low	Sugarcane is not a priority crop in the District.	Low	There is not enough land for sugarcane production Farmers and labourers Department of Water Affairs and water user's association DAFF and WC DA DRDLR
5	Change in viticulture (grapes) production	Areas suitable for viticulture could be substantially reduced or shift to higher altitudes and currently cooler, more southerly locations.	Do you grow or have potential to grow grapes in your area?	Yes	Drier (Klein Karoo, Calitzdorp).	How important is viticulture (grapes) to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low /No Priority Crop = Low	High	Grapes are important in the District as fortified wine, an important commodity for the District. Grapes for wine expanded to Plettenberg Bayenberg Bay and Langklook. Port and wine.	Medium	Department of Water Affairs and water user's association Garden Route District Municipality Climate Change Adaptation Plan Garden Route District Municipality Regional Economic Development Strategy Farmers and labourers DAFF and WC DA DRDLR

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
6	Change in fruit production	Projected reduction of the area suitable for fruit production (e.g. 28% reduction in apple and pears) by as early as 2020.	Do you grow or have potential to grow fruit in your area?	Yes	Deciduous fruits: Apricots, apple, pears, plums and peaches. Citrus fruits: Oranges, lemons, and melons. Soft fruit: Strawberry, and blueberry. Uniondale/Harlem Kanwal Land Langkloof is a well-recognised fruit growing area.	How important is fruit to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	High	The EDM Regional Economic Development Strategy notes that fruit contributes to poverty alleviation in the District. Deciduous and citrus fruit are important for the local economy.	Medium	Farmers and labourers DAFF and WC DA DRDLR Department of Water Affairs and Water User Association Garden Route District Municipality Climate Change Adaptation Plan Garden Route District Municipality Regional Economic Development Strategy

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
7	Change in other crop production areas (e.g. vegetables, nuts, etc.)	Crop production may vary depending on a warmer wetter or warmer drier climate.	Do you grow or have potential to grow other crops in your area?	Yes	<p>ODW - Vegetables</p> <p>Vegetable seed</p> <p>Honey bush tea</p> <p>Aloe products</p> <p>Dried herbs</p> <p>Olives</p> <p>Macadamia nuts</p> <p>Lucerne seed</p> <p>Essential oils – Geranium, and Liquorice</p> <p>Honey, Propolis & Beeswax</p> <p>Summer vegetables: Green beans, sweet corn, onions, tomatoes, and pumpkin.</p> <p>Winter vegetables: Broccoli, cauliflower, brussels sprouts, cabbage, and carrots.</p> <p>Prepacked vegetables – celery, spinach, and lettuce.</p>	<p>How important are other crops to the local economy and livelihoods?</p> <p>High Priority Crop = High;</p> <p>Medium Priority Crop = Medium;</p> <p>Low/No Priority Crop = Low</p>	High	Vegetables are important for sustaining livelihoods and for the local economy.	Medium	<p>DRDLR</p> <p>Farmers and labourers</p> <p>DAFF and WC DA</p> <p>Department of Water Affairs and Water User Association</p> <p>Garden Route District Municipality</p> <p>Climate Change Adaptation Plan</p> <p>Garden Route District Municipality</p> <p>Regional Economic Development Strategy</p>

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
8	Increased areas for commercial plantations	The total area suitable for commercial forestry plantations would increase along the eastern seaboard and adjacent areas.	Do you have or have potential for commercial forestry plantations in your area?	Yes	Forestry + Commercial Knysna/George, Garcia, Heidelberg	Is there capacity for commercial plantation expansion (water use licence, land availability, demand for plantation products)? High Potential for Expansion = High; Medium Potential for Expansion = Medium; Low/No Potential for Expansion = Low	High	The Knysna forest is managed for nature conservation, sustained use of forest products and outdoor recreation. Annual sales of indigenous timber by the state, is the main source of raw material for the long established solid furniture manufacturing industry in the Garden Route District.	Medium	There is not enough land for expansion. Solid wood furniture - indigenous forest. Commercial - structural Timber. Mountain to Oceans Biz on San Parks + Cape Nature

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
9	Increased exposure to pests such as eldana, chilo and codling moth	Exposure to eldana would increase in areas suitable for sugarcane by ~10% to > 30%. The area subject to damage by chilo would increase substantially (sugarcane). The area subject to damage by codling moth would increase substantially (apples, pears, walnuts and quince).	Are you or will you be exposed to agricultural pests in your area?	Yes	Relevant because of expansion of agricultural activities and change in weather conditions. The American Bee has potential to wipe out fruit production. This bee is essential for pollination which is required for fruit production.	How important are crops that are vulnerable to pests to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	High	Agriculture is an important sector in the District. Garden Route's Climate Change Adaptation plan has identified increased pest prevalence due to changes in climatic conditions as a threat to the sector and therefore to food security.	Medium	Farmers and labourers Garden Route Climate Change Adaptation Plan
10	Increased risks to livestock	Projected decreases in rainfall and hence herbage yields would result in negative health impacts for livestock.	Do you or will you have livestock in your area?	Yes	Mossel Bay to Heidelberg and the Little Karoo, more extensive farming methods are practised such as livestock production (sheep, beef, goats, ostriches etc.) and game farming. Tick borne diseases such as malaria affect livestock in the District.	How important is livestock farming to the local economy and livelihoods? High Priority = High; Medium Priority = Medium; Low/No Priority = Low	High	Livestock provides meat, wool, fresh milk, cheese, yoghurt, processed milk and eggs for the District's at the commercial and subsistence level. Avian flu for poultry.	Low	There are interventions, but they are insufficient. Farmers and labourers Garden Route District Municipality Climate Change Adaptation Plan Garden Route District Municipality Regional Economic Development Strategy

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
11	Reduced food security	Reduced food security, particularly of subsistence farmers, and resultant increase in malnutrition.	Do you or will you have food insecurity in your area?	Yes	Extreme weather conditions (drought, floods, fires etc.) have impacts on the agricultural sector.	Percentage households involved in agricultural activities More than 20% = High; Between 20% & 10% = Medium; Less than 10% = Low	Medium	About 9.86% of households are involved in agricultural activities within the Garden Route District Municipality. Agricultural activities provide employment opportunities providing income to households. Soft fruit production provides permanent employment and seasonal employment in Langkloof.	Low	Training workshops for emerging farmers offered focussing on good farming practices and alternative farming practices have been provided. Farmers and labourers Western Cape Department of Agriculture (DoA) Hessequa Agricultural Forum

6.2.2 Biodiversity and Environment

Table 8: Biodiversity Vulnerability Indicator Table Garden Route District Municipality

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
12	Loss of High Priority Biomes	High Priority Biomes (including Grasslands, Nama-Karoo, Indian Ocean Coastal Belt, Fynbos, Forest) to be replaced by other biomes such as savanna and desert.	Do you currently have high priority biomes in your area?	Yes	Fynbos Biome, the Succulent Karoo Biome covers a substantial area in the north of the District Municipal Area. The District also has Albany Thicket and Forest Biomes. Klein Karoo area/coastal area.	How much of this High Priority Biome will be lost due to climate change? A significant amount= High; A moderate amount= Medium; None/a low amount = Low	High	A significant cover of the high priority fynbos biome will be taken over by other biomes, including Albany Thicket and Desert. Forest species are very sensitive and require high levels of protection. Loss of diversity through loss of species in the fynbos biome. This may mean reduced pollinator species resulting in loss of potential medicinal plants. Irreplaceability of fynbos biome.	Medium	Adaptive fairly well because thicket is not fire dependent, so fire risk is reduced. DEADP Care Nature Local Municipalities Garden Route Biodiversity Report Garden Route Biodiversity Action Plan SANParks SANBI DEA FPD

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
13	Increased impacts on threatened ecosystems	Loss of threatened ecosystems due to changes in climate.	Do you currently have threatened ecosystems in your area? (Classified as critically endangered, endangered or vulnerable)	Yes	There are vulnerable ecosystems within the District.	How much of your Municipality is covered by threatened ecosystems? A significant amount= High; A moderate amount= Medium; None/a low amount = Low	High	The following ecosystems within the District are categorised as critically endangered: Langkloof Shale Renosterveld Knysna Sand Fynbos Garden Route Shale Fynbos Cape Lowland Alluvial Vegetation Muscadel Riviere Cape Lowland Alluvial Vegetation Eastern Ruens Shale Renosterveld Ruens Silcrete Renosterveld Garden Route Granite Fynbos Mossel Bay Shale Renosterveld Increasing temperatures and drought periods result in the decrease in species diversity.	Low	There is a lack of institutional support due to poor structuring. There is minimal implementation. Research and policy exists but threats from invasive plants are displacing threatened vegetation types. DEADP Care Nature Local Municipalities Garden Route Biodiversity Report Garden Route Biodiversity Action Plan SANParks SANBI DEA FPD

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
14	Increased impacts on environment due to land-use change	Loss of biodiversity and degradation of natural habitat due to significant land use change (such as alien invasion, soil erosion and urbanisation) which impacts on ability to respond to climate change	Are you currently experiencing land use change?	Yes	Tuin op die Braak (Stilbaai) Lowland coastal Fynbos (George/M. Bay, Knysna and Bitou) Lowland wetlands (Tronehout Southern Cape)	Have you experienced significant loss of habitat since 1990? Above 10% = High; Between 5-10% = Medium; Under 5%= Low	High	Although biodiversity is protected through conservation areas in the District, there is a high rate of land-use change due to soil erosion, the spread of invasive alien species, population growth, the expansion of agricultural and urban areas, increased pollution, and poor waste management. Rowland coastal fynbos has been highly transformed in the last 10 years due to poor spatial development planning and increasing demand for coastal view/access.	Low	People responsible for protecting the environment are approving developments and the main causes for this are financial risks, politics and legal obligations. DEADP Cape Nature SANParks SANBI DEA FPD, Municipalities

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
15	Loss of Priority Wetlands and River ecosystems	Changes in rainfall patterns and temperature are likely to impact on wetlands and the ecosystem services they provide.	Do you have priority wetlands and river ecosystems in your area?	Yes	Stilbaai, Wilderness, Lakes, Goukou Systems, Knysna, and Keurbooms.	How important are wetlands and river ecosystems in providing ecosystem services in your Municipality? A significant amount= High; A moderate amount= Medium; None/a low amount = Low	High	Most wetlands within the District are classified as either 'moderately modified' or 'heavily to critically modified'. Ploughing/excavation of wetland during droughts.	Low	Hardened surfaces replacing wetlands reduce the ability to store stormwater runoff. DEADP Cape Nature SANParks SANBI DEA FPD Local Municipalities

6.2.3 Coastal and Marine

Table 9: Coastal and Marine Vulnerability Indicator Table Garden Route District Municipality

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
16	Impacts on Marine and Benthic Ecosystems	Changes in precipitation and freshwater flow; sea-level rise; increased temperatures and coastal storminess have led to changes in physical processes and biological responses which impacts marine and benthic ecosystems.	Does this or will this take place in your area?	Yes	Breeding ground Estuary Damage Knysna sea horse Damage to coastal infrastructure Invasive mussels/Goggas	What is the Benthic Coastal Threat Status of the area? Critically Endangered and Endangered = High; Vulnerable = Medium; Least Threatened = low	High	There are several threatened ecosystem types in the coastal zone of the District Municipal Area. The 'Southern Benguela Hard Shelf Edge', 'Agulhas Muddy Inner Shelf', 'Agulhas Mixed Sediment Outer Shelf', 'Agulhas Inshore Reef', 'Agulhas Sheltered Rocky Coast' and 'Harbour' are all categorised as critically endangered.	Medium	There are some policies and research but insufficient implementation. DEA Cape Nature DEADP Biosphere Reservoirs Municipalities SANParks Oceans Research Academic Research Institutions Operation Phakisa - New marine protected areas in the District.

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
17	Impacts on estuary ecosystems	Changes in precipitation and freshwater flow; sea-level rise; increased temperatures and coastal storminess have led to changes in physical processes and biological responses which impacts on estuarine ecosystems.	Does this or will this take place in your area?	Yes	Groot Brak Breeding ground Estuary Damage Knysna sea horse/Eelgrass Damage to coastal infrastructure Invasive mussels/Goggas Breede River Estuary Duiwen Hok Swartvlei remains closed with less inflows and higher contamination levels from septic tanks etc. Water quality issues are a big risk. Estuary management beams needed to respond to climate change projections, another risk is toxic algal blooms. Need to act preventatively.	Have estuaries in the area been modified? Critically or Seriously Modified = High; Largely or Moderately Modified = Medium; Unmodified or Natural = Low	High	None of the estuaries in the District Municipal Area are classified as 'critically/extremely modified' but rather as 'largely modified and seriously modified'.	Medium	Cape Nature DEA DEADP Biosphere Reservoirs Municipalities SANParks Oceans Research Academic Research Institutions Funding has been set aside for an estuary plan for the District. Coastal infrastructure: seawalls, roads and services infrastructure.

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
18	Impacts on Coastal Livelihoods	An increase in the intensity and frequency of extreme weather events is likely to impact on fishing activity by reducing the number of viable sea fishing days, affecting catches.	Does this or will this take place in your area?	Yes	Coastal areas of the District.	How important is fishing to the local economy and livelihoods? High Priority = High; Medium Priority = Medium; Low/No Priority = Low	Medium	Fishing is a medium priority activity and climate change will impact on the fishing industry, and at a livelihoods level.	Medium	DEA DEADP Biosphere Reservoirs Municipalities SANParks Oceans Research Academic Research Institutions Fisherman DAFF Cape Nature
19	Loss of land due to sea level rise	Increased loss of land due to sea level rise and storm surges	Does this or will this take place in your area?	Yes	Glentana Wilderness Groot Brak Knysna	Do you have significant areas below 5m elevation? Significant areas = High; Some areas = Medium; Few or no areas = Low	High	The District Municipal Area contains a large amount of coastal land with less than 5.5 m elevation.	Low	Homeowners Local Municipalities Insurance Companies Garden Route Coastal Management Plan. CML's draft available October 2017. There's a need to exercise policy of retreat in SDF.

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
20	Increased damage to property from sea level rise	Increased damage to property and damage to infrastructure (including coastal roads and railways, small fishing ports and harbours, and critical infrastructure such as Koeberg nuclear power station) as a result of rising sea-levels and storm surges.	Does this or will this take place in your area?	Yes	Wilderness Danabaai Herolds + Victoria Bay Alentama Groot Brak Knysna/Sedgefield	Do you have significant areas below 5m elevation? Significant areas = High; Some areas = Medium; Few or no areas = Low	High	The District Municipal Area contains a large amount of coastal land with less than 5.5 m elevation.	Low	Homeowners Municipalities Insurance Companies. Garden Route Coastal Management Plan. Legal weak in enforcing SA14 ICMA

6.2.4 Human Health

Table 10: Health Vulnerability Indicator Table Garden Route District Municipality

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
21	Health impacts from increased storm events	Increased storms will result increased risk of drowning, injuries and population displacement impacts.	Are you or will you experience increased storm events in your area?	Yes	Heidelberg Albertina Riversdale	How populated are areas vulnerable to storms events (e.g. flood zones)? Densely populated = High; Partially populated = Medium; Sparsely or not populated = Low	Low	The District's climate change plan highlights that the District has experienced frequent severe flooding events, which have affected infrastructure especially in floodplains.	High	Stormwater Master Plans updated Stormwater improvements Flood and fire awareness campaigns District Municipality Health Practitioners Municipalities Homeowners Businesses Community members The District CC Adaptation Plan highlights damage to infrastructure in floodplains as a key impact for the District and notes possible interventions.

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
22	Increased heat stress	Increases in average temperatures and extreme events (such as heat waves) are projected to induce heat stress, increase morbidity, and result in respiratory and cardiovascular diseases.	Are you or will you experience increased heat waves in your area?	Yes	Klein Karoo and Oudtshoorn (45 degrees Celsius).	Is there a high percentage of young and elderly in the area? More than 20% = high; Between 15% & 20% = Medium; Less than 15% = low	Medium	About 17.10% of the population are <5yrs and >64yrs, these age groups are vulnerable to heat stress.	Medium	District Municipality Health Practitioners Municipalities Homeowners Businesses Community members Good clinics and medical facilities Midday non-work period Sports cancelled

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
23	Increased vector borne diseases from spread of mosquitoes, ticks, sandflies, and blackflies	Vector borne diseases such as malaria is projected to spread within regions bordering current malaria areas, which are presently too cold for transmission.	Are vector borne diseases present or likely in your area?	Yes	District wide but prevalent inland. Ticks, flies, mosquitoes.	Are you in or neighbouring an area with vector borne diseases (e.g. malaria)? Already in a vector borne disease area = High; Neighbouring a vector borne disease area = Medium; Not near a vector borne disease area = Low	Medium	The District's Climate Change Adaptation Plan identifies weather induced diseases to be a challenge for the District. Avian flu is increasing. Avian flu research for human impact is needed.	Medium	Early warning and watch systems are in place, but improvements are needed. Health is not well represented. District Municipality Health Practitioners Municipalities Homeowners Businesses Community members Garden Route District Climate Change Adaptation Plan

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
24	Increased water borne and communicable diseases (e.g. typhoid fever, cholera and hepatitis)	Favourable conditions for the incubation and transmission of waterborne diseases may be created by increasing air and water temperatures.	Are waterborne and communicable diseases present or likely in your area?	Yes	Floods Hessequa Vibrio virus in water Increase temperature Kaaboom	Have you had an incidence of waterborne and communicable diseases (e.g. typhoid fever, cholera and hepatitis) in the past 3 years Yes = High: No = Low	Medium	Unsure if the District has had an incidence of waterborne and communicable diseases (e.g. typhoid fever, cholera and hepatitis) in the past 3 years, however, the District is vulnerable to waterborne diseases as 12.31 % of the households do not source water from piped water schemes.	Medium	District Municipality Health Practitioners Municipalities Homeowners Businesses Community members DWS Garden Route District Climate Change Adaptation Plan
25	Increased malnutrition and hunger as a result of food insecurity	Climate Change will affect food systems, compromising food availability, access and utilisation, leading to food insecurity (particularly of subsistence farmers).	Do you or will you have food insecurity in your area?	Yes	District wide Fire, floods, and drought.	Child under 5 years severe acute malnutrition case fatality rate More than 10% = high; Between 5% & 10% = Medium; Less than 5% = low	Low	For children under 5 years severe acute malnutrition case fatality rate was 0.3 % during the 2015/16 period.		DAFF Elsenberg Department of Social Development Department of Health NGO's Explore agricultural improvements on crop methods

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
26	Increased air pollution	Health impacts in resulting from exposure to air pollutants include eye irritation, acute respiratory infection, chronic respiratory diseases and TB, and sometimes death.	Do you or will you have air pollution in your area?	Yes	Aloe Factories PetroSA PSP ODN Sea Harvest - process plant Veld fires Disasters	Would you consider your area a high priority in terms of air pollution (e.g. SAAQIS Priority Areas)? Yes = High; Somewhat = Medium; No = Low	Medium	The District is not within the SA Air Quality Priority Areas but has several industrial activities.	Medium	Air Quality Management Plan Municipalities Business Chambers DEADP and DEA
27	Increased Occupational health problems	Temperature is a common climatic factor that affects occupational health (for example, agricultural labourer's productivity) by causing heat stress and dehydration.	Do people work outside or are in conditions that cannot be cooled in your area?	Yes	Temperature increases, rainfall and drought.	Do a significant percentage of people work outside or are in conditions that cannot be cooled? Significant = High; Some = Medium; Low/No = Low	Medium	About 14.3% of the economically active population are employed within the informal sector with minimal infrastructure and services.	Medium	Farm labourers Municipal general workers Field workers Construction Garden Route District Regional Economic Development Strategy

6.2.5 Disaster Management, Infrastructure and Human Settlements

Table 11: Disaster Management, Infrastructure and Human Settlements Vulnerability Indicator Table Garden Route District Municipality

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
28	Loss of industrial and labour productivity	Direct impacts of weather on construction, electricity generation and other industries, resulting in loss of productivity.	Do you have industrial activities in your area?	Yes	Floods, fire and drought impact the manufacturing, construction, and agriculture sectors in Mossel Bay.	How significant is the Mining/Industrial/Manufacturing sector for the local economy? Significant = High; Somewhat = Medium; Low/No = Low	Medium	Extreme weather events affect economic activities within the District. Manufacturing is a significant contributor to the economy.	High	Businesses Communities Unions Municipalities National, provincial and local government Garden Route District Regional Economic Development Strategy

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
29	Increased impacts on strategic infrastructure	Increased disruptions to key strategic infrastructure (e.g. WWTW, storm water, roads, rail, bridges) as a result of extreme weather events.	Do you have strategic infrastructure in your area?	Yes	Flooding, fires (Meiringspoort, N2, Railway).	How important is this strategic infrastructure to the functioning of your municipality? Significant amount = High; Moderate amount = Medium; Minimal or no = Low	High	Damage to infrastructure has already been felt in the District. Roads include N2, R62, N9 and N12. There is also a railway and airport. The 2009/10 Garden Route District drought damage was estimated to be R300 million, and the 2011 Garden Route District floods estimated at R350 million.	Medium	Approximately 45% of the District's disaster relief budget is allocated to the repair and maintenance of road infrastructure after flood damage. Businesses Communities Unions Municipalities National, provincial and local government

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
30	Increased impacts on traditional and informal dwellings	Increased risk of extreme weather events to already vulnerable traditional and informal dwellings, that are often unplanned, and without extensive service or infrastructure.	Do you have traditional and informal dwellings in your area?	Yes	Floods, fire, droughts (informal settlements across the southern cape). There are no traditional dwellings but rather informal dwellings.	What percentage of households are in traditional and informal dwellings in your area? More than 15% = high; Between 15% & 10% = Medium; Less than 10% = low	High	About 14.37% of households are informal and heavily impacted due to changes in the climate, and because of hazards such as fire and floods.	Low	Businesses Communities Unions Municipalities National, provincial and local government
31	Increased isolation of rural communities	Physical isolation of rural communities as a result poor rural roads and increased flooding and erosion.	Do you have isolated rural communities in your area?	Yes	George (Haarlem, Unionsdale) Hessequa (Vermaaklikheid, Casia) Bitou Zoar, Harbearsdei	Is your area predominantly Rural? Mostly Rural = High Equally Urban and Rural = Medium Mostly Urban = Low	High	Garden Route District has the largest rural area of all the Western Cape Districts. Low investment towards transport isolates certain rural settlements within the District.	Medium	Need for integrated rural transport plan. DRDLR Dept. of Human Settlements Municipalities Department of Transport Local Economic Development

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
32	Increased migration to urban and peri-urban areas	Increased migration from rural settlements to urban and peri-urban settlements.	Do you have rural urban migration in your area?	Yes	George, Bitou, Knysna and Mossel Bay are popular and favourable.	Is there a strong rural economy? Low opportunities in rural areas = High; Some opportunities in rural areas = Medium; Strong rural economy = Low	High	The youth migrate from the Eastern Cape and the elderly to the coastal towns of the district.	Low	Immigration from Cape Town to this District due to water shortages. IDP - District MERO Census
33	Increased risk of wildfires	Increased risk of wildfires linked to higher ambient temperatures, dry spells and more frequent lightning storms.	Is this or will this take place in your area?	Yes	The entire District Knysna An increase in invasive alien species in rural areas.	What is the Veld Fire Risk Status of the area? Extreme or High = High; Medium; Low	High	Veldfires have been experienced throughout the District heavily impacting on households and municipal infrastructure. The risk of veld fires is high for most of the District Municipal Area, there are areas of extremely high veld fire risk in the south and low veld fire risk in many parts in the north and west of the District.	Low	Disaster Management Fire Departments Municipalities Working on Fire

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
34	Decreased income from tourism	Reduced income from tourism as a result of reduced recreational opportunities and increased impact on tourism-supporting infrastructure, such as conservation area access roads.	Do you have tourism assets that can be impacted by climate change in your area?	Yes	Coastal, Klein Karoo Fire, Floods, and Drought.	How significant is tourism to the local economy? Significant contributor = High; Some contribution = Medium; Low/No contribution = Low	Medium	Increased frequency and intensity of veld fires and other storm events has led to negative impacts for the tourism sector.	Low	Tourism Industry Municipality Property owners

