Garden Route District Climate Change Adaptation Needs and Response Assessment

2024

Developed as a collaborative initiative by the Garden Route District Municipality, the Department of Environment, Forestry and Fisheries (Local Government Climate Change Support Program), and the below stakeholders:

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- Department of Forestry, Fisheries and the Environmental (DFFE)
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1 Introduction

Climate change is considered to be one of the greatest changing dynamics of our era and it is becoming increasingly apparent that nature and its resources are not unlimited. As a results of climate change, critical biodiversity areas, wetlands and agricultural land are being lost or degraded at a rapid pace. This in turn threatens regional economic assets, public health and safety. This Garden Route District Climate Change Needs and Response Assessment is therefore an essential management mechanism in order to ensure that prioritised and effective climate change implementation responses are put in place within the district.

The Garden Route District Climate Change Needs and Response Assessment document is one of two climate change documents for the Garden Route district as part of alignment with the draft South African Climate Change Act (Bill), 2022.

The draft South African Climate Change Act (Bill) requires that all organs of state align their policies with the Act. They must also give effect to the objectives and principles of the Act. This new Act will be binding to all organs of state. The Garden Route District Municipality therefore took the opportunity to pre-empt the review of its current Garden Route Climate Change Strategy to be aligned with, and to ready, the document in anticipation of the date when the new Act comes into operation by proclamation in the Gazette.

The draft Climate Change Act (Bill), 2022 also requires the Mayor of a District Municipality to develop two documents which must both be reviewed every 5 years, and to be published in the Gazette (RSA, 2022):

1. A climate change needs and response assessment, and;
2. A climate change response implementation plan.

The climate change needs and response assessment, contemplated in subsection 1)(a) of the draft South African Climate Change Act (Bill), 2022, must (RSA, 2022)—
(a) identify climate change response considerations and options;
(b) analyse the nature and characteristics of the province or metropolitan or district municipality, as the case may be, and the particular and unique climate change needs and risks that arise as a result of such nature and characteristics;
(c) identify and spatially map, within the sphere of operations of the province, district or metropolitan municipality, as the case may be, risks, vulnerabilities, areas, ecosystems and communities that will arise, or that are vulnerable to the impacts of climate change;
(d) be based on the best available science, evidence and information; and
(e) identify and determine measures and mechanisms to manage and implement the required climate change response.

In preparation with the requirements of the Act, the Garden Route District Municipality (GRDM) developed this document, entitled the “Garden Route District Municipality Climate Change Needs and Response Assessment, 2024”, which contains the Climate Change Vulnerability Assessment conducted during a stakeholder engagement workshop in 2017, and other info as per the requirements of the new Act. The contents of this document informs the Garden Route District Municipality’s Climate Change Response Implementation Plan. The Climate

Change Response Implementation Plan contains the response measures or programmes relating to both adaptation and mitigation, as per the requirements of the Act.

2 The Nature and Characteristics of the Garden Route District Municipality

2.1 The Garden Route District Municipal Area

The Garden Route district is one of six districts located in the Western Cape and it is located in the south-east of the province. The Garden Route district The district occupies a total land area of 23,331km2, and is defined as the region bounded by the Outeniqua Mountains to the north, and the Indian Ocean to the south. The western boundary of the region occurs near the town Riversdale, and the eastern boundary near the town Plettenberg Bay. A large part of this area falls within the hydrological boundaries of the Greater Gouritz Water Management Area. The geographic area of the municipality consists of seven Category-B municipalities, such as the Bitou, Knysna, George, Mossel Bay, Oudtshoorn, Kannaland and Hessequa local Municipalities (Figure 1).

Figure 1: The Garden Route District Municipal Area

The Table 1 below provides a summary of the key indicators for the Garden Route District Municipal area. The table lists the national indicators for comparison purposes. Many of these indicators are used in the climate change vulnerability assessment process below.

2.2 Key Garden Route District Indicators

The following is some of the key indicators for the Garen Route District Municipal area:

Table 1: Summarised Garden Route district key indicators (Wesgro, 2022).