6.2.6 Water

Table 12: Water Vulnerability Indicator Table Garden Route District Municipality

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
35	Decreased quality of drinking water	Deterioration in water quality due to increased salt concentrations in dams, wetlands and soil/plant systems from enhanced evaporation rates.	Is this or will this take place in your area?	Yes	Fires, floods, overuse of water facilities. Groundwater extraction and unwanted salt. Drought, poor water storage EOU/Fire ODN (De Rust)	What is the Blue Drop Score for the area (2012 Report)? Less than 50% = high; Between 50% & 90% = Medium; More than 90% = low	Medium	Blue Drop Scores: George Local Municipality - 82.77% Mossel Bay Local Municipality - 78.76% Knysna Local Municipality - 61.62% Bitou Local Municipality - 90.43% Oudtshoorn Local Municipality - 51.29% Hessequa Local Municipality - 55.18% Kannaland Local Municipality scored - 31.66% Data provided is outdated, new data needs to be provided.	Medium	Water retention scheme in development for Knysna/Plett. Oudtshoorn is in the process of developing a threatened plant municipal communication to communities. Communities Farm owners Municipalities Blue Drop reports

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
36	Decreased water quality in ecosystem due to floods and droughts	More frequent floods result in increased effluent overflow into rivers. Increased drought means less water is available to dilute wastewater discharges and irrigation return flows to rivers.	Is this or will this take place in your area?	Yes	Drought is the main cause of poor affluent and high salt concentrations.	What is the Green Drop Score for the area? Less than 50% = high; Between 50% & 90% = Medium; More than 90% = low	High	Green Drop Scores: George Local Municipality - 43.10% the Mossel Bay Local Municipality - 40.30% Knysna Local Municipality - 38.30% Bitou Local Municipality - 49.40 % Oudtshoorn Local Municipality - 33.80% Hessequa Local Municipality - 30.10% Kannaland Local Municipality scored - 25.10%	Low	Municipalities DWA BGCMA

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
37	Less water available for irrigation and drinking	Increased periods of drought mean less water is available.	Is this or will this take place in your area?	Yes	Drought Poor quality of borehole water	Years of drought over the past 20 years More than 7 incidence = High; Between 7 & 2 incidence = Medium; Less than 2 incidence = Low;	Medium	The 2009/10 drought damage was estimated at R300 million, and the 2011 flood damage was estimated at R350 million in the District.	Low	Municipalities DWA BGCMA Financial constraints for management of water abstraction. Water losses and proper strategy to address issues. Grey water systems are increasing in number, as well as rainwater harvesting systems in Plett and Knysna.
38	Increased impacts of flooding from litter blocking storm water and sewer systems	Human health and ecosystem impacts, associated with increased rainfall intensities, flash floods and regional flooding resulting in litter and washed-off debris blocking water and sanitation systems.	Is this or will this take place in your area?	Yes	Floods, illegal dumping, and drought.	Percentage of Households using no rubbish disposal More than 10% = High; Between 10% & 5% = Medium; Less than 5% = Low	Low	About 2.29% of households have no access to rubbish disposal systems.		WWTP Municipalities

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
39	Increased fish mortality	Increased freshwater fish mortality due to reduced oxygen concentrations in aquatic environments and mortality of temperature-sensitive fish species.	Do you have fresh water fish in your area?	Yes	Redfin Minors Fresh Water System (Drought)	How significant is fresh water fish to livelihoods? Significant to livelihoods = High; Some dependence = Medium; Low/No dependence = Low	Low	The fishing industry provides an important economic boost to the region and the local community. Poor estuary health negatively impacts on the health of species.	Medium	Care Water State of River Reports Garden Route District Regional Economic Development Strategy Department of Forestry and Fisheries

6.2.7 Air Quality

Table 13: Air Quality Vulnerability Indicator Table Garden Route District Municipality

Indicator No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
1	Increase in Air Pollution	Increased air pollution due to industrial activity	Are you exposed to air pollution at your home, workplace, school, etc.	Yes	Exposure to air pollution	Do you experience air pollution related illnesses?	High	Increase in Air Pollution	Low	Expand monitoring network, g
2	Increase in odour complaints	Increase in odour related complaints	Are you exposed to odorous substances at your home, workplace, school, etc.	Yes	Exposure to offensive odour	Do you experience air pollution related illnesses?	High	Increase in Air Pollution	Low	Stricter enforcement of offensive odour industries and activities.
3	Increase in Brown haze	Brown haze due to vehicle emissions	Are you exposed to brown haze in your town	Yes	Exposure to vehicle emissions	Does the exposure to brown haze affect your health?	High	Increase in Air Pollution	Low	Expand vehicle emission monitoring campaigns g

6.3 Vulnerability Assessment Summary

The tables below list the high and medium priority climate change indicators for the municipality.

6.3.1 High Priority Climate Change Indicators

Based on the above vulnerability assessment the following indicators were identified as high priority climate change vulnerabilities for the municipality. These were shortlisted by answering “yes” to exposure, “high” to sensitivity and “low” to adaptive capacity.

Table 14: High Priority Indicators Garden Route District Municipality

No	Sector	Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
10	Agriculture	Increased risks to livestock	Yes	High	Low
13	Biodiversity and Environment	Increased impacts on threatened ecosystems	Yes	High	Low
14	Biodiversity and Environment	Increased impacts on environment due to land-use change	Yes	High	Low
15	Biodiversity and Environment	Loss of Priority Wetlands and River ecosystems	Yes	High	Low
19	Coastal and Marine	Loss of land due to sea level rise	Yes	High	Low
20	Coastal and Marine	Increased damage to property from sea level rise	Yes	High	Low
30	Human Settlements, Infrastructure and Disaster Management	Increased impacts on traditional and informal dwellings	Yes	High	Low
32	Human Settlements, Infrastructure and Disaster Management	Increased migration to urban and peri-urban areas	Yes	High	Low
33	Human Settlements, Infrastructure and Disaster Management	Increased risk of wildfires	Yes	High	Low
36	Water	Decreased water quality in ecosystem due to floods and droughts	Yes	High	Low
1	Air Quality	Increase in Air Pollution	Yes	High	Low
2	Air Quality	Increase in odour complaints	Yes	High	Low
3	Air Quality	Increase in Brown haze	Yes	High	Low

6.3.2 Medium Priority Climate Change Indicators

Based on the above vulnerability assessment the following indicators were identified as medium priority climate change vulnerabilities for the municipality. These were shortlisted by answering “yes” to exposure, “medium” or “high” to sensitivity and “low” or “medium” to adaptive capacity.

Table 15: Medium Priority Indicators Garden Route District Municipality

No	Sector	Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
1	Agriculture	Change in grain (maize, wheat & barley) production	Yes	Medium	Medium
4	Agriculture	Change in Sugarcane Production	Yes	Low	Low
5	Agriculture	Change in viticulture (grapes) production	Yes	High	Medium
6	Agriculture	Change in fruit production	Yes	High	Medium
7	Agriculture	Change in other crop production areas (e.g. vegetables, nuts, etc.)	Yes	High	Medium
8	Agriculture	Increased areas for commercial plantations	Yes	High	Medium
9	Agriculture	Increased exposure to pests such as eldana, chilo and codling moth	Yes	High	Medium
11	Agriculture	Reduced food security	Yes	Medium	Low
12	Biodiversity and Environment	Loss of High Priority Biomes	Yes	High	Medium
16	Coastal and Marine	Impacts on Marine and Benthic Ecosystems	Yes	High	Medium
17	Coastal and Marine	Impacts on estuary ecosystems	Yes	High	Medium
18	Coastal and Marine	Impacts on Coastal Livelihoods	Yes	Medium	Medium
21	Human Health	Health impacts from increased storm events	Yes	Low	High
22	Human Health	Increased heat stress	Yes	Medium	Medium

No	Sector	Indicator Title	Exposure Answer	Sensitivity Answer	Adaptive Capacity Answer
23	Human Health	Increased vector borne diseases from spread of mosquitoes, ticks, sandflies, and blackflies	Yes	Medium	Medium
24	Human Health	Increased water borne and communicable diseases (e.g. typhoid fever, cholera and hepatitis)	Yes	Medium	Medium
26	Human Health	Increased air pollution	Yes	Medium	Medium
27	Human Health	Increased Occupational health problems	Yes	Medium	Medium
28	Human Settlements, Infrastructure and Disaster Management	Loss of industrial and labour productivity	Yes	Medium	High
29	Human Settlements, Infrastructure and Disaster Management	Increased impacts on strategic infrastructure	Yes	High	Medium
31	Human Settlements, Infrastructure and Disaster Management	Increased isolation of rural communities	Yes	High	Medium
34	Human Settlements, Infrastructure and Disaster Management	Decreased income from tourism	Yes	Medium	Low
35	Water	Decreased quality of drinking water	Yes	Medium	Medium
37	Water	Less water available for irrigation and drinking	Yes	Medium	Low
39	Water	Increased fish mortality	Yes	Low	Medium

7 Sector Response Plans and Implementation Templates

The section below summarises responses that have been identified to address the key vulnerabilities identified above.

7.1 Agriculture

7.1.1 Introduction

Program Name
Agriculture Sector Adaptation to Climate Change
Overview of Key Issues
<p>The South African agricultural sector is highly diverse in terms of its activities and socio-economic context. This sector can be described as two-tiered (commercial vs. small-holder and subsistence farmers), with activities across a wide variety of climatic conditions (especially of rainfall). Roughly 90% of the country is sub-arid, semi-arid, or sub-humid, and about 10% is considered hyper-arid. Only 14% of the country is potentially arable, with one fifth of this land having high agricultural potential.</p> <p>Climate is important in determining potential agricultural activities and suitability across the country, especially in smallholding and homestead settings. Irrigation and conservation tillage practices can overcome rainfall constraints, especially in the high-value commercial agricultural sector. Irrigation currently consumes roughly 60% of the country's surface water resources, with important implications for agricultural exports, and food and water security in the context of climate change.</p> <p>In the Western Cape the current priority areas have been identified in the WCCCRS for the Agriculture sector</p> <ol style="list-style-type: none"> 1. The promotion of climate smart agriculture; 2. Promoting food security at the municipal level; and 3. Research on climate resilient and alternative crops and livestock applicable to the Western Cape <p>Furthermore, the following priority areas have been listed in the Western Cape Climate Change Response Strategy Biennial Monitoring & Evaluation Report 2015/16 (Birch et al., n.d.) for addressing food security and an economically sustainable agricultural industry in the province.</p> <ol style="list-style-type: none"> 1. Farming practices that are in harmony with nature, i.e. 'conservation farming'; 2. Climate smart agriculture; 3. Agricultural water technologies that reduce consumption and increase efficiency (see Water); 4. Research on climate resilient and alternative crops and livestock applicable to the Western Cape; 5. Addressing climate vulnerability through the Municipal Support Programme; and 6. Assessing food security in the context of the resource

	nexus.
	Objectives
	The following objective has been identified through the LGCCSP as a priority area for the agriculture sector in the District Municipality.
10	Manage increasing risks to livestock

7.1.2 Responses

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
10	Manage increasing risks to livestock	Commission research and improve understanding of climate change impacts livestock and land availability							
		Develop a framework that will assist and educate farmers with adjusting to reduced rainfall.							
		Generate and share scientific, social and indigenous knowledge that will assist with adapting to the reduction in herbage yields.							
		Improve collaboration and partnership on existing programs (e.g. LandCare Programme, EPWP and River Health Programmes)							
		Strengthen management plans, to enable continuous monitoring of water and herbage availability for livestock.							

7.2 Biodiversity and Environment

7.2.1 Introduction

Program Name
Biodiversity and Environment Sector Adaptation to Climate Change
Overview of Key Issues
<p>Biodiversity is crucial to ecosystem health, and healthy ecosystems are central to human well-being. Healthy ecosystems interlinked with working landscapes and other open spaces form the ecological infrastructure of the country and are the foundation for clean air and water, fertile soil and food. All South Africans depend on healthy ecosystems for economic and livelihood activities, including agriculture, tourism and a number of income generating and subsistence level activities. These natural ecosystems are under pressure from land use change and related processes causing degradation, as well as invasive alien species. Accelerated climate change (resulting in increasing temperature, rising atmospheric CO₂ and changing rainfall patterns) is exacerbating these existing pressures.</p> <p>Well-functioning ecosystems provide natural solutions that build resilience and help society adapt to the adverse impacts of climate change. This includes, for example, buffering communities from extreme weather events such as floods and droughts, reducing erosion and trapping sediment, increasing natural resources for diversifying local livelihoods, providing food and fibre, and providing habitats for animals and plants which provide safety nets for communities during times of hardship. Sustainably managed and/or restored ecosystems help in adapting to climate change at local or landscape level.</p> <p>In the Western Cape the current priority areas have been identified in the WCCCRS for the biodiversity and ecosystem goods and services sector</p> <ol style="list-style-type: none"> 1. Prioritisation, valuation, mapping, protection, and restoration of ecological infrastructure; 2. Landscape initiatives / biodiversity corridors and identification of requirements for climate change adaptation corridors; 3. Biodiversity stewardship; and 4. Mainstreaming of conservation planning into decision making. <p>Furthermore, the following opportunities, gaps and recommendations have been identified in the Western Cape Climate Change Response Strategy Biennial Monitoring & Evaluation Report 2015/16 (Birch et al., n.d.) for the biodiversity and ecosystem goods and services sector:</p> <ol style="list-style-type: none"> 1. Better data sharing is needed between government entities 2. Finding comprehensive information on the numbers/hectares of aliens cleared is problematic 3. Informally protected areas are hard to track, as the data is often patchy or outdated. 4. Set fact-based climate change targets for this focus area. 5. There is a need to expand the conservation estate within these corridors.

6. Local community stewardship over corridors and unprotected areas should be promoted.

Objectives

The following objectives have been identified through the LGCCSP as priority areas for the Biodiversity and Environment sector in the District Municipality.

- 13 Manage Increased impacts on threatened ecosystems
- 14 Manage Increased impacts on environment due to land-use change
- 15 Manage Loss of Priority Wetlands and River ecosystems

7.2.2 Responses

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
13	Manage Increased impacts on threatened ecosystems	Increase investment in ecological infrastructure that translates into financial revenue for the district such as ecosystem services bonds and market options that reduce flood risk within the region							
		Completion of Invasive Species Control Plan(NEMBA) for all state owned properties in local municipalities and district municipalities. This is to be done by the environmental management departments, EPWP, Parks and Recreation and Disaster Management.							
		Research Programme investigating potential risks associated with loss in fynbos biome through involving local universities (NMMU) stakeholders, SANP, CN, involving scenario planning of loss of species. 0-5 years.							

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
14	Manage Increased impacts on environment due to land-use change	Develop program to diversify community livelihoods strategies to earn income from other activities such as ecotourism and other non-farming activities.							
		Incentivize small scale farmers to practice sustainable and conservative agriculture							
		Incorporate sustainable land use management and planning into other sectors plans.							
15	Manage Loss of Priority Wetlands and River ecosystems	Research and improve understanding of land use change in the municipality.							
		Strengthen institutional capacity to deal with pressure on land use change							
		Adopt a local wetland protection by law that require vegetated buffers around all wetlands							
		Control invasive wetland plants							
		Encourage infrastructure and planning designs that minimize the number of wetland crossings							

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
		Establish volunteer wetland monitoring and adoption programs							
		Identify priority wetlands and River ecosystems to be conserved							
		Restrict discharges of untreated wastewater and stormwater into natural wetlands							

7.3 Coastal and Marine

7.3.1 Introduction

Program Name
Coastal and Marine Sector Adaptation to Climate Change
Overview of Key Issues
<p>Climate change will affect the Coastal and Marine Environment, having various impacts on productivity and diversity of South Africa's coastal, marine and estuarine ecosystems. A changing climate is likely to result in changes in species availability and distribution impacting largely on fisheries. This could result in significant adverse impacts on subsistence fishing markets, community livelihoods as well as commercial industries. Changes in sea surface temperature, rising sea levels and increasing storm frequency will have adverse effects on coastal communities and infrastructure.</p> <p>To develop appropriate adaptation responses a more nuanced understanding of the challenges and options for the Coastal and Marine Sector is required, building on the insights of the existing coastal and marine plans. This understanding needs to consider the importance of associated ecological infrastructure in sustaining local economies and livelihoods as well and building resilient communities.</p> <p>In the Western Cape the current priority areas have been identified in the WCCCRS for the coastal sector</p> <ol style="list-style-type: none"> 5. Establishment of coastal risk overlays and coastal management lines; 6. Research best practice regarding responding to repeated coastal inundation in high risk areas; 7. Protecting and rehabilitating existing dune fields as coastal buffers /ecological infrastructure; 8. Monitor possible linkages between climate change and fisheries industry; and 9. Ensure Estuary Management Plans take cognisance of climate change <p>Furthermore, the following opportunities, gaps and recommendations have been identified in the Western Cape Climate Change Response Strategy Biennial Monitoring & Evaluation Report 2015/16 (Birch et al., n.d.) for the coastal sector:</p> <ol style="list-style-type: none"> 1. Case studies and cost benefit analyses on optimal approaches to coastal protection should be developed for the Western Cape. 2. Fact-based climate change targets for this focus area need to be set out. 3. A better understanding of the fisheries sector and the impact of climate change on the sector in the Western Cape is required. 4. Monitoring standards need to be implemented for estuaries, possibly through the incorporation of a monitoring and evaluation component in all EMPs.

Objectives	
	The following objectives have been identified through the LGCCSP as priority areas for the Coastal and Marine sector in the District Municipality.
19	Manage loss of land due to sea level rise
20	Manage increased damage to property from sea level rise

7.3.2 Responses

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
19	Manage loss of land due to sea level rise	Revise the Spatial Development Framework to consider areas vulnerable to climate change impacts.							
20	Manage increased damage to property from sea level rise	Protect biophysical barriers to coastal storm surges such as rehabilitation of dune systems and the establishment of coastal management zones that will restrict development within at risk areas							
		Incorporate climate-related disaster information into current property valuations and insurance schemes							
		Protection of three primary dune systems in Garden Route District: Stilbaai, Wilderness and Sedgfield. To be implemented by local authority to restore the dune system by June 2020.							

7.4 Disaster Management, Infrastructure and Human Settlements

7.4.1 Introduction

	Program Name
	Human Settlements, Infrastructure and Disaster Management Sector Adaptation to Climate Change
	Overview of Key Issues
	<p>South Africa is a diverse country, not just in terms of populations and biodiversity, but also in terms of its human settlements. These settlements face severe challenges, even before climate change is taken into account. The implications of the compounding impacts of climate change will be profound, and human settlements therefore represent a crucial part of national adaptation strategies. The overarching strategic framework for the development of human settlements is described in the National Development Plan (NDP) and, more specifically in relation to the implications for climate change, in the National Climate Change Response White Paper (NCCRWP).</p> <p>However, to develop appropriate adaptation responses a more nuanced understanding of the challenges and options for human settlements is required, building on the insights of the NCCRWP. This understanding needs to take into account the unusually diverse urban forms of human settlement in the South African context, and the importance of ecological infrastructure in supporting service delivery and building resilient communities.</p> <p>In the Western Cape the current priority areas have been identified in the WCCCRS for the human settlements sector</p> <ol style="list-style-type: none"> 1. Mainstreaming climate change into human settlement developments; 2. Implementation of energy efficiency interventions in low income houses and communities; and 3. Improving the resilience and adaptive capacity of informal settlements. <p>Furthermore, the following recommendation has been identified in the Western Cape Climate Change Response Strategy Biennial Monitoring & Evaluation Report 2015/16 (Birch et al., n.d.) for the human settlements sector for the province: Clearer understanding of what resilience means for humans settlements.</p>
	Objectives
	<p>The following objectives have been identified through the LGCCSP as priority areas for the Disaster Management, Infrastructure and Human Settlements sector in the District Municipality.</p> <p>30 Manage increased impacts on traditional and informal dwellings</p> <p>32 Manage potential increase migration to urban and peri-urban areas.</p>

33	Manage potential increased risk of wildfires
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7.4.2 Responses

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
30	Manage increased impacts on traditional and informal dwellings	Commission a reliable early warning system (linked to radio stations, community leaders and social media) to alert communities and industries on the possible occurrences of storm events.							
		Conduct a climate change risk assessment on informal dwellings.							
		Conduct regular assessments of informal dwellings in order to identify priority areas for interventions to reduce climate change risk.							
		Implement informal settlement upgrades.							
		Update community emergency plans that will assist with responding to climate change related impacts/risks.							
32	Manage potential increase migration to urban and peri-urban areas.	Conduct public awareness on campaigns to save water by Disaster Management sector in collaboration with District Communications Department.							
33	Manage potential increased risk of wildfires	Develop Integrated Veldfire management Plan for the Garden Route District, to be done by the Fire Directorate for June 2018.							

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
		Strengthening of existing initiatives such as Working on Fire and the GEF climate change and fire project							
		Fuel load management master plan to be completed by January 2018 by the GRRRI Load Reduction Workgroup.							
		Buy-in from private landowners and farmers through the construction of firebreaks.							
		Improvement of fire safety through urban fringe management							
		Fireproof alternative building/construction materials							

7.5 Water

7.5.1 Introduction

Program Name
Water Sector Adaptation to Climate Change
Overview of Key Issues
<p>South Africa's climate is generally arid to semi-arid, with less than 9% of annual rainfall ending up in rivers, and only about 5% recharges groundwater in aquifers. In addition, rainfall and river flow are unpredictable in time and unevenly distributed in space, with only 12% of the land area generating 50% of stream flows. Decadal rainfall variability also results in extended dry and wet periods across the country. The main users of surface water resources are agricultural irrigation, domestic, industrial, mining and power generation, while plantation forestry intercepts and reduces runoff before it reaches the rivers and groundwater.</p> <p>Surface water resources were already over-allocated by the year 2000 in five of nineteen water management areas historically used for water planning and management purposes. The potential demand for water is expected to increase with economic growth, increased urbanisation, higher standards of living, and population growth. Because of the critical importance of water in the South African economy the country has a sophisticated water resources planning capacity, founded on a good understanding of the country's variable rainfall. This planning capacity will be a key capability for adaptation planning under ongoing and future climate change.</p> <p>In the Western Cape the current priority areas have been identified in the WCCCRS for the water sector</p> <ol style="list-style-type: none"> 1. Invasive alien vegetation clearing; 2. Prioritisation, valuation, mapping, protection, and restoration of ecological infrastructure in catchments; 3. Effective utilisation of irrigation water; 4. Resource nexus decision support; and 5. Develop ecosystem goods and services (EGS) investment opportunities. <p>Furthermore, the following recommendation has been identified in the Western Cape Climate Change Response Strategy Biennial Monitoring & Evaluation Report 2015/16 (Birch et al., n.d.) for the water sector for the province:</p> <ol style="list-style-type: none"> 1. Review the Specifications of the Regional Bulk Infrastructure Grant (RBIG), Municipal Infrastructure Grant (MIG), Accelerated Community Infrastructure Programmes (ACIP) and other similar funds and allocations to determine their climate responsive state (and link to any other ongoing such initiatives). 2. Protection of Strategic Water Source Areas (SWSAs) should be a strategic climate protection priority for the Western Cape. 3. Ground water monitoring needs to become a growing priority in the Western Cape.

5. Further cooperation between IAP clearing authorities and rehabilitation programmes for wetlands and rivers will be beneficial in a changing climate.
6. Continued focus on the way in which we manage our water systems, and increased emphasis on Water Sensitive Urban Design.

Objectives

The following objective has been identified through the LGCCSP as a priority area for the Water sector in the District Municipality.

36 Manage decreased water quality in ecosystem.

7.5.2 Responses

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
36	Manage decreased water quality in ecosystem.	Adopt and enforce simple, innovative, adaptive engineering approaches wastewater treatment initiatives that will ease the burden on natural water dilution as water quantities decline.							
		Conduct a climate change impact assessment on health risks to aquatic systems.							
		Create an awareness on the reuse of wastewater thus minimising negative impacts of wastewater on aquatic systems.							
		Identify and implement wastewater monitoring initiatives that will indicate risks to aquatic systems.							
		Protect and rehabilitate aquatic systems so that they can provide flow attenuation and ecosystem goods and services that are required to buffer increased pollution.							
		Research and improve understanding of climate change impacts on water quality and availability.							

No	Objective	Project	DAO	Activity Manager	Annual Target	Q1 Target	Q2 Target	Q3 Target	Q4 Target
		Strengthen wastewater treatment management plans, to enable the ability to respond to the declining water reserves.							

8 Climate Change Adaptation Objectives and Projects

Based on the key indicators identified, the following objectives, current projects and future possible projects are prioritised as a response to each of the indicators.

8.1 Agriculture

The Garden Route District Municipality's agricultural sector will be adversely affected by climate change. Increased temperatures, drought, and the increase in frequency and severity of storm events will impact on the crops that can be grown and potentially result in a loss of livestock.

The following key agricultural objectives and projects were identified:

Objective	Current Projects	Future Possible Projects
Manage increasing risks to livestock		Commission research and improve understanding of climate change impacts livestock and land availability.
		Develop a framework that will assist and educate farmers with adjusting to reduced rainfall.
		Generate and share scientific, social and indigenous knowledge that will assist with adapting to the reduction in herbage yields.
		Improve collaboration and partnership on existing programs (e.g. LandCare Programme, EPWP and River Health Programmes).
		Strengthen management plans, to enable continuous monitoring of water and herbage availability for livestock.

Objective	Current Projects	Future Possible Projects
	Review of Garden Route Climate Change Strategy (DEA & DEA&DP)	
Crops that can be grown		Investigate sustainability of dairy industry, as a high-water demand industry, in the District.
		Develop a map indicating the best areas to produce high water demand crops as well as areas where alternative crops should be considered.

8.2 Biodiversity and Environment

Climate change predictions include the shifting of biomes across South Africa. In the Garden Route District Municipality, it is projected that, under a high risk climate scenario, that the area currently covered by the Fynbos Biome will be substantially reduced by the Albany Thicket, Nama-Karoo, Succulent Karoo and Desert Biomes. Terrestrial, wetland, and river ecosystems and their associated species will be negatively impacted. Furthermore, development and changes in land use will impact negatively on the environment in the District.

The following key biodiversity objectives and projects were identified:

Objective	Current Projects	Future Possible Projects
Manage Increased impacts on threatened ecosystems		Increase investment in ecological infrastructure that translates into financial revenue for the district such as ecosystem services bonds and market options that reduce flood risk within the region

Objective	Current Projects	Future Possible Projects
	Development of Draft Garden Route Alien Vegetation Control Plan	Completion of Invasive Species Control Plans (NEMBA) for all state-owned properties in local municipalities and district municipalities. This is to be done by the environmental management departments, EPWP, Parks and Recreation and Disaster Management
	Roll –out of the invasive alien plant control project on Garden Route DM properties.	Research Programme investigating potential risks associated with loss in fynbos biome through involving local universities (NMMU) stakeholders, SANP, CN, involving scenario planning of loss of species. 0-5 years.
	Maintain cleared areas to prevent re-growth of invasives	
Manage Increased impacts on environment due to land-use change		Develop program to diversify community livelihoods strategies to earn income from other activities such as ecotourism and other non-farming activities.

Objective	Current Projects	Future Possible Projects
		Incentivize small scale farmers to practice sustainable and conservative agriculture
	Garden Route Disaster Risk Assessment data have been included into the revised Garden Route SDF	Incorporate sustainable land use management and planning into other sectors plans.
	Commenting on new environmental authorisation applications to control unsustainable land development	Research and improve understanding of land use change in the municipality.
		Strengthen institutional capacity to deal with pressure on land use change
Manage Loss of Priority Wetlands and River ecosystems		Adopt a local wetland protection by law that require vegetated buffers around all wetlands
		Control invasive wetland plants
		Encourage infrastructure and planning designs that minimize the number of wetland crossings
	Establish volunteer wetland monitoring and adoption programs	Wetland restoration/rehabilitation
	Conduct assessment of existing wetlands and Identify priority wetlands and River ecosystems to be conserved	Restrict discharges of untreated wastewater and storm water into natural wetlands

Objective	Current Projects	Future Possible Projects
	Develop Wetland Strategy and Implementation Plan	Protect ecological infrastructure functioning/ecosystem services
Regulatory Documentation and Legislation	Review of Garden Route Climate Change Strategy (DEA & DEA&DP)	Garden Route Environmental Framework
		Garden Route Biodiversity Report

8.3 Coastal and Marine

In the Garden Route District Municipality, changes in precipitation and freshwater flow, sea-level rise, increased temperatures, and coastal storminess are predicted to negatively impact on coastal, marine and estuarine ecosystems. These ecosystem impacts are likely to result in changes in species availability and distribution impacting largely on fisheries. This could result in significant adverse impacts on subsistence fishing markets and community livelihoods in the District. Rising sea levels and increased coastal storms will pose potential risks to coastal infrastructure and communities in the District.

The following key coastal and marine objectives and projects were identified:

Objective	Current Projects	Future Possible Projects
Manage loss of land due to sea level rise	Comment on Environmental Authorisation Applications to control unsustainable/risk coastal development	Revise the Spatial Development Framework to consider areas vulnerable to climate change impacts.
Manage increased damage to property from sea level rise		Protect biophysical barriers to coastal storm surges such as rehabilitation of dune systems and the establishment of coastal management zones that will restrict development within at-risk areas
	Storm surge early warning guideline developed in collaboration with the South African Weather Service. Emergency Breaching of estuaries guideline currently being developed. Disaster Management Emergency breaching of estuaries protocol developed with relevant role-players i.e. San Parks, Knysna LM and Mossel Bay LM.	Incorporate climate-related disaster information into current property valuations and insurance schemes

Objective	Current Projects	Future Possible Projects
	Develop and map Coastal Management Lines for Garden Route (DEA&DP)	
Coastal Management Regulatory Documentation and Legislation	Review and update of the Garden Route Coastal Management Programme	Gouritz Estuary Usage Zonation By-law
	Estuary management and mouth management plans (DEA & DP)	
	Coastal Access Management/legislation	
	Review of Garden Route Climate Change Strategy (DEA & DEA&DP)	
Collaboration partnerships and adaptation management	Community collaboration and estuary advisory forums	
	Collaborative Coastal and Estuary Management Agreements	

8.4 Disaster Management, Infrastructure and Human Settlements

Climate change impacts will affect Disaster Management, Infrastructure and Human Settlements in several ways in Garden Route District Municipality. Increases in the severity of storm events and increase in flooding will damage infrastructure which may result in a loss of industrial productivity and service delivery disruptions. The impacts of storm events will particularly affect communities located in informal settlements, on flood plains and where there is poor drainage infrastructure. In addition, communities in rural areas that depend on subsistence farming may be unable to grow crops that they have grown in the past due to the changing climate. It is predicted that there will therefore be an increase in rates of rural-urban migration. Rural communities may also become more physically isolated due to extreme events impacting on key infrastructure.

The following key human settlement objectives and projects were identified:

Objective	Current Projects	Future Possible Projects
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Objective	Current Projects	Future Possible Projects
Manage increased impacts on traditional and informal dwellings	Dissemination of severe weather early warnings included as part of the SYSMAN disaster management information management system. Final costing has been requested from the service provider.	Commission a reliable early warning system (linked to radio stations, community leaders and social media) to alert communities and industries on the possible occurrences of storm events.
		Conduct a climate change risk assessment on informal dwellings.
	After floods over the last 5 years the placement of informal dwellings received special attention. Lessons learned were incorporated into new housing projects. A district flood hazard master plan has been developed and included as part of the District SDF.	Conduct regular assessments of informal dwellings in order to identify priority areas for interventions to reduce climate change risk.
		Implement informal settlement upgrades.
	The Kleinbrak as well as Grootbrak flood evacuation plans have been updated. The updating of the Sedgefield flood evacuation plan is currently receiving attention.	Update community emergency plans that will assist with responding to climate change related impacts/risks.
Manage potential increase migration to urban and peri-urban areas.	Conduct public awareness on campaigns to save water by Disaster Management sector in collaboration with District Communications Department.	
Manage potential increased risk of wildfires	Develop Integrated Veldfire management Plan for the Garden Route District, to be done by the Fire Directorate for June 2018.	

Objective	Current Projects	Future Possible Projects
		Strengthening of existing initiatives such as Working on Fire and the GEF climate change and fire project
	Fuel load management master plan to be completed by January 2018 by the GRRRI Load Reduction Workgroup.	
		Buy-in from private landowners and farmers through the construction of firebreaks.
		Improvement of fire safety through urban fringe management
		Fireproof alternative building/construction materials
	Review of Garden Route Climate Change Strategy (DEA & DEA&DP)	

8.5 Water

Water resources are the primary medium through which climate change impacts will be felt by South Africans (Schulze et al., 2014). Climate change will affect Garden Route District Municipality's water accessibility, quantity, and quality (Parikh, J 2007). Drought, reduced runoff, increased evaporation, and an increase in flood events will impact on both water quality and quantity.

The following key water objectives and projects were identified:

Objective	Current Projects	Future Possible Projects
Manage decreased water quality in ecosystem.		Adopt and enforce simple, innovative, adaptive engineering approaches wastewater treatment initiatives that will ease the burden on natural water dilution as water quantities decline.

Objective	Current Projects	Future Possible Projects
		Protect and rehabilitate aquatic systems so that they can provide flow attenuation and ecosystem goods and services that are required to buffer increased pollution.
Develop Regulatory Documentation and Legislation	Review of Garden Route Climate Change Strategy (DEA & DEA&DP).	Conduct a climate change impact assessment on health risks to aquatic systems.
Water Research		Research and improve understanding of climate change impacts on water quality and availability.
		Identify and implement wastewater monitoring initiatives that will indicate risks to aquatic systems.
		Investigate international best-practice as well as new technology, innovation and methodologies.
		Strengthen wastewater treatment management plans, to enable the ability to respond to the declining water reserves.
Increasing Water Challenges Awareness and Perceptions	Water services perception surveys.	Create awareness on the reuse of wastewater thus minimising negative impacts of wastewater on aquatic systems.
	Water Demand Management/Water Conservation Initiatives to conserve water usage/ensure water use efficiency.	Alternative water resources – new non-potable treated wastewater pipeline for non-potable household use.

Objective	Current Projects	Future Possible Projects
Water Resource Management Collaboration and Partnerships	Water Resource Management Collaboration Initiatives and Partnerships – Breede-Gouritz Catchment Management Agency, City of Cape Town and some local Category B-Municipalities.	Integrated water resource management and adaptation initiatives.
	Implement Garden Route Water Forum.	
	Seawater desalination plants.	

8.6 Air Quality

The linkage between Air Quality and Climate change is well documented. Controlling the Air Quality Environment is directly correlated to Climate Change mitigation. The District Air Quality sections therefore play an important role in climate change mitigation. The following objectives are set in the Air Quality Management Plan and will play a direct and indirect role in Climate change mitigation.

Objective	Current Projects	Future Possible Projects
Set Air Quality goals	Set up air quality goals that are linked to climate change mitigation and which talks to all the applicable legislation.	3rd Generation AQMP development
	Emissions Database Maintaining the current Garden Route Air Quality emissions inventory and the NAEIS system. The sources can be grouped into three classes: - Point Sources: Industrial emissions: stacks, fugitive process emissions, etc. - Area Sources: Residential and refuse sources, etc. - Line Sources: motor vehicles, ships, aircraft, trains, etc.	
Set up Air Quality management system	Air Quality Monitoring Network Maintaining and expanding the Garden Route monitoring network. Passive sampling programmes Diesel vehicle emission testing programmes with the B-authorities.	Procuring a full air quality monitoring station for the Garden Route region.

Objective	Current Projects	Future Possible Projects
	Dispersion Modelling Carrying out of regional dispersion modelling studies.	Purchasing a dispersion model software (AERMOD or CALPUF)
Assess and Select Control Measures	Air Quality Information Define a strategy to disseminate ambient air quality data to the general public through various media, e.g. newspapers, EDM's web site, etc. Data reporting requirements of the EDM Council need to be formalised for regular updates of monitoring data. Additional specialised reports will be supplied on demand.	Appointment of staff.
Carry out Risk assessments	Carrying out of Risks assessments taking into consideration: - Dose - Health Effects - Ecological	
Revise Air Quality goals	Based on the air quality information generated from the AQ monitoring stations and the outcome of risk assessments, a decision must be made on the implementation of remedial actions and the source sector on which the remedial actions must be focused. Potential interventions must be identified and ranked in order of perceived effectiveness and cost.	
Linkage to IDP	Should it appear that health and ecological risk assessments reveal an increased risk due to the presence of air pollutants in the atmosphere, or that industrial growth, urbanisation, etc., result in the long-term decrease in air quality, it may become necessary to revise the air quality goals adopted as an initial step to the implementation of the AQMP.	
	Link the Air Quality Climate change interventions and projects with the IDP in order to secure the necessary funding.	

9 References (still being updated)

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Annexure 1: Vulnerability Assessment Methodology

The vulnerability assessment methodology consisted of a combination of desktop research and stakeholder engagement activities. Initially, desktop research was conducted on the climate change status quo for each of the key sectors in the district. This research was used for the basis of the stakeholder engagement activities.

The workshop methodologies were based on the active-based learning theory approach. Action learning is an approach used to train and to encourage stakeholders to solve real life problems. The workshop methodologies ensured there was a focus on knowledge exchange and capacity building at the workshops.

There were three stakeholder engagement occurrences. These were:

- Provincial level workshop, where key stakeholders were introduced to the core concepts of climate change and the LGCCSP program. The exposure component of the vulnerability assessment was also undertaken by various stakeholders at this workshop, including government officials and other key community members. The workshop therefore involved presentations, participatory exercises and associated discussions.
- A District Municipality Level workshop, where the focus was specifically on the identification and review of key climate change vulnerabilities for the area. A more detailed vulnerability assessment was undertaken by the participants. The process included the identification of context specific climate change indicators, assessing exposure, sensitivity and adaptive capacity. Participants also developed priority climate change responses.
- A final Provincial Level workshop, where key stakeholders were invited to present their municipal climate change plans.

These workshops aimed to provide the necessary tools, build capacity and provide support to stakeholders to develop and review existing Climate Change Vulnerability Assessments and response plans.

What is a Vulnerability Assessment?

According to the Intergovernmental Panel on Climate Change (IPCC) (Parry et al. 2007) "vulnerability to climate change is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change". A vulnerability assessment therefore is a multifaceted assessment of an area's vulnerability to climate change. Nelitz et al. further define a climate change vulnerability assessment as "a process for assessing, measuring, and/or characterizing the exposure, sensitivity, and adaptive capacity of a natural or human system to disturbance" (Nelitz, M, Boardley, S, and Smith, R 2013). The methodology used in assessing climate change vulnerability for the Garden Route District used the three assessment criteria, namely: exposure, sensitivity and adaptive capacity.

- **Exposure** refers to the magnitude and extent, to which a municipal area is exposed to climate change impacts (Amos, E, Akpan, U, and Ogunjobi, K 2015) and is a function of one's location and environment.
- **Sensitivity** on the other hand refers to the extent to which a municipal area is affected by the climate change impacts

- The [IPCC](#) (Parry et al. 2007) formally defines **adaptive capacity** as: "The ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences".

Exposure and sensitivity increases one's vulnerability to climate change, while adaptive capacity decreases vulnerability. The above-mentioned components allow for more detailed characterizations of climate change vulnerability.

Steps involved in a Vulnerability Assessment

Four steps were followed when conducting a vulnerability assessment, they are:

- Step 1: Identify indicators of potential impacts.
- Step 2: Assess whether the impact will take place (exposure).
- Step 3: Assess how important the risk is (sensitivity).
- Step 4: Assess if you can respond to the risk (adaptive capacity).

Figure 22 below illustrates how the components of a Climate Change Vulnerability Assessment link to each other.

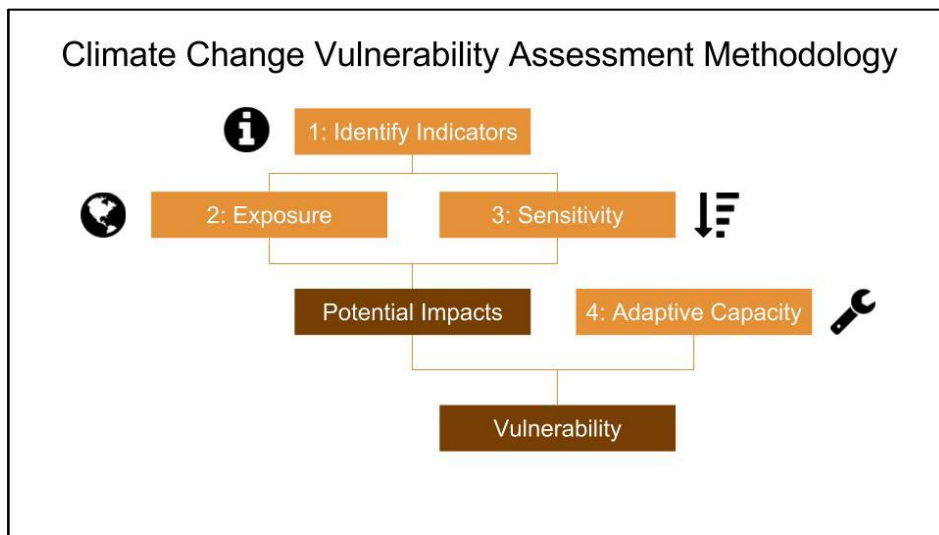


Figure 22: Vulnerability Assessment Methodology

Step 1: Develop Climate Change Indicators

As mentioned above, the first step in a Climate Change Vulnerability Assessment is the identification of context specific indicators. Essentially, indicators are potential climate change induced impacts in a specific area. The LGCCSP Vulnerability Assessment Toolkit developed a draft of several indicators using the [Long Term Adaptation Scenario Reports](#) (Department of Environmental Affairs 2013b). The indicators are grouped into six sectors (agriculture; biodiversity and environment; coastal and marine; human health; disaster management, infrastructure and human settlements; and water).

Step 2: Assessing Exposure

The assessment of exposure followed the identification of indicators. Exposure assessment aimed to ascertain whether the identified indicators are relevant in the District Municipality. If the District Municipality was exposed to a particular indicator, stakeholders scored that indicator a 'yes'.

Step 3: Assessing Sensitivity

The third step of the Climate Change Vulnerability Assessment 'asks' the question, "if you are exposed, how important is the potential impact?" This is termed "sensitivity" and is assessed using a graded scale (High, Medium, Low). If an indicator scored a "yes" in the exposure assessment, the sensitivity of the Municipality to that indicator was then analysed using the graded scale.

Step 4: Assessing Adaptive Capacity

Once exposure and sensitivity were determined, the next step was the assessment of adaptive capacity. The question directed at stakeholders during the workshop was "If there are going to be significant impacts due to climate change, do you have the necessary systems (policy, resources, social capital) in place to respond to the change?"

The indicators that scored "yes" for the exposure questions and "high" or "medium" for the sensitivity questions, were then assessed in terms of adaptive capacity. For the purpose of the LGCCS Vulnerability Assessment Toolkit, the guiding question was "Do you have high, medium or low adaptive capacity (policy, institutional, social and finance) to respond to the change?" The adaptive capacity answers were scored using a graded scale (high, medium or low).

Those that scored a "low" or "medium" were recorded as indicators with potential adaptive capacity constraints in Garden Route District Municipality.

Step 5: Develop Response Plans for Priority Indicators

Upon completion of the exposure, sensitivity and adaptive capacity assessments, priority indicators were identified using the criteria below:

- Exposure - Yes
- Sensitivity - High
- Adaptive Capacity - Low

Priority indicators are perceived to be the ones the district is most vulnerable to. A response plan was then developed to address climate change vulnerabilities and inform resource allocation for climate change adaptation. To facilitate the development of a response plan, stakeholders were given a LGCCS generic response plan template for each sector, which was used as a starting point to develop sector specific response plans for Garden Route District Municipality.

Desired Adaptation Outcomes

The Department of Environmental Affairs (DEA) has developed (ongoing process) a set of Desired Adaptation Outcomes (DAOs). The DAOs provide evidence of climate change impacts and of responses to climate change in South Africa. DAOs identify desired states that, individually and in combination, will contribute to climate resilience in the short to medium-term (i.e. over the next five to 20 years). They aim to provide clear insights into climate change adaptation in South Africa and help capture the country's unique circumstances to aid reporting on adaptation at national and international levels. They also provide a means of assessing the capacity of 'at risk' sectors and their stakeholders to adapt to climate change and whether the measures being taken are appropriate, efficient and effective.

The current set of DAOs are provided below:

- G1 - Robust/integrated plans, policies and actions for effective delivery of climate change adaptation, together with monitoring, evaluation and review over the short, medium and longer-term.
- G2 - Appropriate resources (including current and past financial investments), capacity and processes (human, legal and regulatory) and support mechanisms (institutional and governance structures) to facilitate climate change adaptation.
- G3 - Accurate climate information (e.g. historical trend data, seasonal predictions, future projections, and early warning of extreme weather and other climate-related events) provided by existing and new monitoring and forecasting facilities/networks (including their maintenance and enhancement) to inform adaptation planning and disaster risk reduction.
- G4 - Capacity development, education and awareness programmes (formal and informal) for climate change adaptation (e.g. informed by adaptation research and with tools to utilise data/outputs).
- G5 - New and adapted technologies/knowledge and other cost-effective measures (e.g. nature-based solutions) used in climate change adaptation.
- G6 - Climate change risks, impacts and vulnerabilities identified and addressed.
- G7 - Systems, infrastructure, communities and sectors less vulnerable to climate change impacts (e.g. through effectiveness of adaptation interventions/response measures).
- G8 - Non-climate pressures and threats to human and natural systems reduced (particularly where these compound climate change impacts).
- G9 - Secure food, water and energy supplies for all citizens (within the context of sustainable development).

The activities in the Sector Response Plans have a column to allocate to the DAOs. This will assist the DEA to monitor and evaluate the implementation of climate change adaptation throughout the country.

Annexure 2: Key Garden Route District Indicators

The table below provides a summary of the key indicators for the District. The table lists the national indicators for comparison purposes. Many of these indicators are used in the climate change vulnerability assessment process below.

Table 16: Key District Municipal Indicators for the Garden Route DM compared to the National Average

General Information	Garden Route District Municipality	South Africa
Code	DC04	
Province	Western Cape	
Seat	George	
Area (km ²)	23331	1219740
Census Statistics		
Criteria	Garden Route District Municipality	South Africa
Population	574266	51770553
Age Structure		
Population under 15	25.85%	29.17%
Population 15 to 39	39.97%	44.30%
Population 40 to 64	26.36%	21.19%
Population over 65	7.81%	5.34%
Dependency Ratio		
People in age group 0-14 & 65+, supported by age group 15-64	50.7%	52.7%
Employment (between 15 and 64)		
Employed	45.95%	38.87%
Not economically active	36.71%	39.21%
Unemployed	13.33%	16.50%
Discouraged work-seeker	4.00%	5.41%
Education (aged 20 +)		
Post School Qualification	9.00%	9.94%
Grade 12/Matric	27.18%	27.83%
High School	33.71%	32.16%
Less than High School	20.81%	16.43%
Other	9.29%	13.64%
Vulnerability Indicators		
Criteria	Garden Route District Municipality	South Africa

Household Dynamics		
Households	164103	14450151
Average household size	3.50	3.58
Percentage households involved in agricultural activities	9.86%	20.56%
Dwelling Type		
Percentage Households that are Informal Dwelling	14.37%	13.58%
Percentage Households that are Traditional Dwelling	0.67%	7.89%
Combined Percentage Households that are Traditional and Informal Dwelling	15.05%	21.47%
Sources of Water		
Percentage of Population that sources water from Boreholes	2.66%	1.76%
Percentage of Population that do not source water from piped water schemes	12.31%	21.82%
Percentage of Population that source water from Service Providers (e.g. Municipalities)	87.69%	78.18%
Percentage of Population that sources water from Water Tanks	1.29%	2.67%
Electricity Usage		
Percentage of households that use alternatives to electricity for cooking	17.38%	26.12%
Percentage of households that use alternatives to electricity for cooking, heating or lighting	8.34%	17.77%
Sanitation		
Percentage Population with flush toilets	84.31%	56.51%
Percentage Population using pit latrines	6.68%	30.73%
Percentage of Population with no toilet facilities	3.68%	5.34%
Percentage of Population with other toilet facilities	5.34%	7.42%
Refuse		
Percentage of Households with no rubbish disposal	2.29%	5.97%
Percentage of households with refuse removed by local authority/private company	85.70%	59.40%
Health		
Percentage of young (<5yrs) and elderly (>64yrs)	17.10%	16.32%
Percentage workforce employed in the informal Sector	14.31%	12.20%
Vulnerability Tool Indicators		
Criteria	Garden Route District Municipality	South Africa
Percentage households involved in agricultural activities	9.86%	20.56%

Percentage Population with flush toilets	84.31%	56.51%
Percentage of young (<5yrs) and elderly (>64yrs)	17.10%	16.32%
Percentage Households that are Traditional and Informal Dwelling	15.05%	21.47%
Percentage of Households with no rubbish disposal	2.29%	5.97%

Annexure 3: Garden Route District Sector Summaries

Garden Route District Agriculture Sector Summary

The Agriculture sector is an important sector in the Garden Route District Municipal Area (Garden Route District Municipality 2017a, 2017b). It is characterised by irrigated and rainfed pastures and crops as well as intensive livestock farming along the coast (i.e. using relatively high levels of capital, labour and fertiliser compared to land size) and extensive livestock farming further inland (i.e. using relatively low levels of capital, labour and fertiliser compared to land size) (Garden Route District Municipality 2017a, 2017b). Intensive agricultural activities in the coastal areas are attributed to the higher levels of rainfall and soil fertility that occur there (Garden Route District Municipality 2016). Away from the coast, agriculture strongly corresponds to where rivers occur, especially in the drier Oudtshoorn Local Municipal Area (Garden Route District Municipality 2017b). Additionally, some commercial forestry occurs in the District Municipal Area in the areas around Tsitsikamma and George (Garden Route District Municipality 2017b). Furthermore, commercial agriculture and commercial forestry cover much of the land in the District Municipal Area and said to be the main drivers of the loss of biological diversity in the District Municipal Area (Garden Route District Municipality 2016).