TABLE 1: GARDEN ROUTE DISTRICT KEY INDICATORS	
Executive Mayor	Ald. Memory Booysen
Population (2021)	626, 649
Total Area	23, 331 km^2
GVA at basic prices (constant 2015 prices) (2021)	ZAR43.34bn
Real GDP Growth (2021)	4.68%
Unemployment Rate (2021)	21.06%
Population Groups (2021)	Coloured (53.67%), Black African (29.55%), White (16.35%), and Indian and Asian (0.43%)
Languages	Afrikaans (75.6%); Xhosa (17.3%); English (6.2%)
Matric Pass Rate (2020)	80.1%
Gini Coefficient (2020)	0.63
HDI (2020)	0.76

2.2.1 Demographics

With a population of 626, 649 in 2021, the Garden Route district was the third most populous district in the Western Cape, after the City of Cape Town, and the Cape Winelands district. The Garden Route's population is estimated to have grown by an annual average annual growth rate of 1.07% from 2017 to 2021 Figure 2) (Wesgro, 2022).

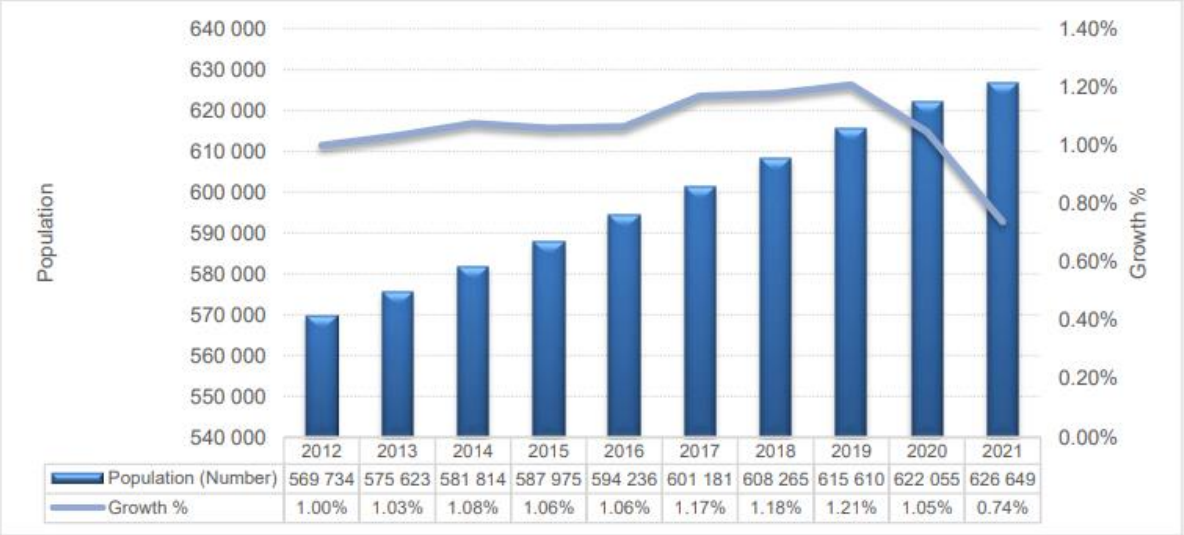
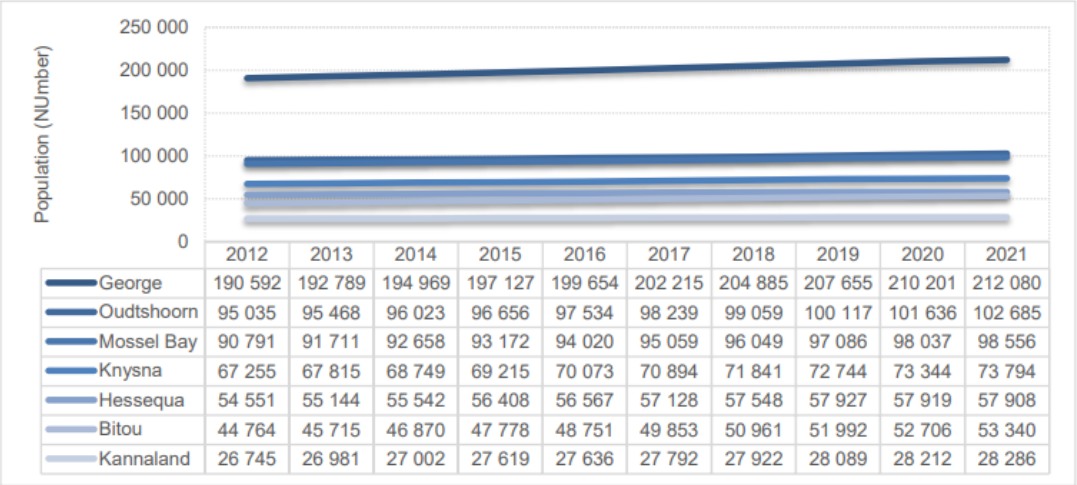