The main commercial agricultural activities in the Garden Route District Municipal Area are the production of ostriches and deciduous fruit (Garden Route District Municipality 2016). Other commercial agricultural activities in the District Municipal Area include port (fortified wine), aloe products, vegetable crops, honeybush tea and dairy products (Garden Route District Municipality 2016). Small areas of production with potential to expand their production in the District Municipal Area include aqua farming (fish), honey, flowers, essential oils, livestock and poultry (Garden Route District Municipality 2016). Furthermore, agri-processing plants in the District Municipal Area mostly occur in the area surrounding George and to a lesser degree, the area surrounding Oudtshoorn (Garden Route District Municipality 2017a).

Being so varied and large, the agriculture sector is one of the most important employers in the Garden Route District Municipal Area, however, employment in the agriculture sector is declining (Garden Route District Municipality 2017a, 2017b). Overall, employment in the agriculture, forestry and fisheries sector accounted for approximately 8.9 % of the total number of people employed within the District Municipal Area (Garden Route District Municipality 2017b). However, between 2004 and 2015 the agriculture sector experienced a net decrease in employment of approximately 15.850 jobs (Garden Route District Municipality 2017a).

Furthermore, the South African National Census of 2011 estimated that only 9.86 % of households in the Garden Route District Municipal Area (Figure 2323) are involved in agricultural activities (Statistics South Africa 2011). This is lower than the national average of 20.56 % (Statistics South Africa 2011). The Garden Route District Municipality has however noted that rural households that are highly dependent on agriculture are under pressure from declining natural resources (Western Cape Government 2013). In the map (Figure 23) the darker areas indicate higher percentages of households involved in the agriculture sector (Statistics South Africa 2011).

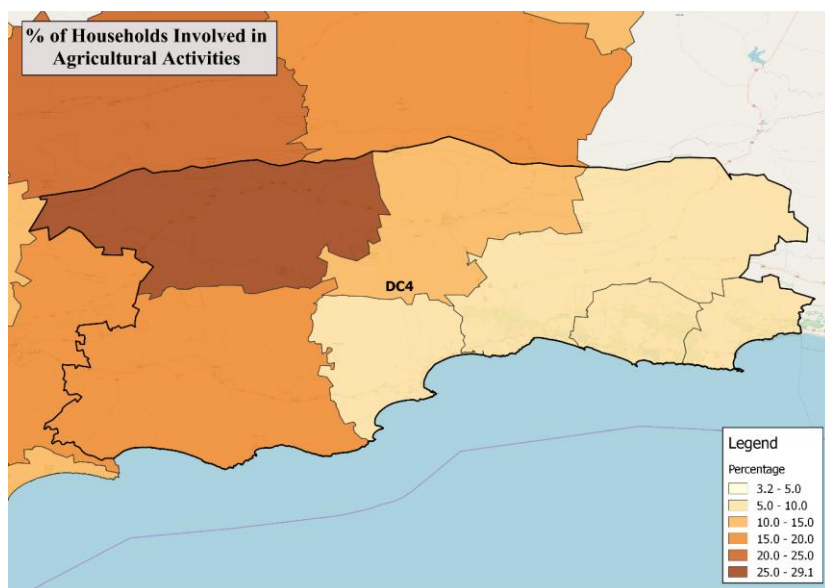


Figure 23: Percentage of households involved in agricultural activities across the District Municipal Area (Statistics South Africa 2011)

Similar to the decrease in employment is the change in the agriculture sector's contribution to the Garden Route District Municipal Area's economy. Overall the agriculture, forestry and fisheries sector only contributed approximately 3.1 % of the Garden Route District Municipal Area's total GDP in 2015 (Garden Route District Municipality 2017a). This makes the agriculture sector amongst the three lowest economic contributors in the District (Garden Route District Municipality 2017a). The GDP refers to the total value of all the goods and services produced in the District Municipal Area (Blignaut and De Wit 2004). Furthermore, the Garden Route District Municipality predicts an average decline in the agriculture, forestry and fisheries sector from 2016 to 2021 of 2.9 % per annum (Garden Route District Municipality 2017a).

To understand this predicted decrease in the agriculture sector, it is worth considering the SmartAgri Zones that fall within the Garden Route District Municipal Area and their predicted future agricultural potential (SmartAgri and African Climate and Development Initiative 2015). There are seven SmartAgri Zones in the District Municipal Area, three of which fall entirely in the District (Figure 24) (Western Cape Department of Agriculture 2017).

The Bo-Langkloof-Outeniqua, Groot Brak-Plettenberg Bay, Mossel Bay-Herbertsdale, Rûens-east and Tankwa-van Wyksdorp SmartAgri Zones are all predicted to become less productive due to water availability and heat issues (SmartAgri and African Climate and Development Initiative 2015). The GrootBrak-Plettenberg Bay and Rûens-east SmartAgri Zones could, however, improve depending on how rainfall patterns shift, while the productivity of the MosselBay-Herbertsdale SmartAgri Zone could improve if additional irrigation capacity becomes available (SmartAgri and African Climate and Development Initiative 2015). Additionally, the future agricultural potential of the Klein-Karoo and Montagu-Barrydale SmartAgri Zones are predicted to maintain moderately high and high agricultural potential respectively so long as there is sufficient water (SmartAgri and African Climate and Development Initiative 2015).

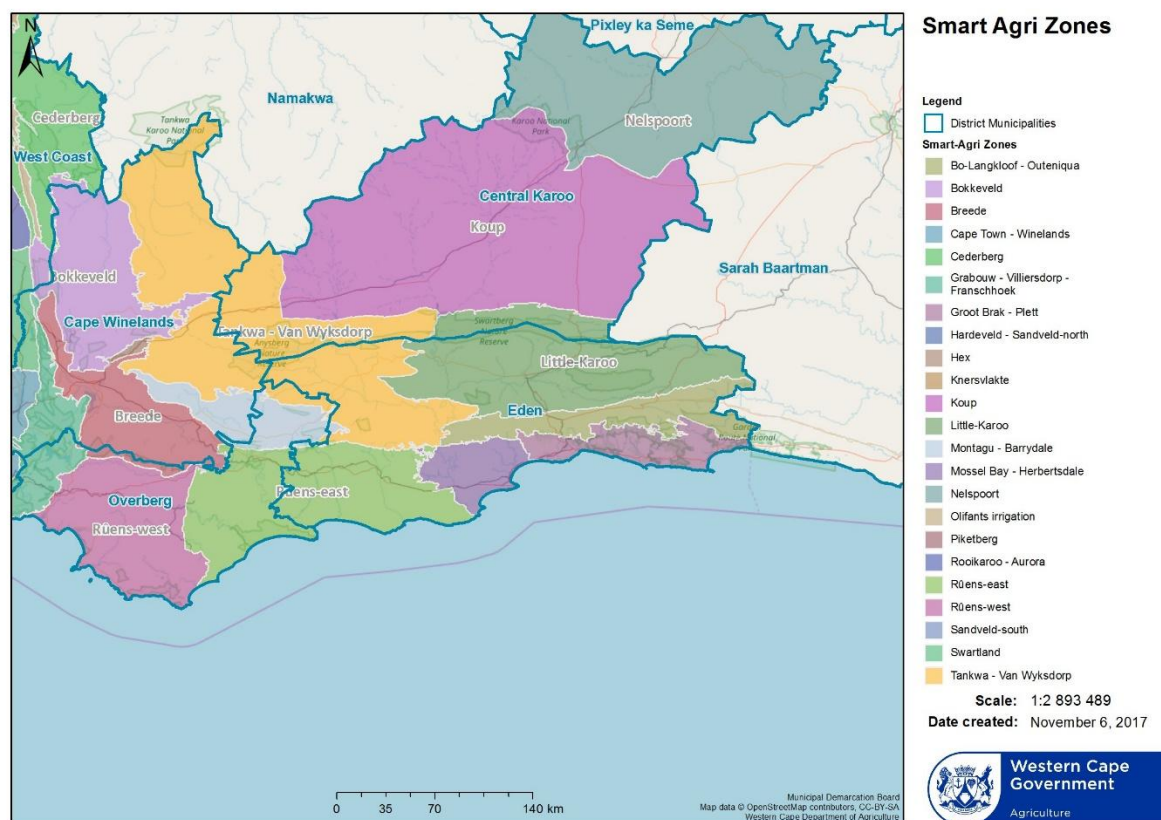


Figure 24: SmartAgri Zones in the District Municipal Area (Western Cape Department of Agriculture 2017)

Regarding grazing capacity, the northern part of the Garden Route District Municipal Area has the highest grazing capacity (i.e. the highest number of hectares required per large stock unit for viable grazing) in the District Municipal Area, while the southeast has the lowest grazing capacity (Figure 2525) (Western Cape Department of Agriculture 2017). Much of the south of the District Municipal Area has been categorised as “Transformed rangeland” and thus has no grazing capacity (Western Cape Department of Agriculture 2017). It should be noted that the data for this map is from 1993 and so the grazing capacities may have changed somewhat in the intervening years.

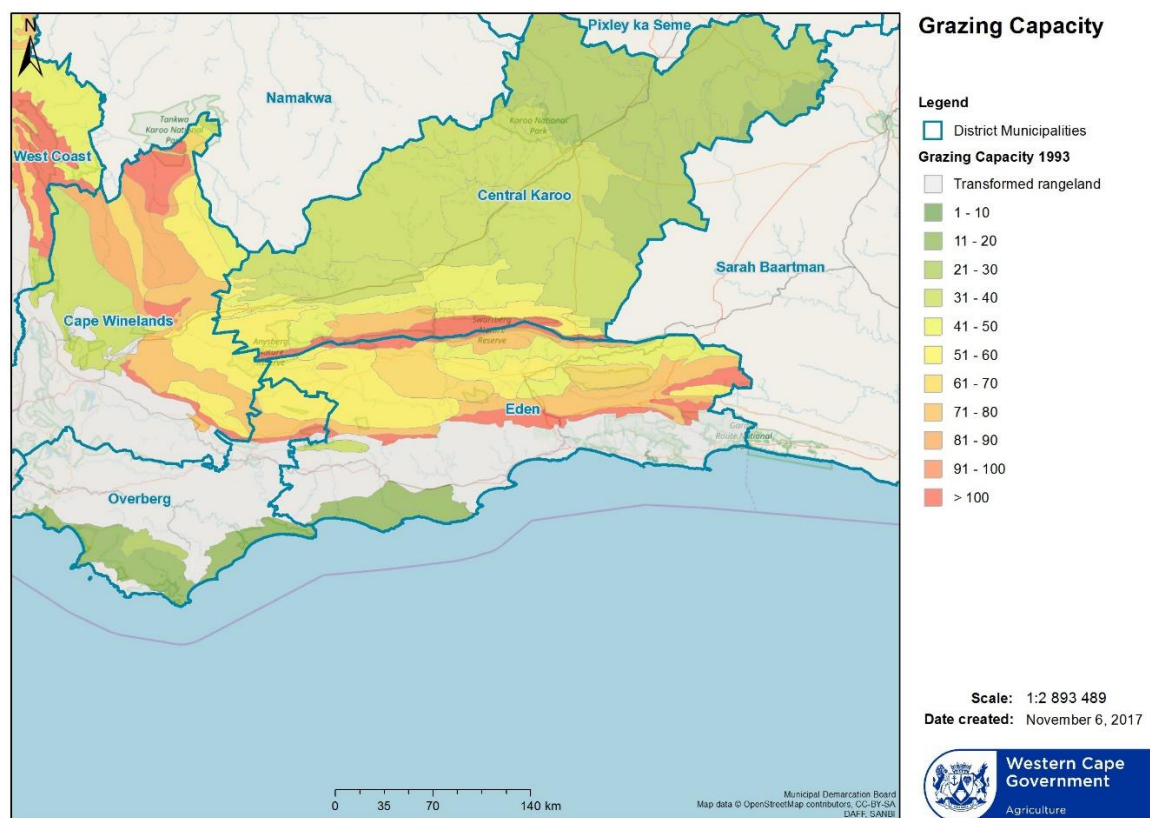


Figure 25: Grazing capacity in the District Municipal Area (Western Cape Department of Agriculture 2017)

Looking at specific livestock density levels (i.e. the number of animals per square kilometre), small stock occurs throughout much of the Garden Route District Municipal Area in a wide range of density levels (Figure 2626) (Western Cape Department of Agriculture 2017). Specifically, the southeast, south and central parts of the District Municipal Area have the highest small stock density levels (Western Cape Department of Agriculture 2017).

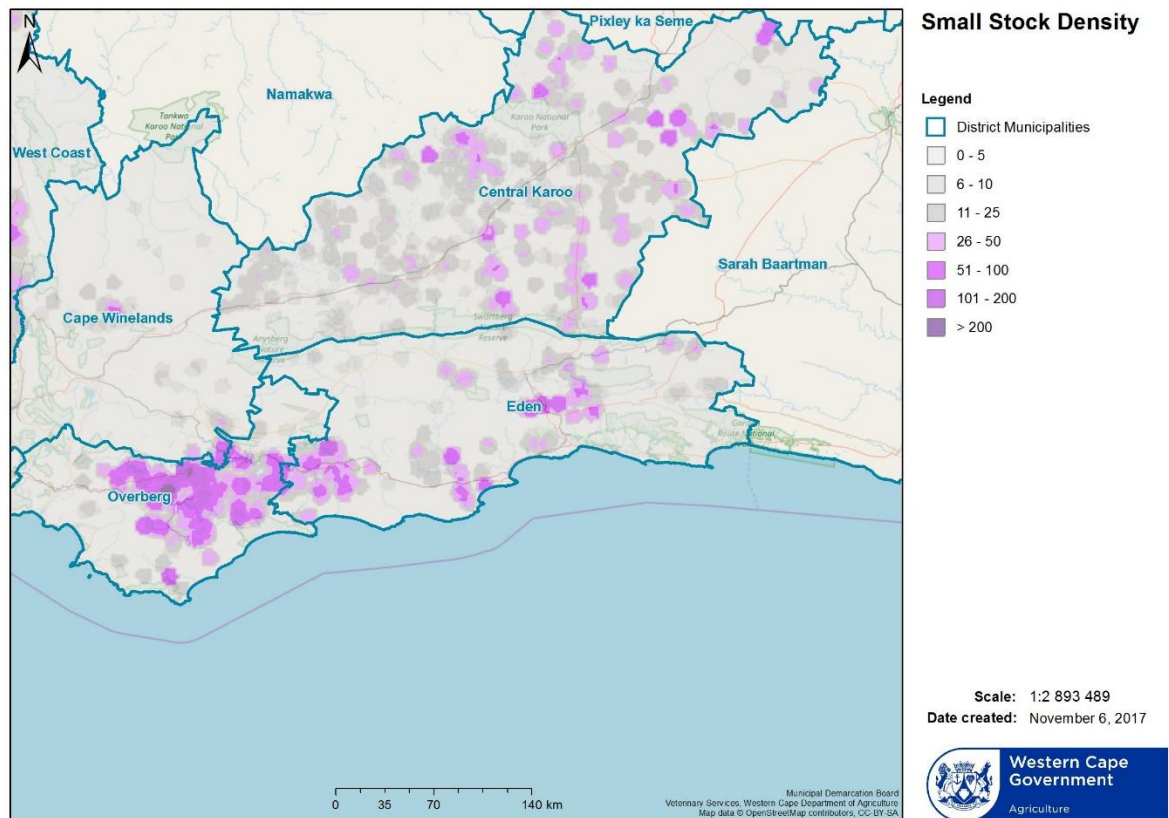


Figure 26: Small stock density levels in the District Municipal Area (Western Cape Department of Agriculture 2017)

Additionally, bovine density levels (Figure 2727) are mostly low in the Garden Route District Municipal Area (Western Cape Department of Agriculture 2017). Specifically, cattle density levels are at their highest in the south and west of the District Municipal Area (Western Cape Department of Agriculture 2017).

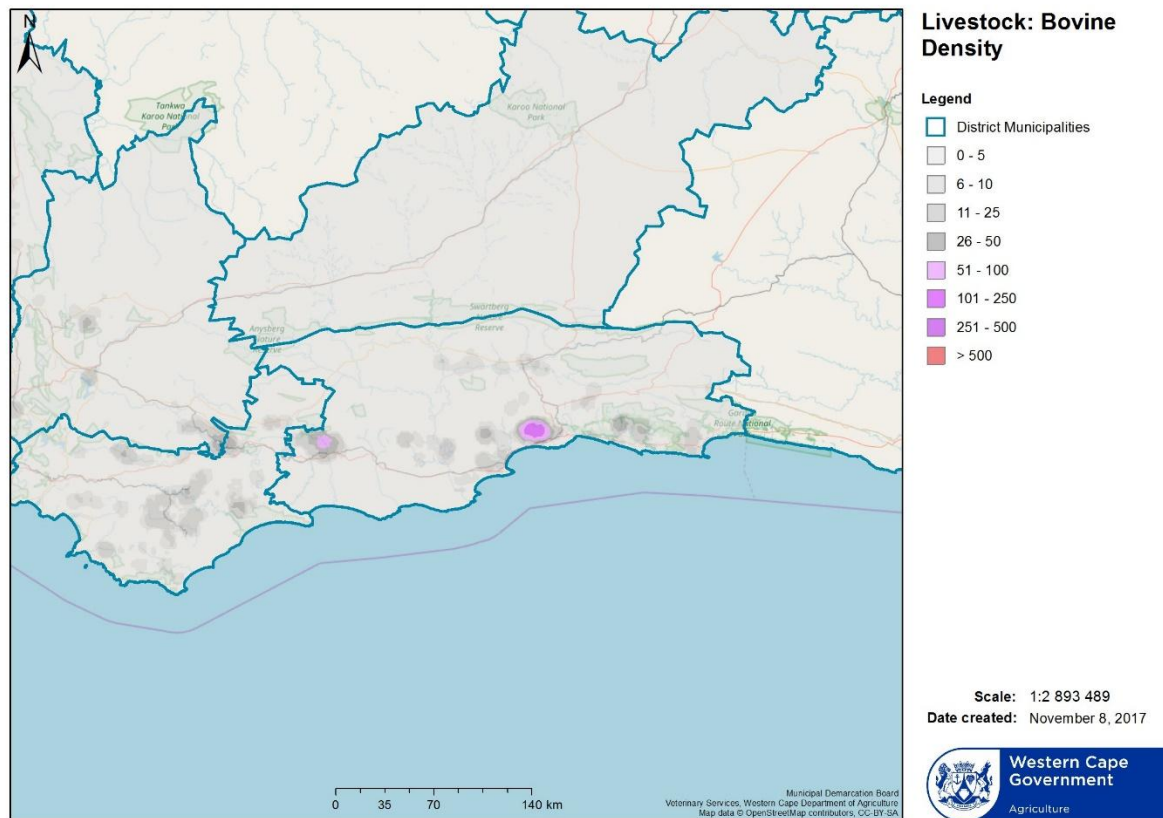


Figure 27: Bovine density levels in the District Municipal Area (Western Cape Department of Agriculture 2017)

Furthermore, ostrich farming (Figure 2828) occurs in central parts of the Garden Route District Municipal Area in relatively low density levels per square kilometre (Western Cape Department of Agriculture 2017). Ostriches also occur in the centre of the District Municipal Area in lower density levels than in the southeast or northwest of the District (Western Cape Department of Agriculture 2017).

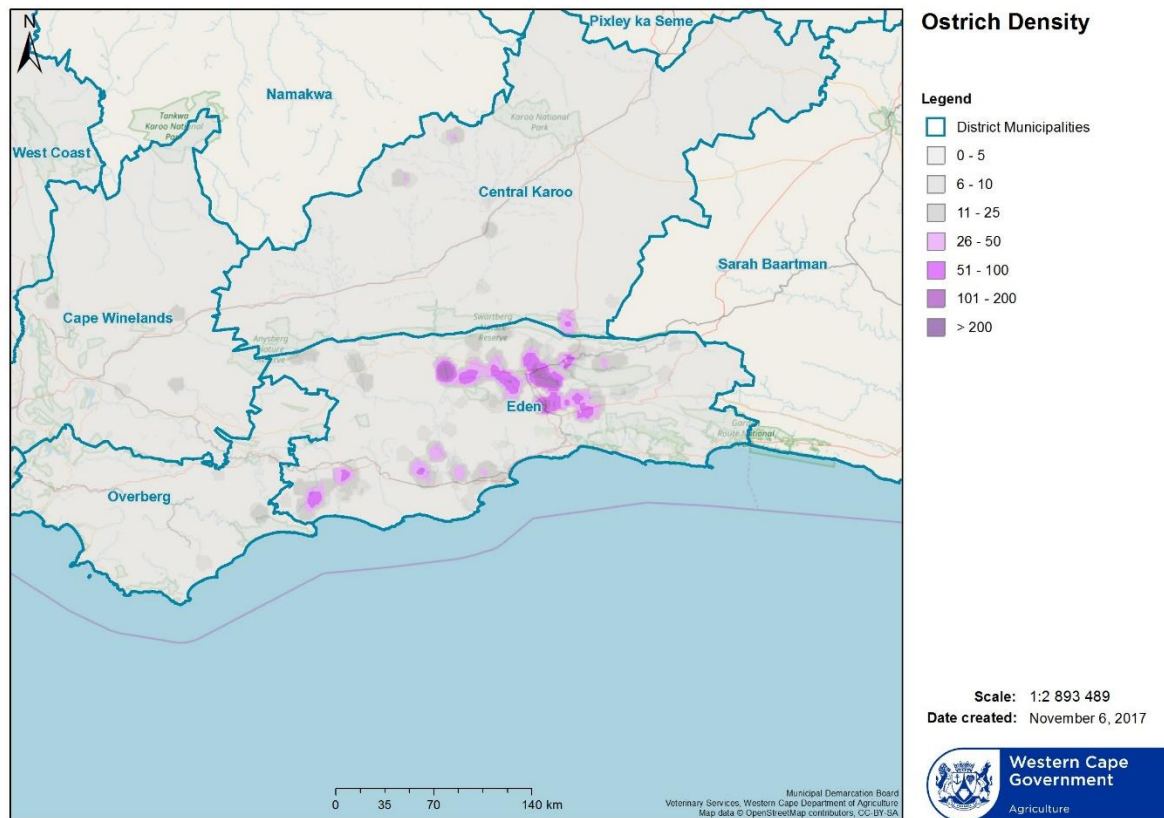


Figure 28: Ostrich density levels in the District Municipal Area (Western Cape Department of Agriculture 2017)

While there are varying grazing capacities in the Garden Route District Municipal Area, the crop census (Figure 2929) shows that there is a lot of crop production in the District Municipal Area (Western Cape Department of Agriculture 2017). Specifically, there a wide band of crops grown near the coast, while further inland crops are mainly grown alongside the bigger rivers in the District (Western Cape Department of Agriculture 2017). The main crops grown in the District Municipal Area are 'planted pastures', 'grains and mixed' and 'oil seeds' (Western Cape Department of Agriculture 2017).