Figure 2: Garden Route District Municipal area population, 2012 – 2021 (Wesgro, 2022).

Within the Garden Route district, the George local municipality recorded the biggest population between 2012 and 2021 (Figure 3). This local municipality recorded a population of 212, 080 in 2021, followed by the Oudtshoorn and Mossel Bay local municipalities with 102, 685 and 98, 556 people, respectively (Wesgro, 2022).



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
George	190 592	192 789	194 969	197 127	199 654	202 215	204 885	207 655	210 201	212 080
Oudtshoorn	95 035	95 468	96 023	96 656	97 534	98 239	99 059	100 117	101 636	102 685
Mossel Bay	90 791	91 711	92 658	93 172	94 020	95 059	96 049	97 086	98 037	98 556
Knysna	67 255	67 815	68 749	69 215	70 073	70 894	71 841	72 744	73 344	73 794
Hessequa	54 551	55 144	55 542	56 408	56 567	57 128	57 548	57 927	57 919	57 908
Bitou	44 764	45 715	46 870	47 778	48 751	49 853	50 961	51 992	52 706	53 340
Kannaland	26 745	26 981	27 002	27 619	27 636	27 792	27 922	28 089	28 212	28 286

Figure 3: The Garden Route local municipality population, 2012 – 2021 (Wesgro, 2022).

2.2.2 Gender and Age Breakdown

The bar chart below (Figure 4) shows the age and gender breakdown of the population of the Garden Route district. As is shown in the graph, the largest percentage of the population are below 35 years of age, indicating that the majority of the population is still young (Wesgo, 2022).

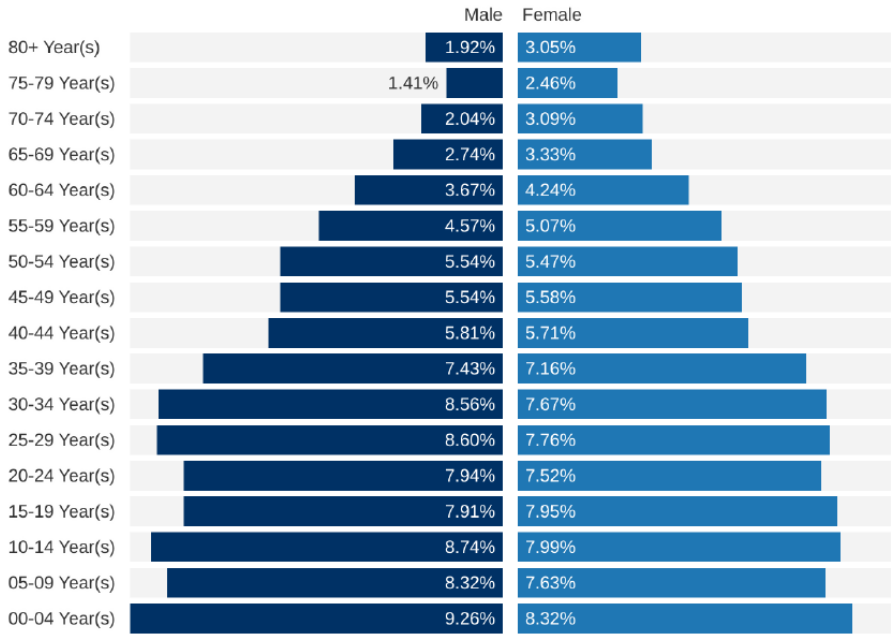


Figure 4: bar chart below shows the age and gender breakdown of the population of the Garden Route district (Wesgo, 2022).