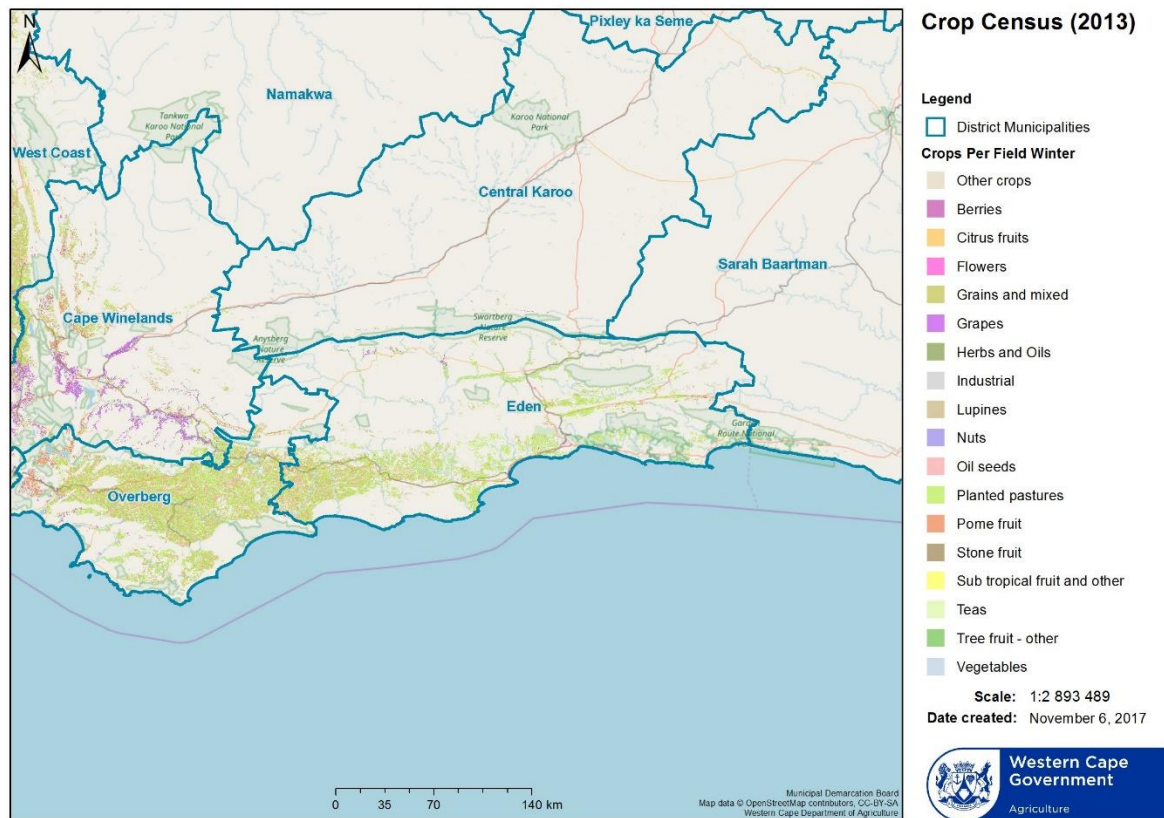


Figure 29: Crop census in the District Municipal Area (Western Cape Department of Agriculture 2017)

There are also three Wine of Origin districts within the Garden Route District Municipal Area (Figure 3030), namely, the Calitzdorp, Langeberg-Garcia and Plettenberg Bayenber Bay districts (Western Cape Department of Agriculture 2017). Wine of Origin districts are more specific than wine regions and they signify that all the grapes came from the same specific area (Western Cape Department of Agriculture 2017).

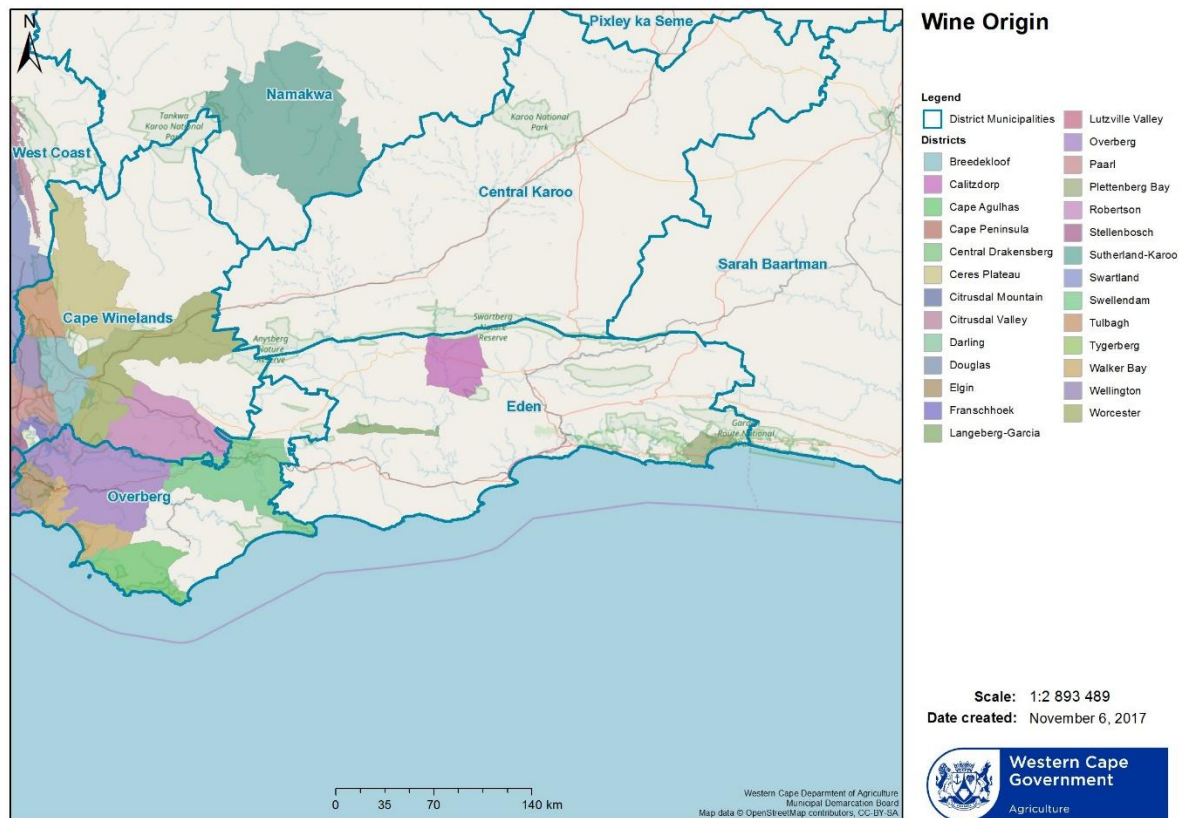


Figure 30: Wine of origin districts in the District Municipal Area (Western Cape Department of Agriculture 2017)

Additionally, some small commercial plantations consisting of *Pinus* species are scattered in the south, east and, to a lesser degree, west of the Garden Route District Municipal Area (Figure 3131) (De Lange 2013). Plantations are predicted to be exposed to greater risks from an increase in the frequency and severity of fires due to climate change related increases in average temperatures (Garden Route District Municipality 2014, 2017b). Fires have already caused the loss of thousands of hectares of plantations in the District Municipal Area as well as subsequent impacts in terms of job losses and a decline in the economic contribution of the agriculture, forestry and fisheries sector (Garden Route District Municipality 2017b).

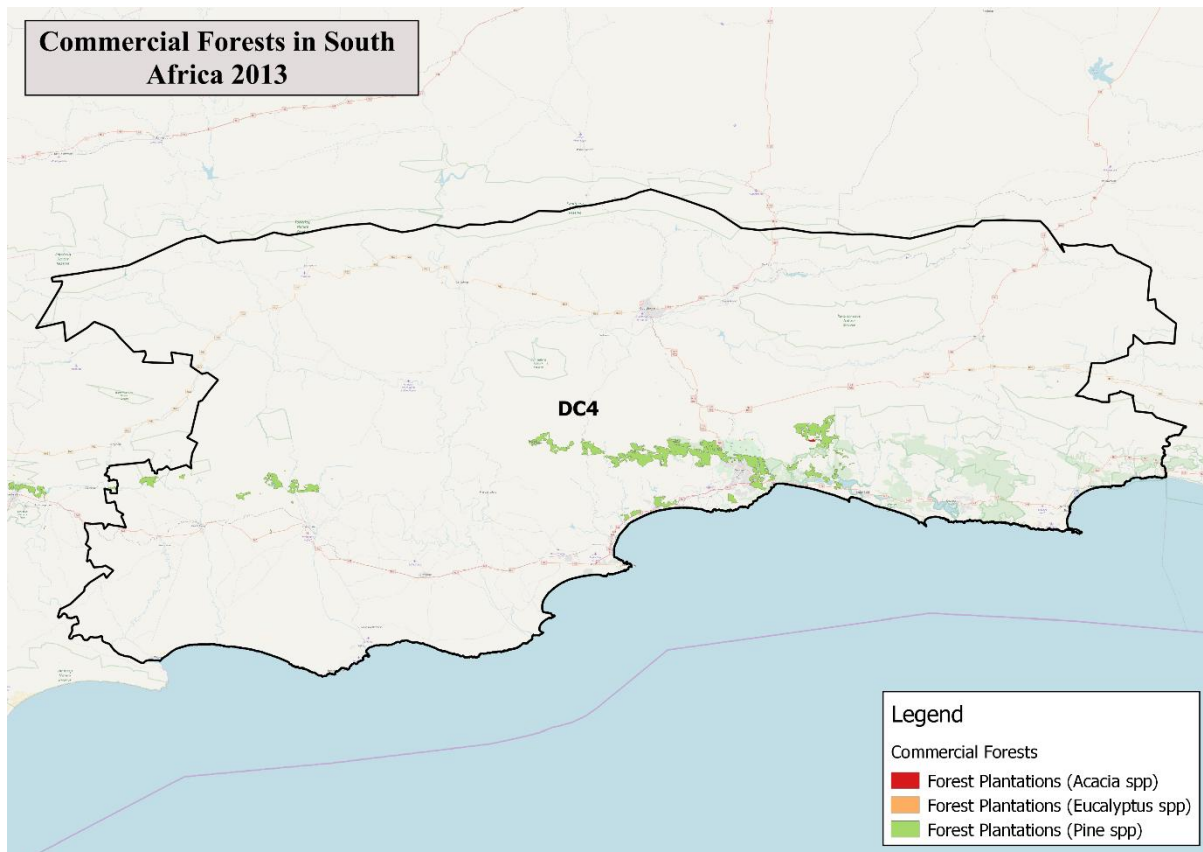


Figure 31: Commercial forestry distribution across the District Municipal Area (De Lange 2013)

Despite the potential for expanding agricultural production in the Garden Route District Municipal Area, it is predicted that climate change will affect the agriculture sector both positively and negatively.

The predicted changes in average rainfall and temperature are forecast to reduce the areas that are suitable for viticulture or shift them to areas that are higher or cooler than current locations (Department of Environmental Affairs 2013c). The reduction in rainfall (and runoff) is forecast to reduce the yields of fruit and vegetables, notably deciduous fruit and rain-fed wheat production in the Western Cape (Department of Environmental Affairs 2013c). Furthermore, the production of fruit (such as apples and pears) and sugar cane will be increasingly vulnerable to damage from a predicted expansion of the areas affected by agricultural pests (Department of Environmental Affairs 2013c).

By decreasing agricultural yields, climate change could also impact the agriculture sector by reducing profitability and job opportunities in the sector as well as increasing food security risks, especially amongst subsistence farmers and their dependents (Department of Environmental Affairs 2013c; Garden Route District Municipality 2014, 2017b). Indeed, the Garden Route District Municipality's 2017/2018 *Integrated Development Plan* has noted that climate change impacts could have dire consequences for the agriculture sector in the District Municipal Area (Garden Route District Municipality 2017a).

Specifically, it is anticipated that climate change will result in higher temperatures, lower rainfall and increased rainfall variability in the Garden Route District Municipality (Garden Route District Municipality 2014, 2017b). Furthermore, impacts such as more frequent and intense droughts, fires and floods are predicted to not only result in agricultural losses but also impact other sectors of the

local economy as well (Garden Route District Municipality 2014, 2017b, 2017a). Nevertheless, the Garden Route District Municipality's 2017/2018 *Integrated Development Plan* has noted that agriculture in the District Municipal Area has high adaptive capacity on a production level (Garden Route District Municipality 2017a).

Garden Route District Biodiversity Sector Summary

While the Garden Route District Municipality is dominated by the Fynbos Biome, there is a substantial amount of the Succulent Karoo Biome in the north of the Garden Route District Municipal Area. The Garden Route District Municipal Area also contains areas of the Albany Thicket and Forest Biomes (Figure 3232). The Fynbos Biome is part of the Cape Floristic Kingdom (one of six recognised floral kingdoms globally). The Fynbos Biome is made up of fynbos and renosterveld, and includes an extremely high number of species (Mucina and Rutherford 2006). The Fynbos Biome is renowned for its high levels of endemism (Mucina and Rutherford 2006). The Succulent Karoo Biome is extremely dry and is characterised by low winter rainfall. The prevailing vegetation in the Succulent Karoo biome is dwarf, succulent shrubs, with large displays of flowers (annuals) in the spring (Mucina and Rutherford 2006). For the size and dryness of the Succulent Karoo Biome, it has a very high number of plant and flower species (Mucina and Rutherford 2006). The Albany Thicket Biome occurs in semi-arid areas with unreliable, all-year rainfall and grows largely in fire-protected valleys (Mucina and Rutherford 2006). It has a high level of plant endemism and a low level of faunal endemism. The vegetation in the Albany Thicket Biome is mostly shrubs and succulents that are dense, thorny and woody, with an average height of two to three metres (Mucina and Rutherford 2006). The Forest Biome is the smallest biome in South Africa, covering approximately 0.1% of the land area (Mucina and Rutherford 2006). The Forest Biome is made up of afrotemperate, subtropical and azonal (Lowveld riverine forest, swamp forest and mangrove forest) forests that are characterised by small, fragmented patches of trees that overlap to form canopies (Mucina and Rutherford 2006).

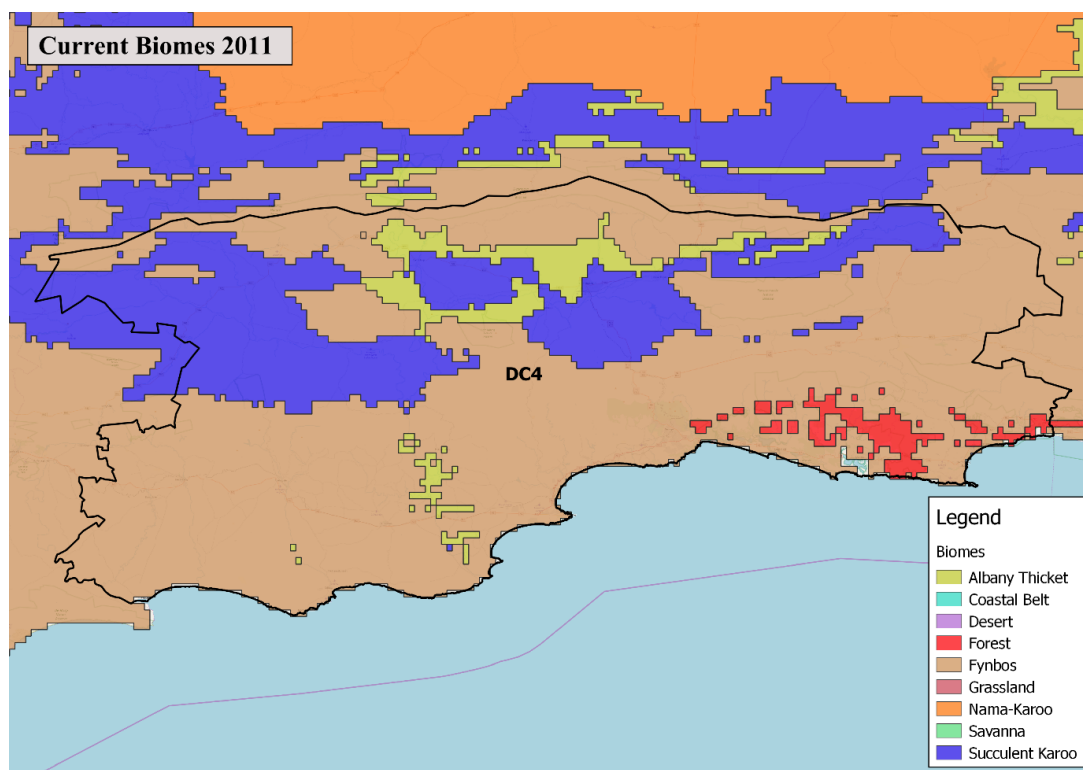


Figure 32: Current biome delineation in the District Municipal Area (South African National Parks 2011a)

Climate change is predicted to shift the biomes in South Africa, resulting in a change to the ecosystems and vegetation found in the Garden Route District Municipal Area. The Long Term Adaptation Scenarios Report on biodiversity highlights the following biomes as the most vulnerable and “in need of strong protection, restoration and/or research” (Department of Environmental Affairs 2013b).

- Highest priority for action: Grassland and Indian Ocean Coastal Belt.
- High priority for action: Fynbos and Forest.
- Medium priority for action: Nama Karoo and Succulent Karoo.

The maps below (Figure 3333 and Figure 3434) show the shift in biomes in the Garden Route District Municipal Area given different climate scenarios modelled by the South African National Biodiversity Institute (SANBI) in 2011. It is forecast that under a medium risk climate scenario, the Albany Thicket Biome will expand substantially at the expense of the Fynbos Biome. Additionally, areas of Nama Karoo, Desert and Indian Ocean Coast Belt Biome will appear. Under a high risk climate scenario, it is forecast that the area currently covered by the Fynbos Biome will be substantially reduced by the Albany Thicket, Nama-Karoo, Succulent Karoo and Desert Biomes. Furthermore, patches of Savanna Biome will appear.

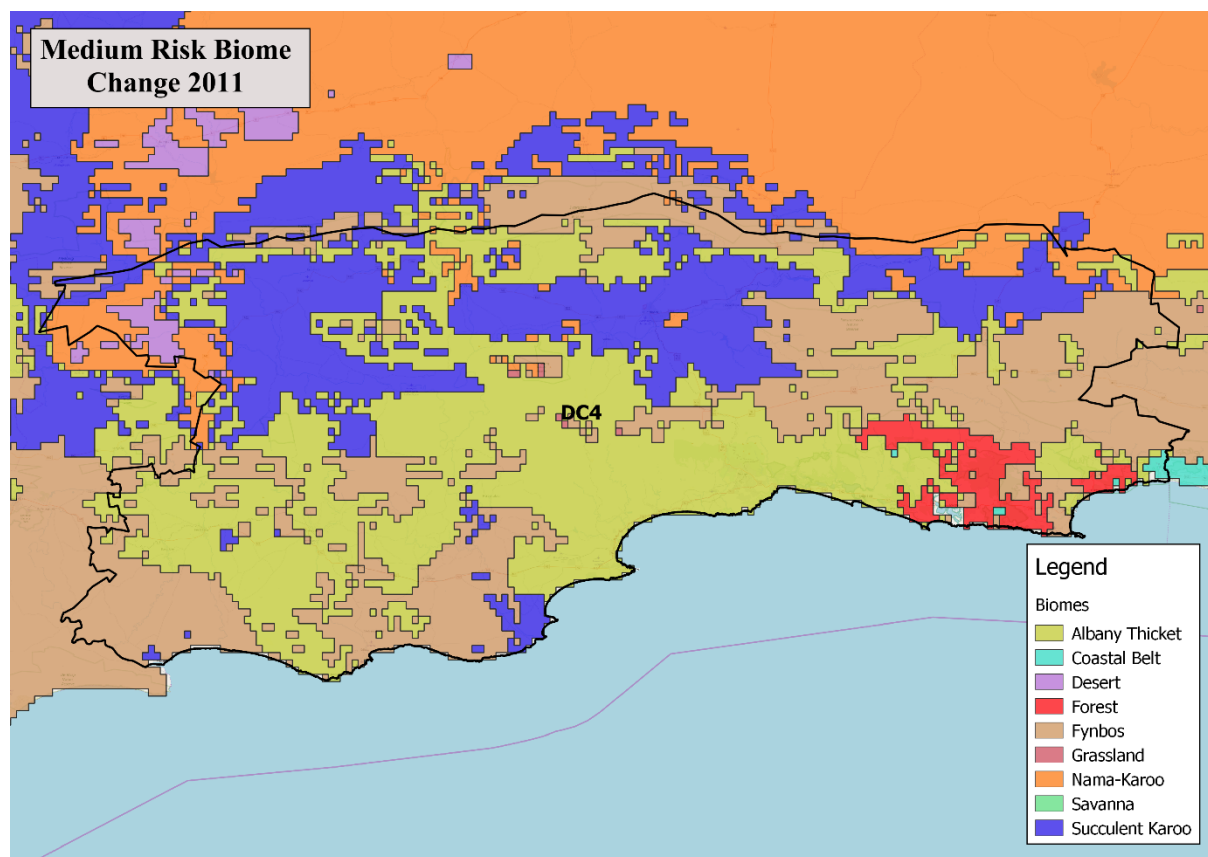


Figure 33: Predicted shift in biomes in the District Municipal Area using a medium risk scenario (South African National Parks 2011c)

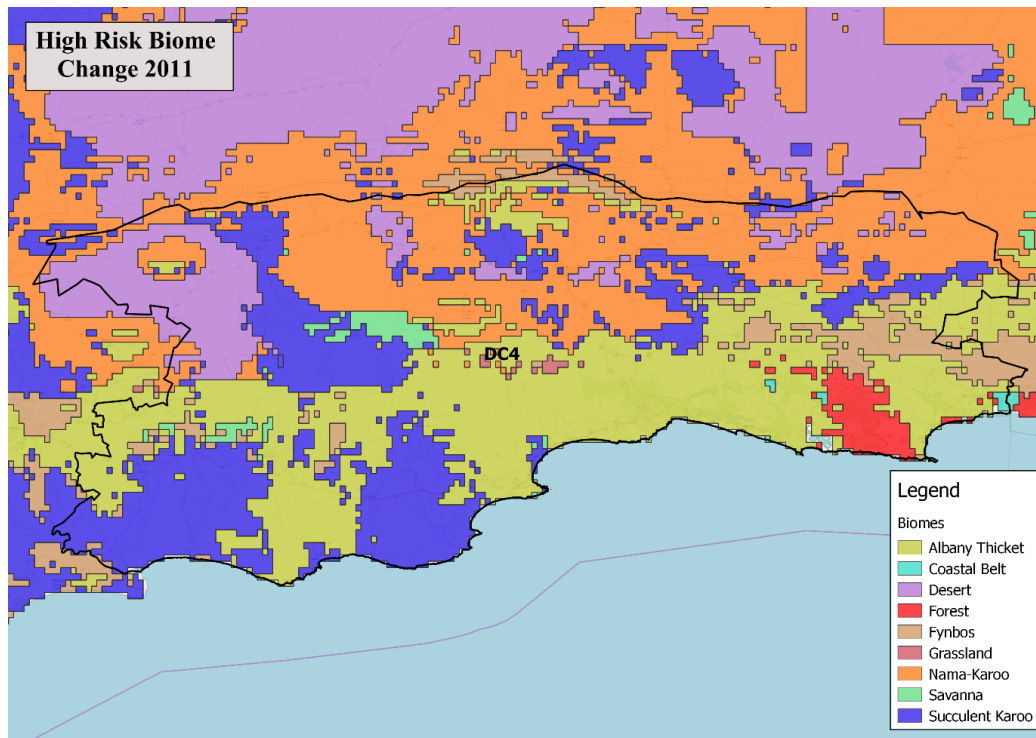


Figure 34: Predicted shift in biomes in the District Municipal Area using a high risk scenario (South African National Parks 2011b)

Within the Biomes found in the Garden Route District Municipal Area, there are numerous threatened ecosystems types (Figure 3535). The 'Langkloof Shale Renosterveld', 'Knysna Sand Fynbos', 'Garden Route Shale Fynbos', 'Cape Lowland Alluvial Vegetation', 'Muscadel Riviere', 'Cape Lowland Alluvial Vegetation', 'Eastern Ruens Shale Renosterveld' and 'Ruens Silcrete Renosterveld' are all categorised as critically endangered ecosystem types (South African National Biodiversity Institute 2011b). Additionally, the 'Garden Route Granite Fynbos' and 'Mossel Bay Shale Renosterveld' are both categorised as endangered ecosystem types (South African National Biodiversity Institute 2011b). There are also quite a few ecosystem types that are categorised as vulnerable.

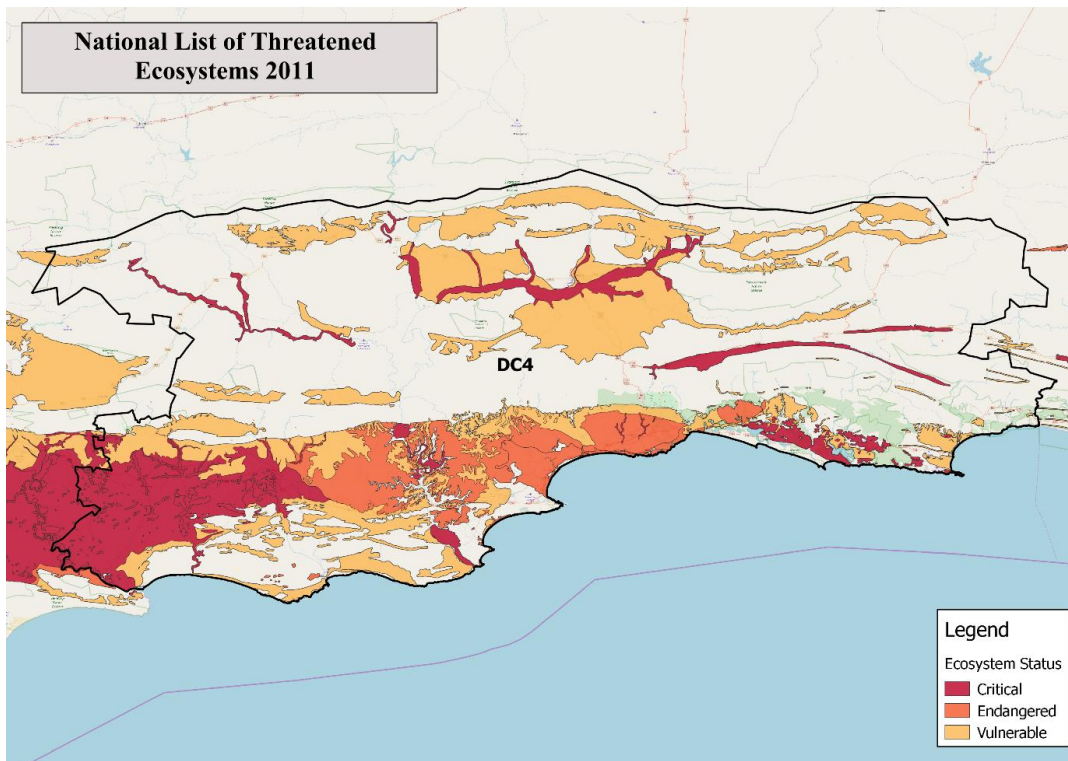


Figure 35: Threatened ecosystem types in the District Municipal Area (South African National Biodiversity Institute 2011b)

In South Africa, a ‘protected area’ is defined as areas of land (e.g. a national park) or ocean (e.g. a marine protected area) that is legally protected and managed for the conservation of biodiversity, as per the National Environmental Management: Protected Areas Act (No. 57 of 2003) (Department of Environmental Affairs 2009). Internationally, the International Union for Conservation of Nature’s (IUCN) definition of protected area includes areas that are not legally protected, which the Department of Environmental Affairs refers to as ‘conservation areas’ (Department of Environmental Affairs 2009). Within the Garden Route District Municipal Area there are 55 protected areas (Figure 3636).

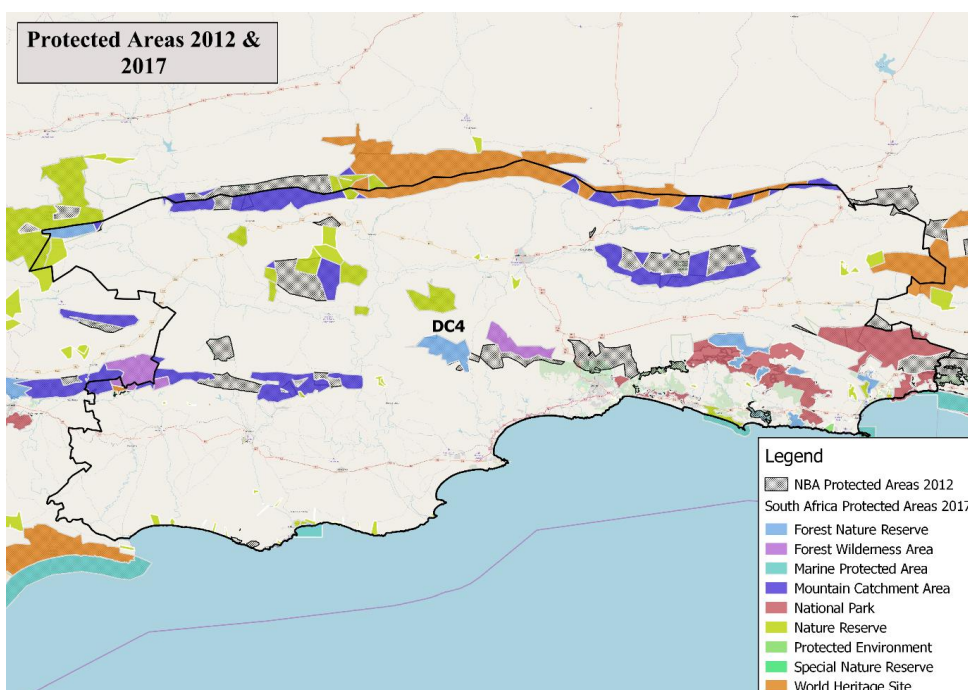


Figure 36: Protected areas in the District Municipal Area (South African National Parks / South African National Biodiversity Institute 2011; Department of Environmental Affairs 2017)

In South Africa, 65% of wetlands are threatened, of which 48% are critically endangered, 12% are endangered and 5% are vulnerable (Driver, A. et al. 2012). Wetland degradation is caused by inter alia: poor land management practises, spatial developments near urban areas, the spread of invasive alien plants; agricultural practises, pollution and the building of dams (Driver, A. et al. 2012).

In the Garden Route District Municipal Area (Figure 3737), most wetlands are classified as either 'moderately modified' (between 25% and 75% of the wetland land cover is natural) or 'heavily to critically modified' (less than 25% of the wetland land cover is natural) (Council for Scientific and Industrial Research 2011). Wetlands classified as 'mostly natural or good' (more than 75% of the wetland land cover is natural) are much fewer in number (Council for Scientific and Industrial Research 2011).

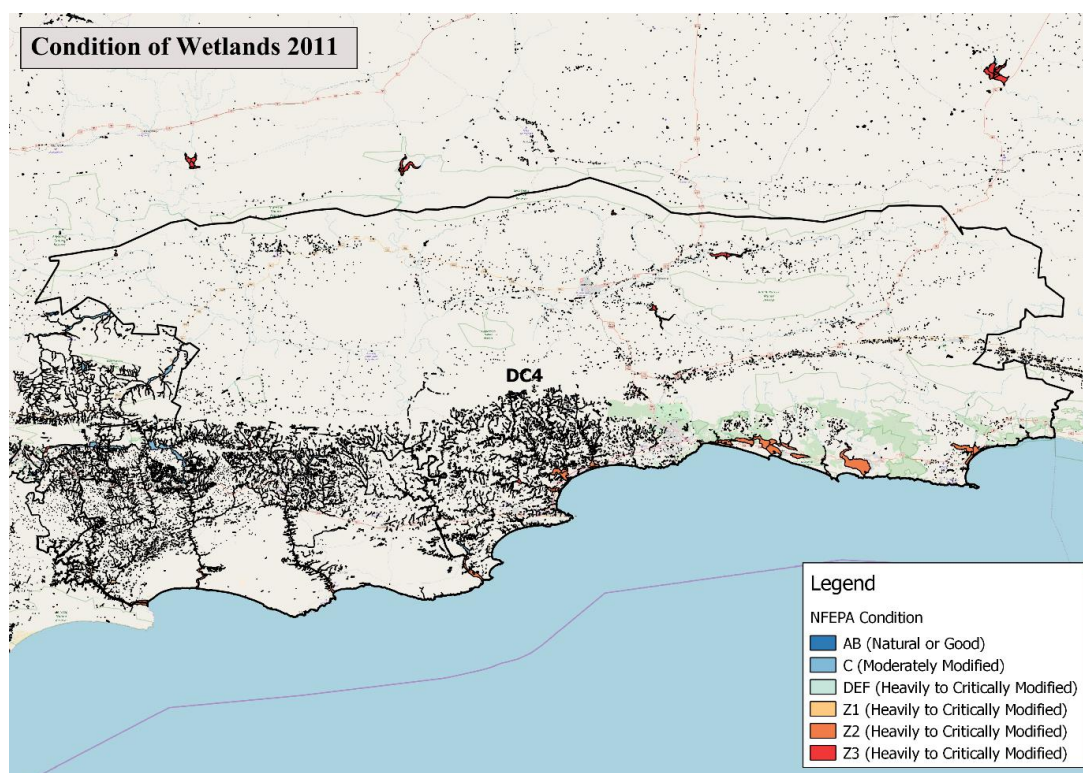


Figure 37: Condition of wetlands in the District Municipal Area (Council for Scientific and Industrial Research 2011)

Land use in the Garden Route District Municipal Area consists of agriculture (including game farms), forestry (plantations), conservation areas, urban areas and some limited mining areas (Garden Route District Municipality 2017a, 2016). These land uses have had varying effects on the biodiversity of the Garden Route District Municipal Area.

Biodiversity in the Garden Route District Municipal Area has been positively influenced by the conservation areas. It has been negatively influenced by: land degradation, soil erosion, coastal erosion, fires, the spread of invasive alien species, population growth, spatial development (such as the expansion of agricultural and urban areas) increased pollution, poor waste management and climate change (Garden Route District Municipality 2017a, 2016, 2014).

According to the Millennium Ecosystem Assessment (2005) ecosystem services are “the benefits that people obtain from ecosystems”, which can be divided into four categories: provisioning (e.g.

timber), supporting (e.g. nutrient recycling), regulating (e.g. water purification), cultural (e.g. recreational activities) (Millennium Ecosystem Assessment 2005). The existing challenges that negatively affect the biodiversity in the Garden Route District Municipal Area (discussed above) have also reduced ecosystem services (particularly provisioning services and regulating services) in the Garden Route District Municipal Area and will continue to do so, if these impacts are not reduced.

If the biodiversity and related ecosystem services in the Garden Route District Municipal Area are badly reduced, it could have direct negative consequences for the economy and social structures in the Garden Route District Municipality. These consequences could have a detrimental effect on efforts to reduce poverty, inequity and unemployment in the Garden Route District Municipal Area. Furthermore, it is predicted that climate change will exacerbate these challenges and their effects on the biodiversity and related ecosystem in South Africa.

Garden Route District Marine and Coastal Sector Summary

The coastal zone in South Africa includes the inshore, offshore and estuarine ecosystems. It is a continually changing area where land and ocean meet, and includes beaches, rocky shores, estuaries, wetlands and the ocean near the coast (Nelson 2013; Provincial Government of the Western Cape 2005). A coastal zone extends seaward up to the boundary of the exclusive economic zone, which is 200 nautical miles (roughly 370 km) out to sea, and inland up to one kilometre after the high-water mark (Republic of South Africa 2014).

Climate change is predicted to result in several changes to South Africa's coastal zone (Department of Environmental Affairs 2013e, 2012). It is forecast that climate change will:

5. increase impacts on marine and benthic ecosystems
6. increase impacts on estuary ecosystems
7. increase impacts on coastal livelihoods, and
8. increase impacts on infrastructure and property due to sea level rise.

These impacts are expected to affect all coastal district municipalities in South Africa (Department of Environmental Affairs 2013e).

In assessing benthic and marine ecosystems, it is worth considering the threat status of the coastal zone. There are several threatened ecosystem types in the coastal zone of the Garden Route District Municipal Area (Figure 3838). The 'Southern Benguela Hard Shelf Edge', 'Agulhas Muddy Inner Shelf', 'Agulhas Mixed Sediment Outer Shelf', 'Agulhas Inshore Reef', 'Agulhas Sheltered Rocky Coast' and 'Harbour' are all categorised as critically endangered ecosystem types (South African National Biodiversity Institute 2011a). Furthermore, the 'Agulhas Hard Inner Shelf' is categorised as endangered ecosystem types (South African National Biodiversity Institute 2011a). There are also numerous ecosystem types in the Garden Route District Municipal Area that are categorised as vulnerable (South African National Biodiversity Institute 2011a). Some of these threatened ecosystems are partially being conserved in marine protected areas.

The Garden Route District Municipality currently has three marine protected areas entirely within its coastal zone: Robberg Marine Protected Area, Goukamma Marine Protected Area and Stilbaai Marine Protected Area (Department of Environmental Affairs 2017). It also has a small part of the Tsitsikamma Marine Protected Area, which was the first marine protected area in South Africa (Department of Environmental Affairs 2017; WWF SA 2017).

However, the expanse of marine protected areas off the coast of the Garden Route District Municipal Area is set to grow. In 2016, through its participation in the Operation Phakisa Initiative, the Department of Environmental Affairs published draft notices and regulations to declare 22 new marine protected areas in South Africa's coastal zone (Department of Environmental Affairs 2016). In the coastal zone of the Garden Route District Municipal Area it is proposed that the offshore Southwest Indian Seamount Marine Protected Area be created (Republic of South Africa 2016).

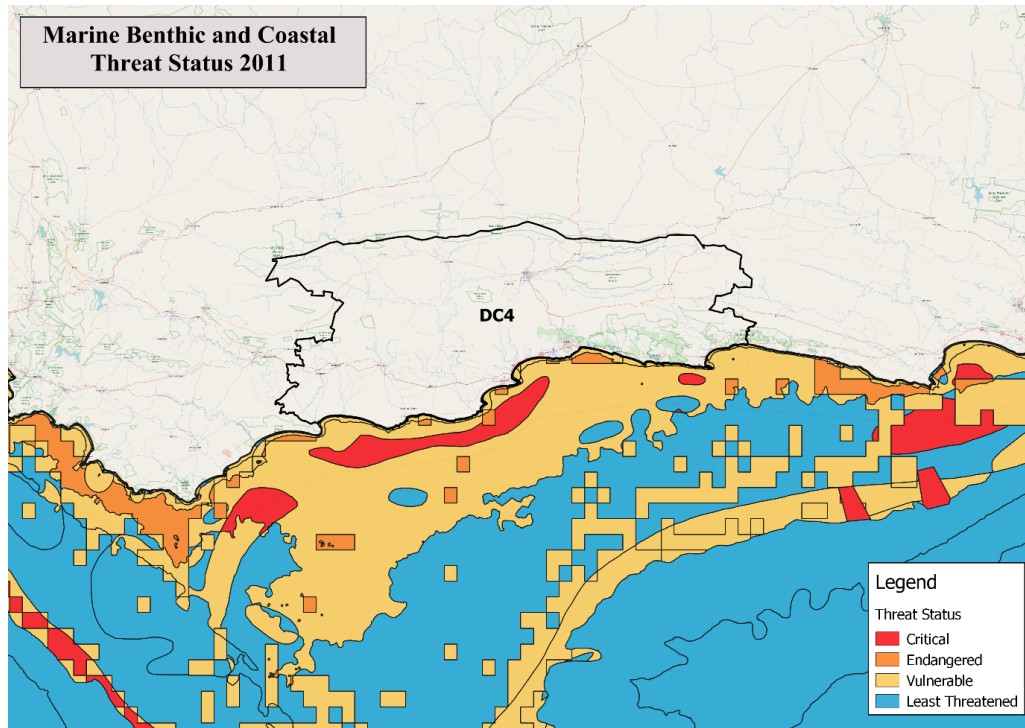


Figure 38: Threatened marine, benthic and coastal ecosystems in the District Municipal Area's coastal zone (South African National Biodiversity Institute 2011)

There are 22 estuarine systems wholly in the Garden Route District Municipal Area (Figure 39) and two (the Breede and Bloukrans estuaries) that mark the borders of the Garden Route District Municipal Area (South African National Biodiversity Institute and CSIR 2012). The health condition of the estuaries in the Garden Route District Municipal Area is varied. The Bloukrans, Sout (Oos) and Keurbooms estuaries are classified as 'unmodified, natural' (South African National Biodiversity Institute and CSIR 2012). The Groot (Wes), Matjies, Noetsie, Knysna, Goukamma, Swartvlei, Wilderness, Kaaimans, Gwaing, Maalgate, Blinde, Duiwenhoks and Breede estuaries are all classified as 'largely natural with few modifications' (South African National Biodiversity Institute and CSIR 2012). The Piesang, Klein Brak, Gourits and Goukou (Kaffirkui) estuaries are classified as 'moderately modified' (South African National Biodiversity Institute and CSIR 2012). The Hartenbos estuary is classified as 'largely modified' and the Groot Brak estuary is classified as 'seriously modified' (South African National Biodiversity Institute and CSIR 2012). There are no estuaries in the Garden Route District Municipal Area that are classified as 'critically/extremely modified' (South African National Biodiversity Institute and CSIR 2012). According to the *Garden Route District Municipality Integrated Development Plan 2017/2018 - 2021/2022*, the Garden Route District Municipality has allocated funding for three years, starting in the 2017/2018 municipal financial year, for the implementation of a coastal management and estuaries plan (Garden Route District Municipality 2017a).

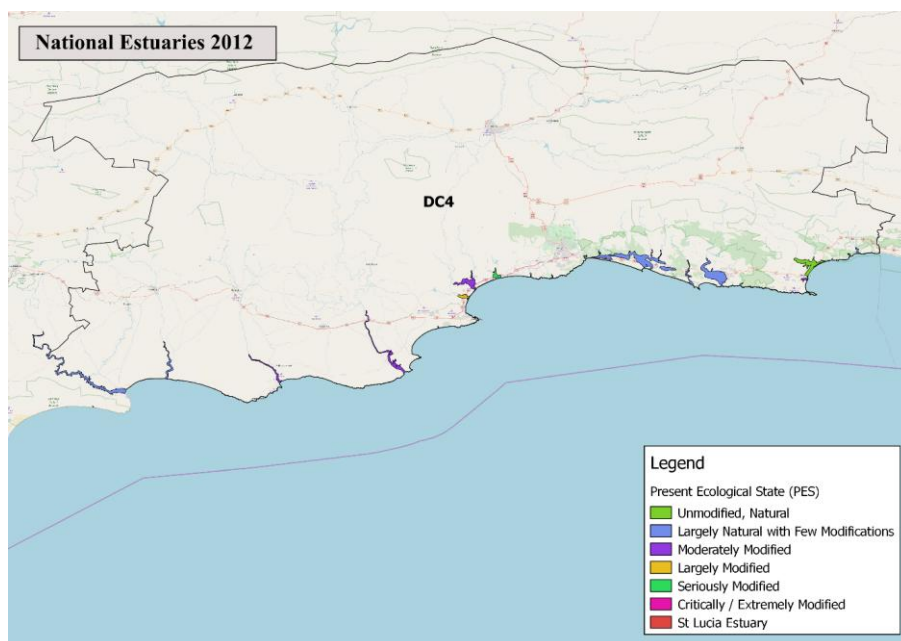


Figure 39: Estuaries in the District Municipal Area (South African National Biodiversity Institute and CSIR 2012)

In South Africa, 43 % of estuary ecosystems are threatened (Department of Environmental Affairs 2012). Estuary ecosystems are experiencing increasing pressure from human related activities that are decreasing the quantity and quality of available estuarine ecosystem services (Department of Environmental Affairs 2012). These pressures are caused by: the activities that happen in and around the estuary; changes to the quantity and quality of fresh water entering the estuary; and, poor land use practises and degradation higher up in the catchment (Department of Environmental Affairs 2012). Estuary ecosystems are also impacted by: artificially breaching the mouths of estuaries; pollution; and the expected impacts of climate change, especially escalating sea level rise, coastal erosion, and increased coastal storm frequency and intensity (Palmer, van der Elst, and Parak 2011; Department of Environmental Affairs 2013e).

Climate change is expected to reduce the diversity and quantity of fishes and other biota in estuarine ecosystems (as well as inshore and offshore ecosystems) through changes to: land and sea surface temperatures; frequency and distribution of precipitation; water runoff patterns; increased coastal storm frequency and intensity; oxygen levels; and wind (Department of Environmental Affairs 2013e). Sea level rise may also cause salt water intrusions into estuarine and agricultural lands which can lead to a reduction in their ecosystem services (Atkinson and Clark 2005).

Climate change may also have a negative effect on coastal livelihoods (Department of Environmental Affairs 2013e). Predicted increases in the severity and frequency of storms and sea level rise may reduce the number of feasible fishing days and cause damage to shore-based infrastructure (e.g. harbours and launch sites) and fishing boats (Department of Environmental Affairs 2013e).

With regards to impacts from sea level rise, the *Long-Term Adaptation Scenarios* specifically considers all land under 5.5 metres (m) above the current mean sea level to be part of the coastal zone (Department of Environmental Affairs 2013f). The reason for this is that 5.5 m is the maximum estimated height of land that could be affected by the predicted increases in storm surges, sea level rise and tidal fluctuations by the year 2100 (Department of Environmental Affairs 2013f).

Within the Garden Route District Municipal Area (Figure 4040), 54 square kilometres (km²) in Knysna Local Municipality, 35 km² in the Mossel Bay Local Municipality, 30 km² in the Hessequa Local

Municipality, 20 km² in the Bitou Local Municipality and 12 km² in the George Local Municipality are estimated to be below a 5.5 m elevation (Department of Environmental Affairs 2013b). At 151 km² in total, the Garden Route District Municipal Area contains a relatively large amount of coastal land with less than a 5.5 m elevation (Department of Environmental Affairs 2013b). These areas under a 5.5 m elevation are at risk of being negatively affected by the predicted increases in storm surges, sea level rise and tidal fluctuations, due to climate change (Department of Environmental Affairs 2013b).

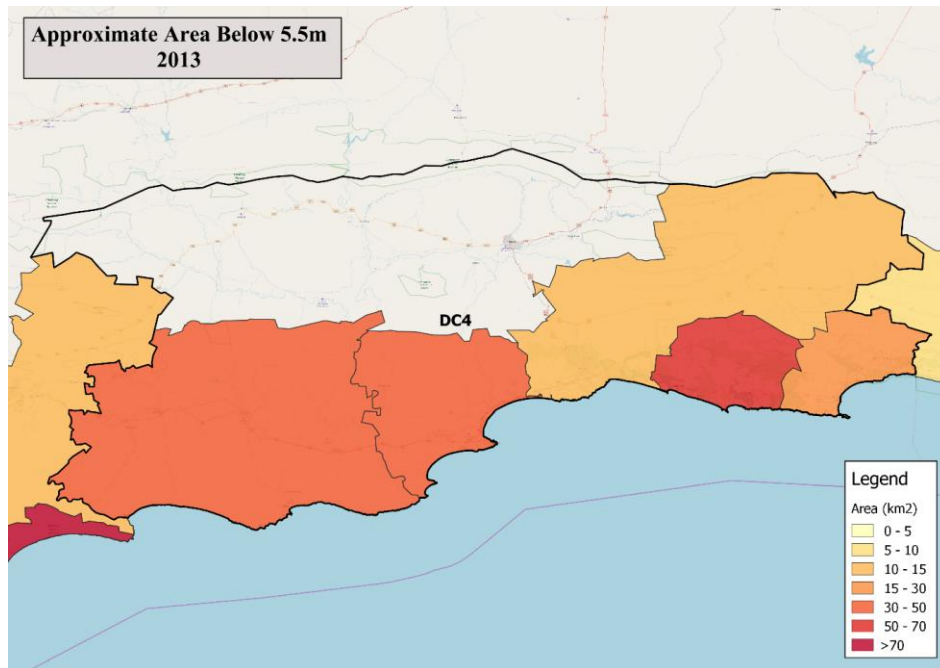


Figure 40: Approximate area below 5.5m in the District Municipal Area (Department of Environmental Affairs 2013f)

In addition to the predicted effects of climate change, the coastal zone in South Africa is susceptible to anthropogenic impacts such as ecosystem overuse (e.g. overfishing) and degradation, increased pollution, and the increased nutrient runoff from coastal developments leading to eutrophication of wetlands, estuaries, etc. (Department of Environmental Affairs 2013e). The anthropogenic and climate change impacts have already negatively affected biodiversity and ecosystems services in the coastal zone (and across South Africa) and are expected to worsen these issues unless climate change adaptation and mitigation responses are developed and implemented (Department of Environmental Affairs 2013e).