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Within the Garden Route district, the George local municipality recorded the biggest population between 2012 and 2021. This local municipality recorded a population of 212, 080 in 2021, followed by the Oudtshoorn and Mossel Bay local municipalities with 102, 685 and 98, 556 people, respectively (Wesgro, 2022).

2.2.3 Employment Indicators

The Table 1 below provides a snapshot of indicators for employment in the Garden Route district in 2021. The unemployment rate at this time was 21.06%, with 203, 493 people employed from a working age population of 406, 194 people.

Table 2: Garden Route District Employment Indicators (Wesgro, 2022).

Employment Indicators for the Garden Route District Municipal Area	
Population aged 15 – 64 years	406, 194
Labour force participation rate (%)	63, 46%
Employed	203, 493
Formally employed	161, 882
Informally employed	41, 611
Unemployed	54, 285
Not economically active	148, 416
Unemployment rate (%)	21, 06%

2.3 Future Climate Change Projections for the Garden Route District

The impacts of increasingly severe climatic changes includes natural disasters such as severe storms, floods, droughts, fire risks, an increase in sea level and limited access to good quality water. Due to climate change, disaster management comes at a public, economic and household cost. Poorer households are less likely to recover from the effects on climate change related disasters, and as a result, have a greater reliance on the government. As extreme climatic events will take place more frequently in the futire, it is more sustainable to implement interventions to reduce disaster risks rather than having to recover from the impact of extreme disasters (GRDM, 2017).

According to the Intergovernmental Panel on Climate Change (IPCC), It is clear that the global mean surface temperature (GMST) has been increasing in the past. The average over the decade 2006-2015 was 0.87°C [with 95% confidence interval between 0.75°C and 0.99°C] higher than the average over the 1850–1900 period (IPCC, 2018). Average temperatures in the Western Cape region have increased at 1.2 times the global average and the change in temperature has been larger than natural variability (Pinto *et al*., in review). Hot extremes have increased and cold extremes have decreased over the period of 1931-2005 (Kruger and Nxumalo, 2017).

Due to its physical location, topography and the climatic conditions of the Garden Route district, the area is particularly vulnerable to the impact of climate change. Climate change is already harming food production and these impacts are projected to increase over time, with potentially devastating effects (Figure 5).

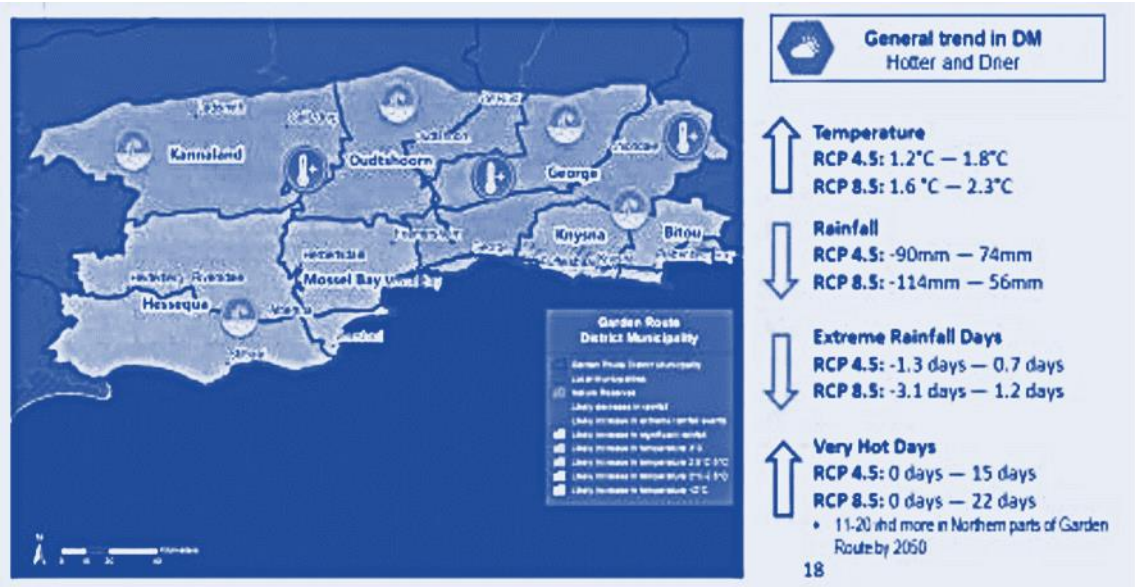

Figure 5: The 2050 climate change overview for the Garden Route District (WCG: CGTA,)