The National Environmental Management: Integrated Coastal Management Amendment Act, No 36 of 2014 requires that every coastal district municipality has a Coastal Management Programme (Republic of South Africa 2014). In 2012, the Garden Route District Municipality released their Coastal Management Programme (Garden Route District Municipality 2012, 2017a). In addition to three years of funding for the implementation of a coastal management and estuaries plan in the Garden Route District Municipal Area, The Garden Route District Municipality has also put forward a project to annually review “Garden Route’s Coastal Management Plan and District Environmental Framework” during the 2017/2018 to 2021/2022 time period (Garden Route District Municipality 2017a).

Garden Route District Health Sector Summary

A great proportion (82.4 %) of South Africa's population are dependent on the public health sector for health related services of which there are 3,880 public facilities (Health Systems Trust 2012). These public facilities are divided into two main groups: 3,487 primary health care facilities (consisting of 3,074 clinics; 238 community health centres; 125 satellite clinics; 44 community day centres; four specialised clinics and two health posts) and 391 hospitals (of which six are central hospitals; 10 tertiary; 55 regional; 254 district and 66 specialised hospitals) (Health Systems Trust 2012). Of the above, 34 clinics, six district hospitals, one regional hospital and seven other hospitals fall within the Garden Route District Municipal Area (Massyn et al. 2016).

According to a health care facilities audit by the Health Systems Trust, the Garden Route District Municipal Area received a score of 57 % on vital measures in the six ministerial priority areas for health care facilities and 63 % for the infrastructure of health facilities (Health Systems Trust 2012). The score on vital measures in the six ministerial priority areas relates to patient-centred care, specifically focusing on: positive and caring attitudes; waiting times; cleanliness; patient safety; infection prevention and control; and availability of medicines and supplies (Health Systems Trust 2012). The infrastructure score meanwhile is based on the assessment of mainly: building and site infrastructure, facility infrastructure management and standards around the availability of space (Health Systems Trust 2012).

The total population of the Garden Route District Municipal Area was approximately 574,266 people in 2011 (Statistics South Africa 2011). In the District Municipal Area children under the age of 15 make up 25.85 % of the total population, while those aged between 15 and 39 account for a further 39.97 % (Statistics South Africa 2011). Furthermore, the 40 to 64 age group makes up 26.36 % of the population and the elderly (>64yrs age group) make up the remaining 7.81 % of the population (Statistics South Africa 2011). Furthermore, the young (<5yrs age group) and elderly (>64yrs age group) constitute 17.10 % of the total population (Figure 41) (Statistics South Africa 2011). These two groups are said to be the most vulnerable to climate change impacts. The darker areas on the map (Figure 41a1) indicate higher percentages of young and elderly people.

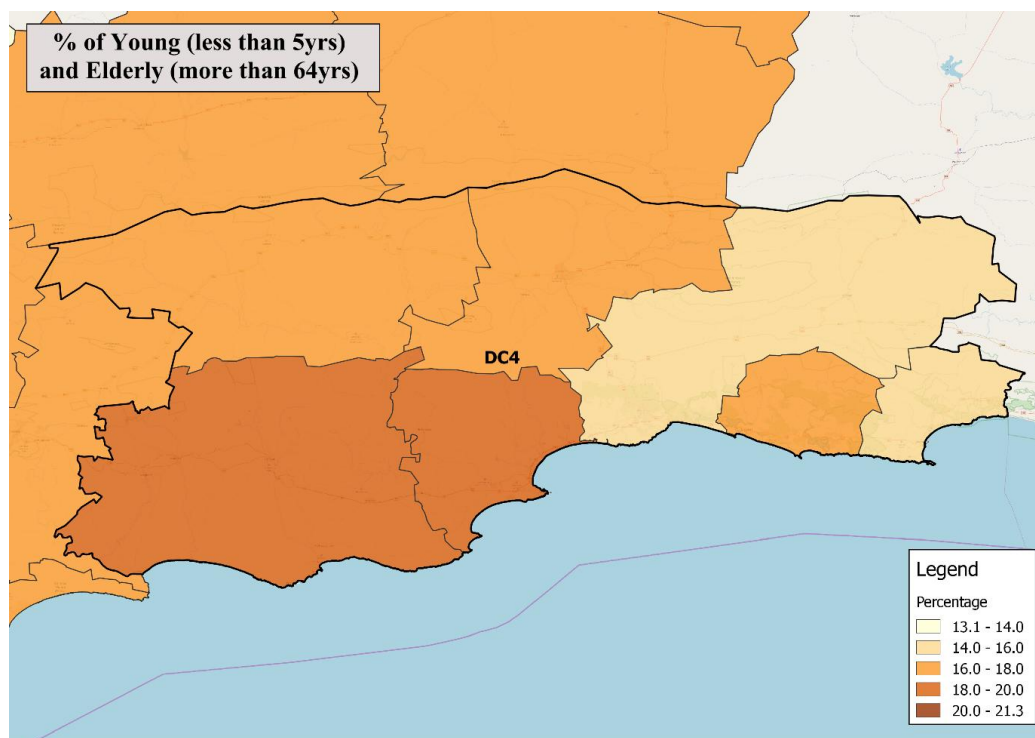


Figure 41: Percentage of young (<5yrs age group) and elderly (>64yrs age group) across the Garden Route District Municipal Area (Statistics South Africa 2011)

In 2015, the total number of deaths in South Africa was 460,236, of which 5,633 occurred in the Garden Route District Municipal Area (Statistics South Africa 2015). The distribution of deaths by age for South Africa revealed that in, 2015, 7 % of the deaths occurred in children under the age of five, while individuals over the age of 64 accounted for 34.4 % of the deaths (Statistics South Africa 2015).

In 2015, the top ten underlying natural causes of death within the Garden Route District Municipal Area were: tuberculosis; HIV disease; cerebrovascular diseases; ischaemic heart diseases; diabetes mellitus; chronic lower respiratory diseases; malignant neoplasms of respiratory and intrathoracic organs; malignant neoplasms; other forms of heart disease; and hypertensive diseases (Statistics South Africa 2015).

Specifically, the leading causes of death for children under five years of age, for the 2009 to 2014 period, in the Garden Route District Municipal Area were a group of communicable (infectious) diseases together with perinatal, maternal and nutritional conditions (Massyn et al. 2016). Preterm birth complications (21.0 %) were the leading cause of children's (<5yrs age group) deaths, followed by lower respiratory infections, which accounted for 17.5 % of deaths (Massyn et al. 2016).

Additionally, the leading causes of death for the elderly (>64yrs age group) in the Garden Route District Municipal Area were a group of non-communicable diseases (which cannot be transferred from one person to the next) that accounted for 57.7 % of the deaths between 2009 and 2014 (Massyn et al. 2016). Of these non-communicable diseases, ischaemic heart disease was the leading cause (16.6 %) of deaths, followed by Cerebrovascular disease (14.5 %) (Massyn et al. 2016).

Concerning waterborne and communicable diseases, approximately 12.31 % of the Garden Route District Municipal Area's households do not source water from piped water schemes (Statistics South Africa 2011) and are therefore vulnerable to waterborne diseases. For the "children under five years diarrhoea case fatality" (that is children under five years who died in hospital from diarrhoeal disease) the District Municipal Area ranked 1st (where 1st represents the best performance and 52nd

represents the worst performance in South Africa) with a diarrhoea case fatality rate of 0.0 % during the 2015/16 period (Massyn et al. 2016). The national average for “children under five years diarrhoea case fatality” was 2.2 % over the same time period (Massyn et al. 2016).

Furthermore, for the “Child under 5 years severe acute malnutrition case fatality rate” (that is children under five years who died from acute malnutrition) the Garden Route District Municipal Area ranks 3rd (where 1st represents the best performance and 52nd represents the worst performance in South Africa) with a rate of 0.3 % during the 2015/16 period (Massyn et al. 2016). This is below the national average of 8.9 % over the same time period (Massyn et al. 2016).

In terms of risks posed by working conditions, about 45.95 % of the Garden Route District Municipal Area’s economically active population are employed, of which roughly 14.3 % are employed within the informal sector (Statistics South Africa 2011). Many of the people employed in the informal sector work outdoors in poor conditions, with limited infrastructure and services such as shade, and limited access to amenities such as water and sanitation (Statistics South Africa 2011).

Additionally, 9.86 % of the Garden Route District Municipal Area’s households are involved in agricultural activities (Statistics South Africa 2011). People who work outdoors, like those involved in agricultural activities, are especially vulnerable to the impacts of extreme weather conditions. Moreover, climate change is forecast to exacerbate the frequency and severity of extreme weather events (Department of Environmental Affairs 2013c). Consequently, predicted impacts for households involved in agriculture include reduced agricultural yields and water security as well as increased food insecurity.

The main disaster risks that are likely to affect human health in the Garden Route District Municipal Area are wild fires, drought, severe storms and floods (Garden Route District Municipality 2014). It is predicted that these disasters will be exacerbated by climate change (Garden Route District Municipality 2014).

From the information above, the predicted impacts of climate change on human health and health services are mostly negative. Hence, there is a need for climate change adaptation (and mitigation) to limit the negative impacts and encourage any positive effects of climate change on human health in the Garden Route District Municipal Area.

Garden Route District Human Settlements Sector Summary

The Garden Route District Municipality population is approximately 574,266 (Statistics South Africa 2011). Of the District Municipalities, Garden Route District Municipality is the second most populous after Cape Winelands District Municipality (Garden Route District Municipality 2014). Almost half of the District’s population resides in two Local Municipalities, namely, the George Local Municipality and Mossel Bay Local Municipality (Garden Route District Municipality 2012). Within the District Municipal Area, 39.97% of the population are between 15 and 39 years old, while children under 15 years old make up 25.85% of the total population (Statistics South Africa 2011). People between the ages of 40 and 64 constitute a total share of 26.36%, while people over 64 years old constitute the smallest part (7.81%) of the total population (Statistics South Africa 2011).

The District Municipal Area is characterised by low literacy levels with 27.18% of the population having completed matric, while 9.00% of the population have earned post-school qualifications, 33.71% have some secondary schooling and have some or completed primary schooling (Statistics

South Africa 2011). The remaining 9.29% have been classified as “other” in terms of their level of education (Statistics South Africa 2011).

The non-economically active population constitutes 36.71% of the District’s working-age population (those aged 15 to 64) (Statistics South Africa 2011). Of the working-age population, 45.95% are employed (Statistics South Africa 2011). The formal sector is the largest employer, employing 72.1% of employed people in the District (Statistics South Africa 2011). Additionally, the unemployed constitute 13.33% of the working-age population, while the remaining 4.00% are discouraged work-seekers (Figure 4242) (Statistics South Africa 2011).

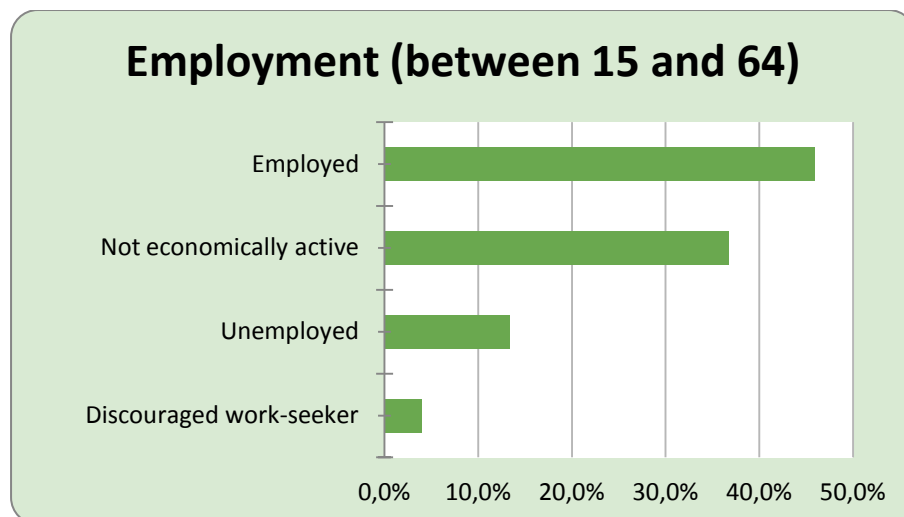


Figure 42: Employment status in the District Municipal Area (Statistics South Africa, 2011)

The Garden Route District Municipality is the largest district in the Western Cape (Garden Route District Municipality 2017b). Inland areas within the District are mostly covered by agricultural and conservation land uses (Garden Route District Municipality 2017b). The District has many dispersed hamlets and small towns, which are isolated due to a lack of adequate transport infrastructure (Garden Route District Municipality 2017b). There are 164,103 households and on average four individuals per household in the District Municipality (Statistics South Africa 2011). The majority (73.1%) of the District’s dwellings are formal¹ (house) (Figure 4343), while 13.9% are informal, 2.2% are apartments and 10.8% have not been specified (Statistics South Africa 2011).

¹ “Formal House” includes cluster houses, flat or apartment, house/flat/room in backyards, house or brick/concrete block structure on a separate stand or yard or on a farm, room/flatlet on a property or larger dwelling/servant’s quarters/granny flat and semi-detached houses.

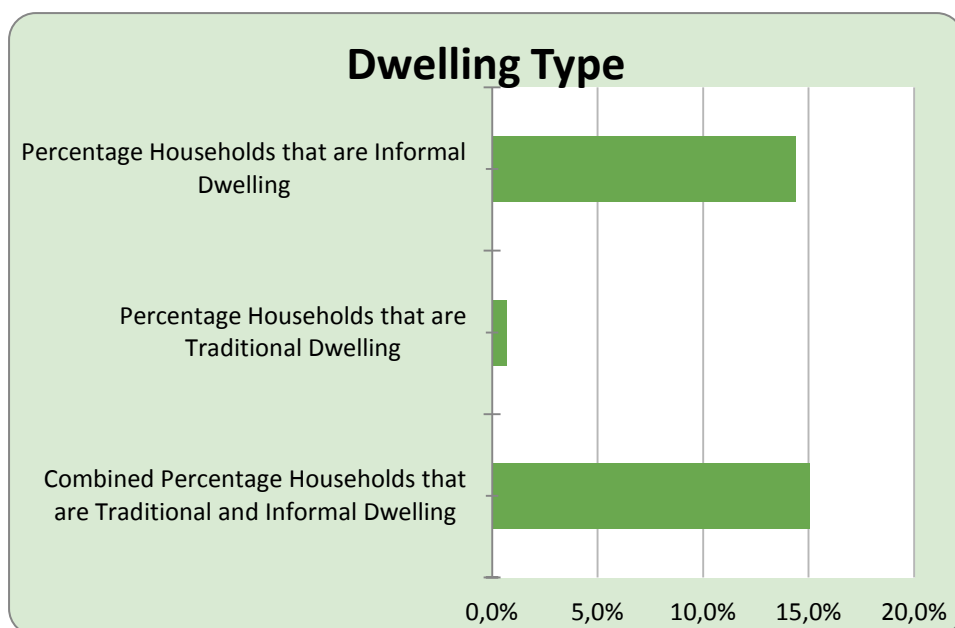


Figure 43: Households by type of dwelling in the District Municipal Area (Statistics South Africa, 2011)

Eskom is the main electricity provider in the District (Garden Route District Municipality 2017b). Roughly 91% of the District's population had access to electricity in 2011 (Garden Route District Municipality 2017b). Yet 17.38% of the households within the District Municipality use alternatives to electricity for cooking and 8.34% use alternatives to electricity for cooking, heating and lighting (Statistics South Africa 2011).

The majority (87.69%) of the District's population (Figure 4444) receive water from service providers while 12.31% do not source water from piped water schemes (Statistics South Africa 2011). Additionally, 2.66% of the population source water from boreholes and 1.29% get their water from water tanks (Statistics South Africa 2011).

Regarding sanitation services (Figure 4545), 84.31% of the population have access to flush toilets, while 6.68% use pit latrines, 5.34% have access to other toilet facilities and 3.68% of the population have no toilet facilities (Statistics South Africa 2011).

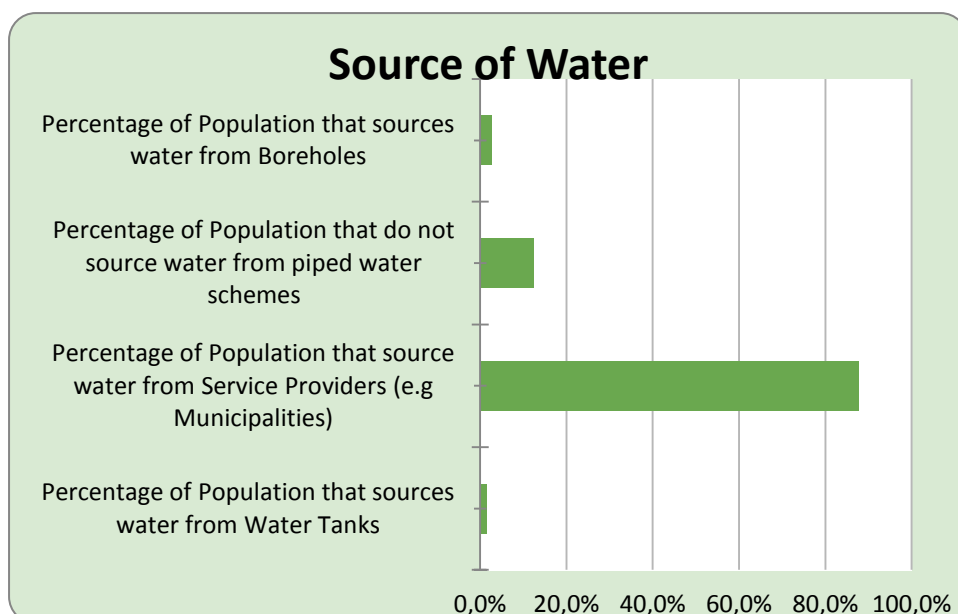


Figure 44: Household water sources in the District Municipal Area (Statistics South Africa 2011)

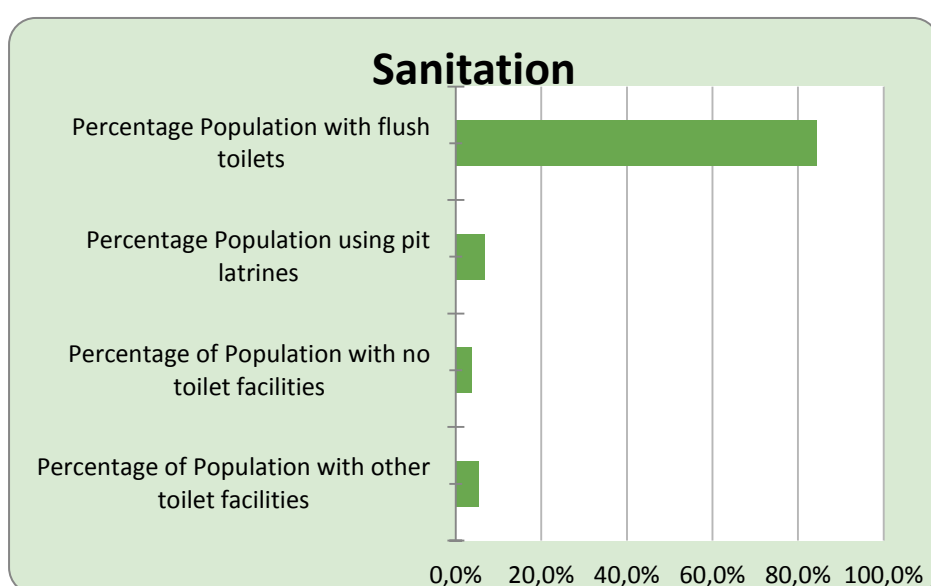


Figure 45: Sanitation facilities in the District Municipal Area (Statistics South Africa 2011)

Due to strategic transport infrastructure, the district can be accessed by road, air, rail, and sea. Among the important roads are the N2, R62, N9 and N12 (Western Cape Government 2013; Garden Route District Municipality 2017a). Rail transport is operational, however, rail connectivity between settlements is poor due to low investment (Garden Route District Municipality 2017a). With regards to air transport there are two commercial airports in the District, one is in George and the other is in Plettenberg Bay/George Bay (Garden Route District Municipality 2017a). There are also municipal owned airfields in the Mossel Bay, Oudtshoorn and Bitou Local Municipalities (Garden Route District Municipality 2017a). In addition, there are two landing strips, one of which is situated at Riversdale and the other at Still Bay (Western Cape Government 2013; Garden Route District Municipality 2017a). These landing strips are usually used for landing aircraft during disasters (Western Cape

Government 2013; Garden Route District Municipality 2017a). Water transport is facilitated by the Port at Mossel Bay, which happens to be the smallest of the nine national ports under the Transnet National Ports Authority (Garden Route District Municipality 2017b). It is utilised mainly by the fishing and oil/gas industries (Garden Route District Municipality 2017b). There is also a harbour at Stilbaai that is used mainly for fishing purposes (Garden Route District Municipality 2017b).

The district's vulnerability to climate change impacts is attributed to its physical location, topography and general climate conditions (Garden Route District Municipality 2017a). In addition, increased vulnerability to climate change has been caused by rapid urbanisation and informal developments (Western Cape Government 2013). Urbanisation has increased because of in migration of the youth from the Eastern Cape and the elderly to the coastal towns (Garden Route District Municipality 2017b). However, housing delivery has not been able to keep up with the migration, hence the ongoing increase in informal dwellings in the District (Garden Route District Municipality 2017b). Furthermore, the natural and scenic beauty of the District is a major tourist attraction that could be negatively affected by the impacts of climate change (Garden Route District Municipality 2017a).

The following climate change impacts have already been observed in the District: increased average temperatures; shifts in seasonality; increased frequency of veld fires; increased magnitude and frequency of storm events accompanied by strong winds; more frequent and severe storm surges; and, increases in rainfall variability and the number of dry days (Garden Route District Municipality 2014).

In addition, sea level rise and associated hazards are a major concern for coastal areas within the District (Garden Route District Municipality 2012). Sea level rise impacts are likely to include *inter alia* coastal erosion, flooding, destruction of infrastructure and salt water contamination of fresh water bodies (Western Cape Government 2013).

Major climatic hazards in the District Municipal Area include: drought, floods and veld fires (Garden Route District Municipality 2014, 2017a). Climate change is expected to increase the frequency and severity of these hazards (Garden Route District Municipality 2014). Additionally, financial losses in the District, due to these climate hazards, has already been high (Garden Route District Municipality 2014). For example, it was estimated that the 2009/2010 drought cost the District R 300 million, while the cost of the 2011 floods was estimated to be R 350 million (Garden Route District Municipality 2014). Furthermore, approximately 45% of the District's disaster relief budget is allocated to the repair and maintenance of road infrastructure after flood damage (Garden Route District Municipality 2014). Another 45% of the District's disaster relief budget is spent on fire-related disasters (Garden Route District Municipality 2014).

Veld fires occur mainly between November and February, however, in Knysna they occur throughout the year (Western Cape Government 2013). Increases in the frequency and intensity of veld fires have had negative impacts in the agricultural, forestry and tourism sectors (Garden Route District Municipality 2014). The risk of veld fires is high for most of the District Municipal Area, however, there are areas of extremely high veld fire risk in the south and low veld fire risk in many parts in the north and west of the District (Figure 4646) (Department of Agriculture, Forestry and Fisheries 2010). There are also several areas of medium veld fire risk spread throughout the District (Department of Agriculture, Forestry and Fisheries 2010).