The most frequent disasters in the Garden Route District between are drought, floods, storm damage, fires (Veldt), fires (Informal settlements), sea level rise, animal diseases and environmental degradation.

2.3.1 Rainfall Trends

In their studies of the 2015-2017 drought, Sousa et al. (2018) and Mahlalela et al. (2019) revealed a strong drying trend, particularly in the post-1979 period. Wolski et al. (2021) performed a rigorous analysis of rainfall trends in station data over the western two thirds of the Western Cape Province, the area dominated by the “Day Zero” drought. They revealed that over the most recent period (1981-2017) there has been a drying trend in a majority of stations, although mostly not statistically significant. However, during the 1981-2014 period (i.e. prior to the drought), only a few stations had statistically significant drying and a large number of stations in the region experienced an increase in rainfall (Figure 6). These results suggest that the predominant tendency towards decreasing rainfall noted by Sousa et al. (2018) and Mahlalela et al. (2019) emerged only due to the very low rainfall of the 2015-2017 drought (Figure 6). Longer-term trends in the period prior to the 2015-2017 drought are generally weak, with direction varying between individual locations and do not support a message of consistent historical drying (Figure 6). The recent drying trend identified in the winter rainfall region in MAM is likely associated with changes in large-scale drivers, in this case SAM and the expansion of the Hadley cell, which in turn affect the positioning of the westerlies, fronts and jet streams (Sousa et al., 2018; Burls *et al.*, 2019; Mahlalela et al., 2019).

With increases in global warming levels, the region is expected to experience upward trends in hot extremes and downward trends in cold extremes (Mbokodo *et al.,* 2020; Seneviratne and Hauser, 2020; Vogel *et al*., 2020). Projections from climate models suggest a further drying associated with the Hadley cell expansion, positive phases of SAM and a poleward shift of the westerlies over the coming decades (Lim *et al.,* 2016; Pinto *et a*l., 2016, 2018; Maúre

et al., 2018; Seager *et al*., 2019; Almazroui *et al*., 2020; Naik and Abiodun, 2020; Ukkola *et al.,* 2020).

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 8) 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).

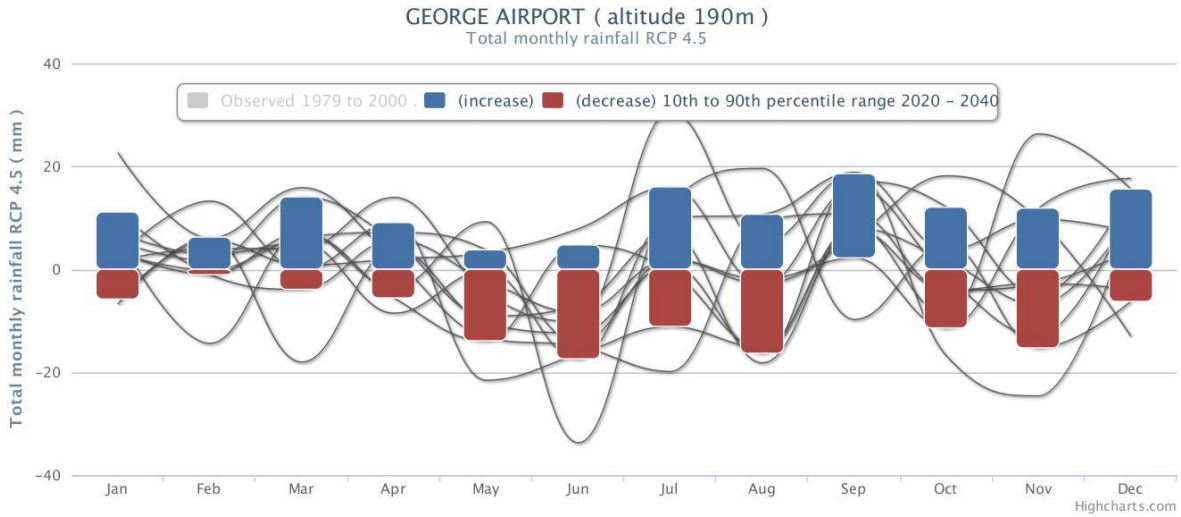

Figure 6: Rainfall Projections for George (Climate System Analysis Group, 2017a)

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.

2.3.2 Increasing Temperatures

The Figure 7 below shows projected changes in annual average temperatures, highlighting increasing temperatures throughout the district for the period 2021-2050 under the RCP 8.5 scenario. By 2050, the district is projected to be affected by higher annual average temperatures, which will adversely affect water and food security. Evaporation rates will also likely increase and agricultural outputs may reduce (CSIR, 2019).

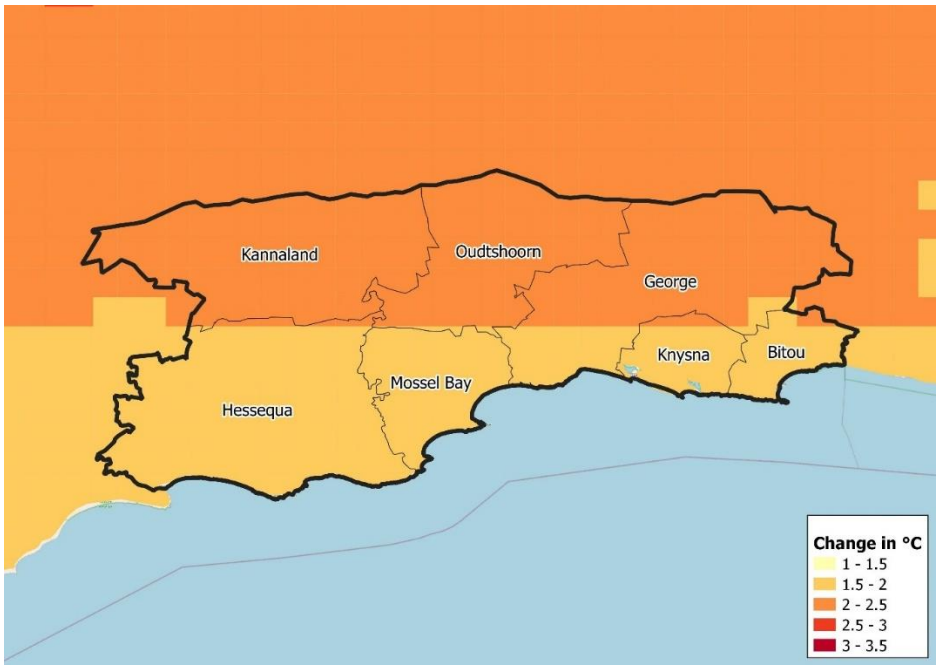

Figure 7: Projected changes in annual average temperatures throughout Garden Route over the period 2021-2050 under the RCP 8.5 scenario (CSIR, 2019).

2.3.3 Increasing Rainfall Variability

The Figure 8 below shows projected shifts in annual average rainfall throughout the district between 2021-2050 under the RCP 8.5 scenario. Annual average rainfall amounts vary across the district. There is uncertainty regarding projected future rainfall (CSIR, 2019).