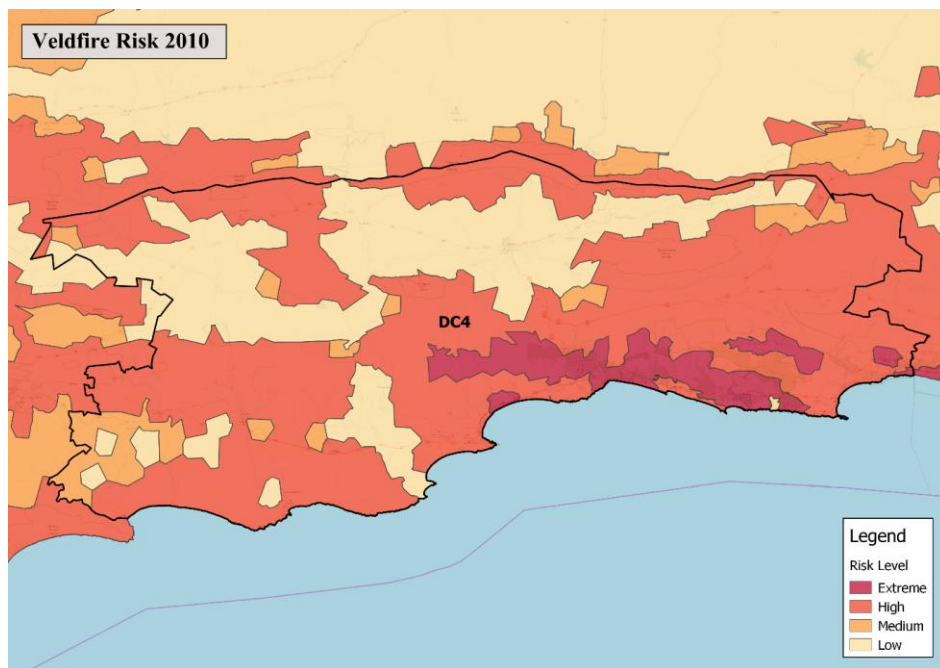


Figure 46: Veld fire risk for the District Municipal Area (Department of Agriculture, Forestry and Fisheries 2010)

Garden Route District Water Sector Summary

The Garden Route District Municipality falls mainly under the Breede-Gouritz/Berg Hydrological Zone (Figure 47), while small areas in the east fall within the Mzimvubu-Tsitsikama Hydrological Zone (Department of Environmental Affairs 2013d). As outlined above` (in Figure 1), in the warmer wetter scenario, the Breede-Gouritz/Berg Hydrological Zone is predicted to experience an increase in rainfall in winter and spring, and a decrease in autumn (Department of Environmental Affairs 2013d). While in the hotter and drier scenario, the region will experience a decrease in rainfall in all seasons and a strong decrease in rainfall in the west of the Hydrological Zone (Department of Environmental Affairs 2013d).

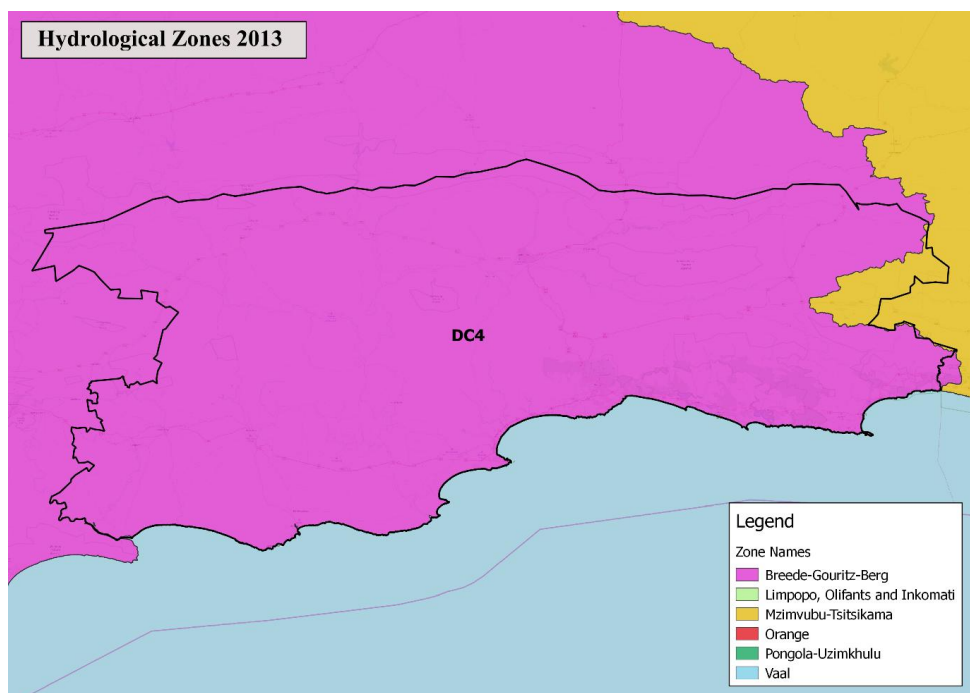


Figure 47: Hydrological Zone for the District Municipal Area (Department of Environmental Affairs 2013d)

Most of the Garden Route District Municipality falls under the Breede-Gouritz Water Management Area (Figure 4848), while small parts in the east fall within the Mzimvubu-Tsitsikama water management area (Department of Environmental Affairs 2013d). Within the Garden Route District Municipality Area there are 24 main water resources (such as dams, lakes and estuaries), some of which are the: Stompdrift, Garden Route, Wolwedans, Tierkloof and Prinsrivier Dams; Knysna and Sedgefield Lagoons; Groenvlei; Swartvlei; Rondevlei; and, the Touws River Estuary (Department of Water and Sanitation 2016b). While these resources are spread throughout the Garden Route District Municipal Area (Figure 4949), they are mostly found in the south of the District Municipal Area (Department of Water and Sanitation 2016b).

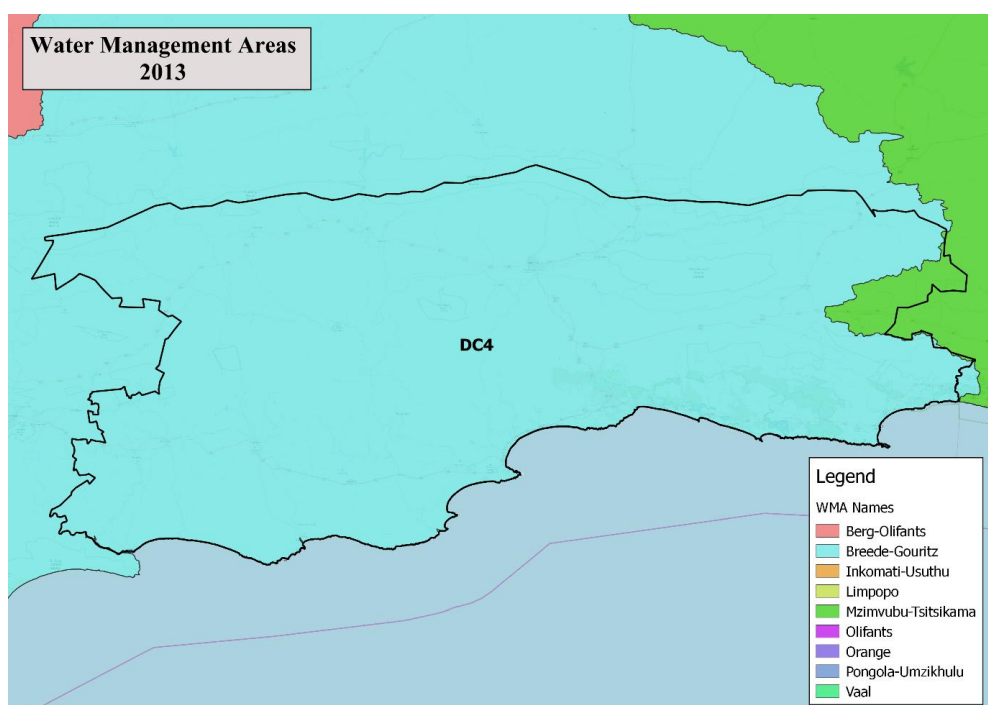


Figure 48: Water Management Area for the District Municipal Area (Department of Water Affairs 2013)

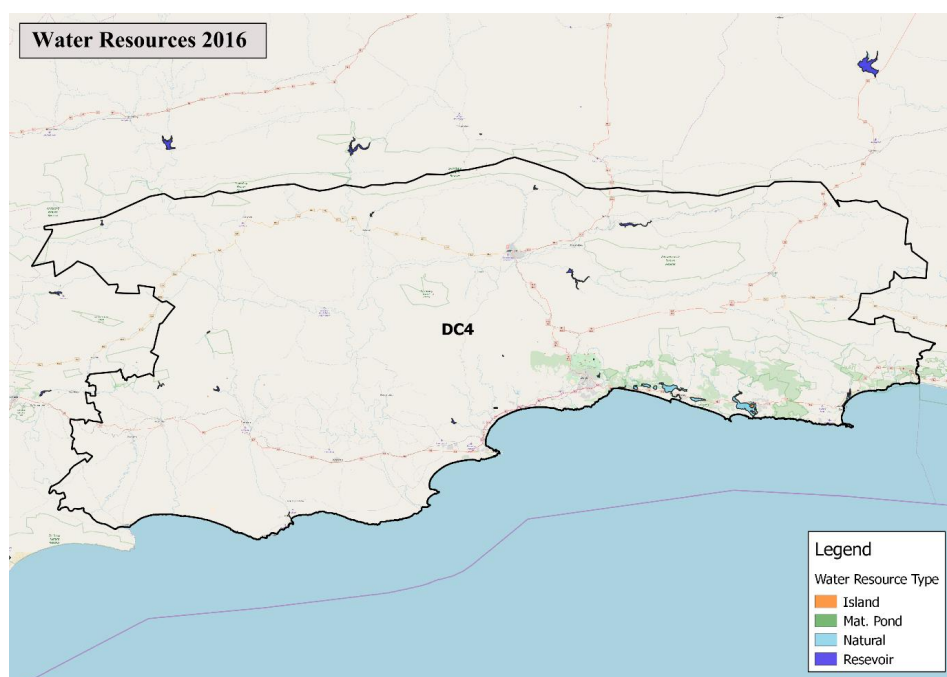


Figure 49: Water resources within the District Municipal Area (Department of Water and Sanitation 2016b)

The river quality within the Garden Route District Municipal Area is mostly in a poor state, which means that many rivers are unable to contribute towards river ecosystem biodiversity targets (SANBI 2011). The health of a river system is graded into one of several categories (SANBI 2011). These categories are listed in Text Box 1.

Text Box 1: Freshwater Ecosystem Priority Areas (FEPAs) classification for river ecosystem conditions

River conditions in South Africa have been classified according to the Freshwater Ecosystem Priority Areas (FEPAs) for river ecosystems (SANBI 2011). The different grades are provided below:

- A = Unmodified, Natural
- B = Largely Natural with Few Modifications
- Ab = A or B Above
- C = Moderately Modified
- D = Largely Modified
- E = Seriously Modified
- F = Critically/Extremely Modified
- Ef = E or F Above
- Z = Tributary Condition Modelled as Not Intact, According to Natural Land Cover

Rivers that are unmodified or in their natural state are able to contribute towards river ecosystems biodiversity targets (SANBI 2011). In contrast, rivers that are categorised as 'largely modified' or worse are unable to contribute towards river ecosystems as they are not in a good state.

Several of the main rivers in the Garden Route District Municipality Area (Figure 5050) such as the Kammanassie, Olifants, Touws, and Wynands Rivers as well as sections of the Groot River are classified as 'largely modified' (SANBI 2011). Additionally, the Gourits River and sections of the Groot

River are classified as ‘moderately modified’ (SANBI 2011). Furthermore, most tributaries are classified as either ‘largely natural with few modifications’ or ‘tributary conditions modelled as not intact, according to natural land cover’ (SANBI 2011).

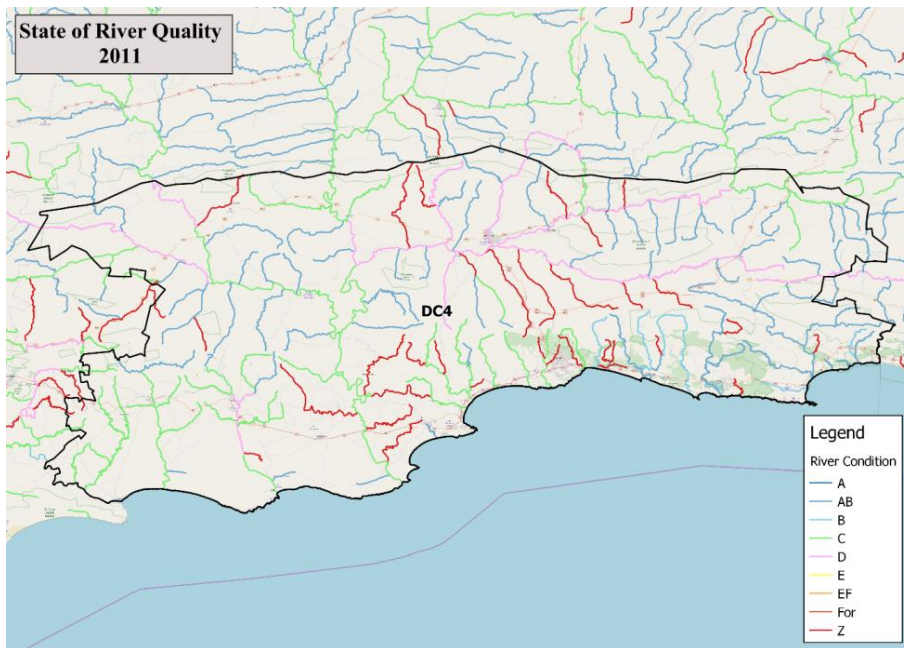


Figure 50: State of water quality in rivers in the District Municipal Area (SANBI 2011)

Water resources in any catchment are largely depended on rainfall. The Historical Climate Monthly Averages include long-term historical monthly average rainfall totals and monthly averaged minimum and maximum temperatures for a particular spot (Climate System Analysis Group 2017b). The Historical Climate Monthly Averages for the Garden Route District Municipal Area have been calculated using the nearest weather data station to the Municipality, which is the measuring station at George (Figure 5151). The graph (Figure 5151) shows that average temperatures peak in January and February, while rainfall is fairly consistent throughout the year, indicating that the Garden Route District Municipal Area is a year-round rainfall area (Climate System Analysis Group 2017b). The lowest average monthly rainfall historically occurs in June, which averages less than 38 mm (Climate System Analysis Group 2017b).

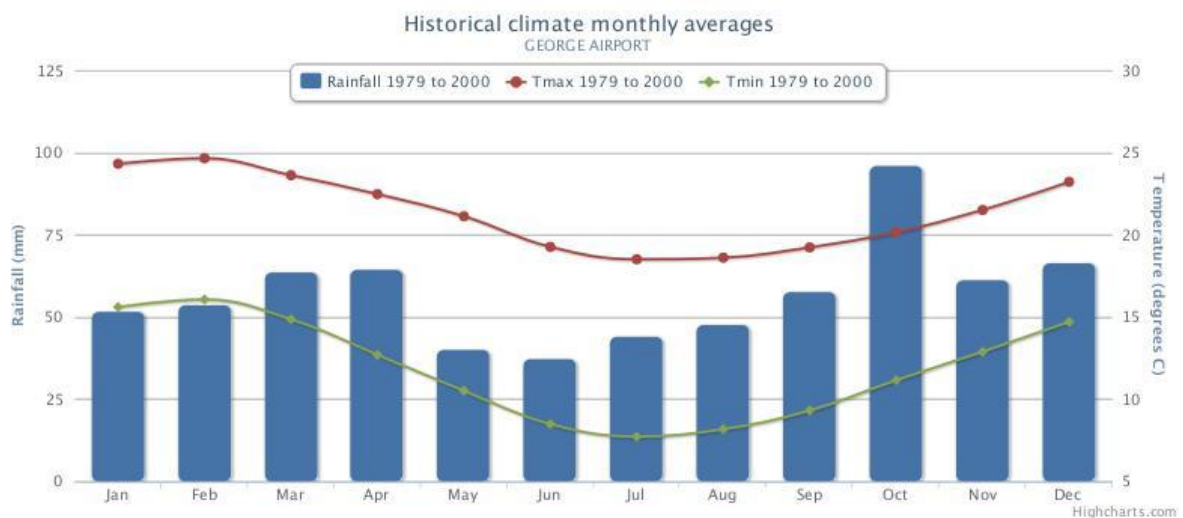


Figure 51: Historical Climate Monthly Averages for George (Climate System Analysis Group 2017b)

Linked to the rainfall and rivers in the Garden Route District Municipal Area are the water and sanitation services. Specifically, a total of 12.31 % of households in the Garden Route District Municipal Area do not receive their water from piped water schemes, which is lower than the national average of 21.82 % (Statistics South Africa 2011). Furthermore, the percentage of the population with flush toilets in the Garden Route District Municipal Area is 84.31 % while the national average is 56.51 % (Statistics South Africa 2011). This indicates a good spread of sanitation access within the Garden Route District Municipal Area.

Although the Garden Route District Municipality has high scores for the provision of water and sanitation services to households in the District Municipal Area, there is still room for improvement. Accordingly, the Garden Route District Municipality in its 2017/2018 *Integrated Development Plan* has identified the need for increased efficiency in the use of water and other natural resources while enabling environmentally sustainable developments (Garden Route District Municipality 2017a). This is especially necessary given the ongoing drought in the Western Cape and the water supply issues in Knysna and surrounding areas.

Directly linked to water and sanitation services in the Garden Route District Municipal Area are the Blue and Green Drop scores. Blue Drop scores rate the quality of drinking water, while Green drop scores rate the quality of wastewater. Blue Drop scores rate the quality of drinking water supplied by water service providers. The Blue Drop score can be understood using the following scale: 90 – 100 % = 'Excellent situation'; 75 - <90 % = 'Good status'; 50 - <75 % = 'Average performance'; 33 - <50 % = 'Very poor performance'; and, 0 - <33 % = 'Critical status' (Department of Water Affairs 2011). There is no 2014 Blue Drop score for the Garden Route District Municipality, rather there is a Blue Drop score for each local municipality within the Garden Route District Municipality (Department of Water and Sanitation 2014).

The 2014 Blue Drop scores of each local municipality within the Garden Route District Municipality are as follows: The George Local Municipality scored 82.77 %; the Mossel Bay Local Municipality scored 78.76 %; the Knysna Local Municipality scored 61.62 %; the Bitou Local Municipality scored 90.43 %; the Oudtshoorn Local Municipality scored 51.29 %; the Hessequa Local Municipality scored 55.18 %; and the Kannaland Local Municipality scored 31.66 % (Department of Water and Sanitation 2014).

The Green Drop score rates the quality of wastewater management in municipalities. The Garden Route District Municipality currently has 37 wastewater treatment works that are operated at the local municipality level, because a regional wastewater treatment scheme does not exist within the District Municipal Area (Garden Route District Municipality 2017a). The Green Drop score can be understood using the following scale: 90 – 100 % = 'Excellent situation'; 80 - <90 % = 'Good status'; 50 - <80 % = 'Average performance'; 30 - <50 % = 'Very poor performance'; and, 0 - <30 % = 'Critical state' (Department of Water and Sanitation 2016a). There is no 2013 Green Drop score for the Garden Route District Municipality, rather there is a Green Drop scores for each local municipality within the Garden Route District Municipality (Department of Water and Sanitation 2013).

The 2011 Green Drop scores of each local municipality within the Garden Route District Municipality are as follows: The George Local Municipality scored 84.90 %; the Mossel Bay Local Municipality scored 79.20 %; the Knysna Local Municipality scored 78.73 %; the Bitou Local Municipality scored 98.82 %; the Oudtshoorn Local Municipality scored 69.95 %; the Hessequa Local Municipality scored 47.86 %; and the Kannaland Local Municipality scored 50.27 % (Department of Water and Sanitation 2013). These Green Drop scores indicates that the wastewater services in most of the local

municipalities within the Garden Route District Municipality are being managed according to the expectations of the Department of Water and Sanitation as assessed by the Green Drop score.

In addition to the Green Drop scores, 85.70 % of households have their refuse removed by local authority/private company in the Garden Route District Municipal Area (Statistics South Africa 2011). This is much better than the national average for household refuse removal, which is 59.40 % (Statistics South Africa 2011). Nevertheless, uncollected waste often still ends up in water and sanitation infrastructure, blocking stormwater drains and polluting rivers. It is predicted that climate change will affect these water and sanitation challenges.

Climate change is predicted to have an impact on rainfall patterns in South Africa. Future rainfall projections for the Garden Route District Municipality (using the measuring station at George) for the period 2020 to 2040 (Figure 52) are made using the Representative Concentration Pathways (RCP) 4.5 greenhouse gas concentration trajectories (Climate System Analysis Group 2017a).

The bar charts (Figure 52) show the potential change in rainfall, with the blue bars indicating a potential increase in average rainfall and the red bars indicate a potential decrease in average rainfall (Climate System Analysis Group 2017a). The grey lines represent the various models used for this projection. It is therefore projected across most of the models that Garden Route District Municipality could experience an increase in rainfall in the months of January, February, March, April, July, September, October and December, and a decrease in rainfall during May, June, August and November (Climate System Analysis Group 2017a).

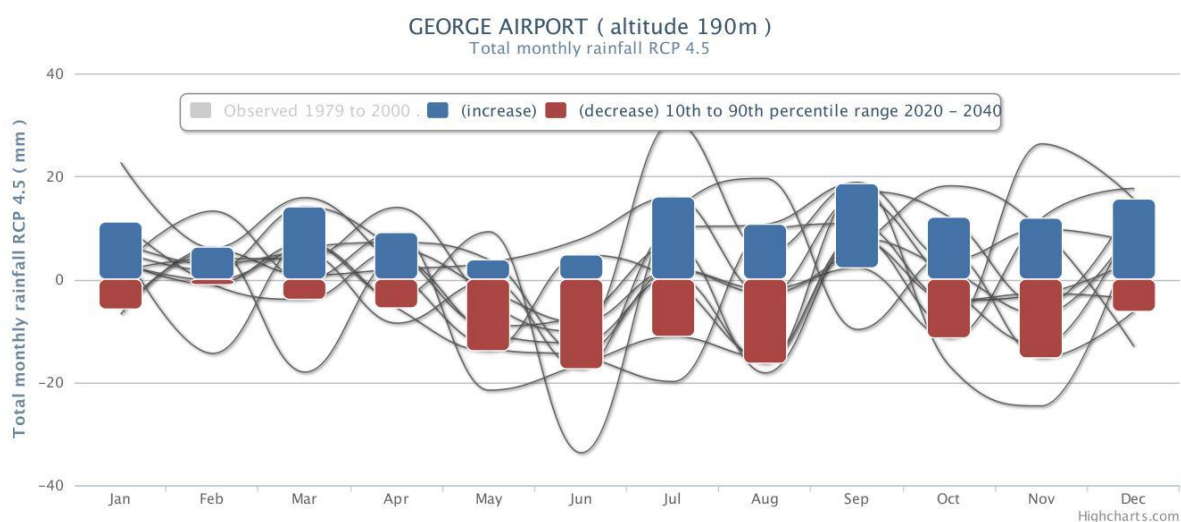


Figure 52: Rainfall Projections for George (Climate System Analysis Group 2017a)

Climate change is also predicted to increase the number and severity of droughts, fires and floods in the in the Garden Route District Municipal Area (Garden Route District Municipality 2014). To counter these risks, the Garden Route District Municipality intends to conserve water resources, wetlands and biodiversity, through updated land-use and settlement plans that take disaster risk management criteria into account, and by increasing public awareness regarding water conservation, droughts, fires and floods (Garden Route District Municipality 2014, 2017a). This is particularly pertinent given the recent devastating fires in and around the Garden Route as well as the severe ongoing drought in Western Cape (Garden Route District Municipality 2014, 2017a).