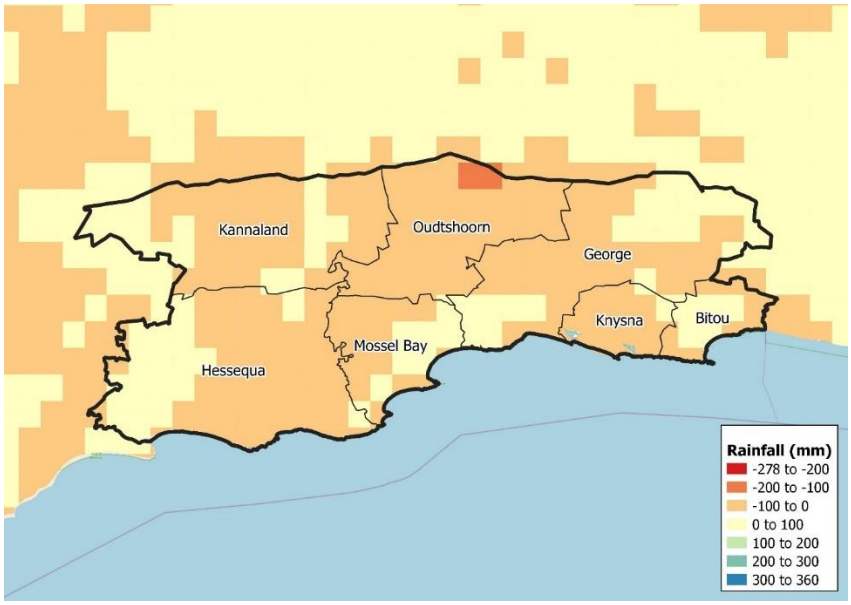

Figure 8: Projected changes in annual average rainfall throughout Garden Route over the period 2021-2050 under the RCP 8.5 scenario (CSIR, 2019).

2.3.4 Increasing Storms and Flooding Events

The Figure 9 below shows projected changes in the annual average number of extreme rainfall days throughout the district over the period 2021-2050 under the RCP 8.5 scenario. Increases in the number of rainfall days are likely to result in an increase in intense storms, and flooding events across the district (CSIR, 2019).

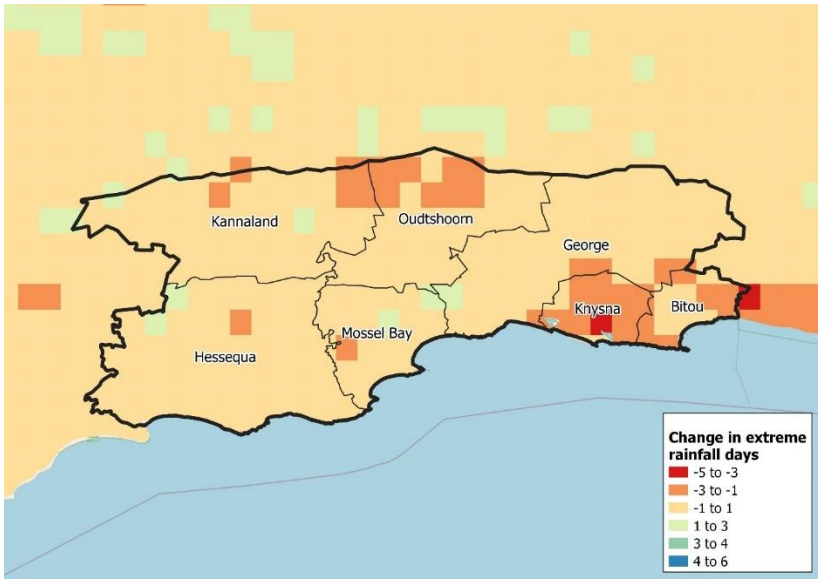

Figure 9: Projected changes in the annual average number of extreme rainfall days throughout Garden Route over the period 2021-2050 under the RCP 8.5 scenario (CSIR 2019).

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 experience 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 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).

2.4 Garden Route District Sector Summaries

2.4.1 Garden Route District Agricultural Sector Summary

The Agricultural 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 (Figure 10) (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).

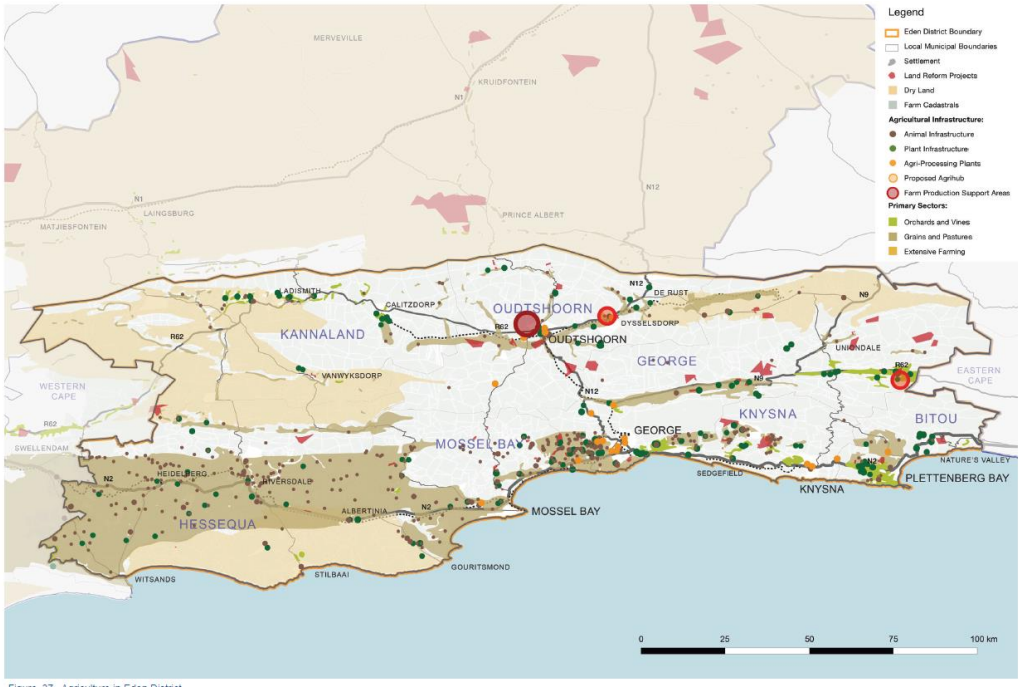

Figure 10: Agriculture in the Garden Route District Municipal Area (GRDM SDF, 2017).

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).

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 (Figure 11) (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 (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).

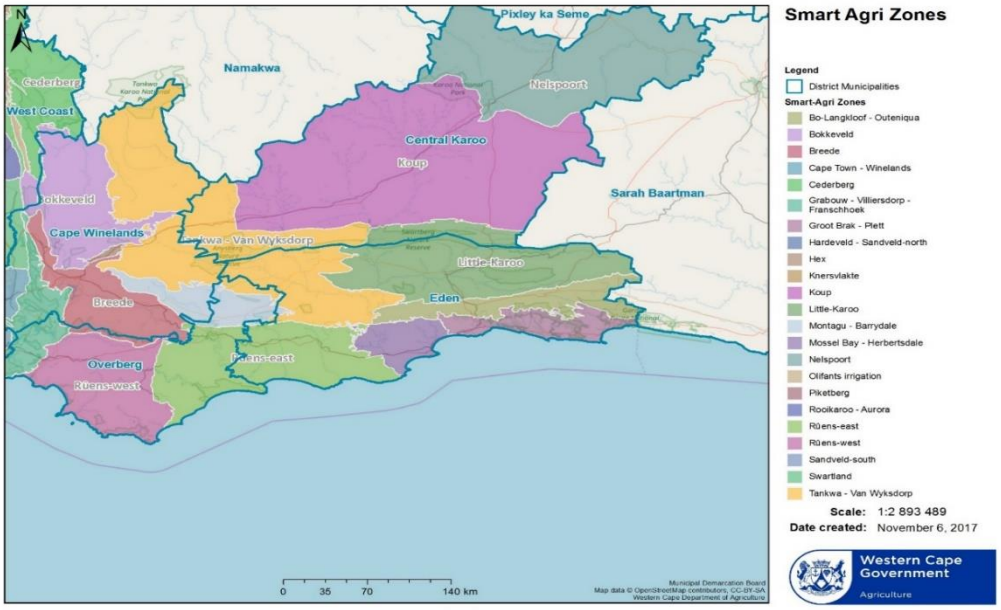

Figure 11: SmartAgri Zones in the District Municipal Area (Western Cape Department of Agriculture, 2017).

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, while the southeast has the lowest grazing capacity (Figure 12) (Western Cape Department of Agriculture, 2017). Much of the south of the district 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.

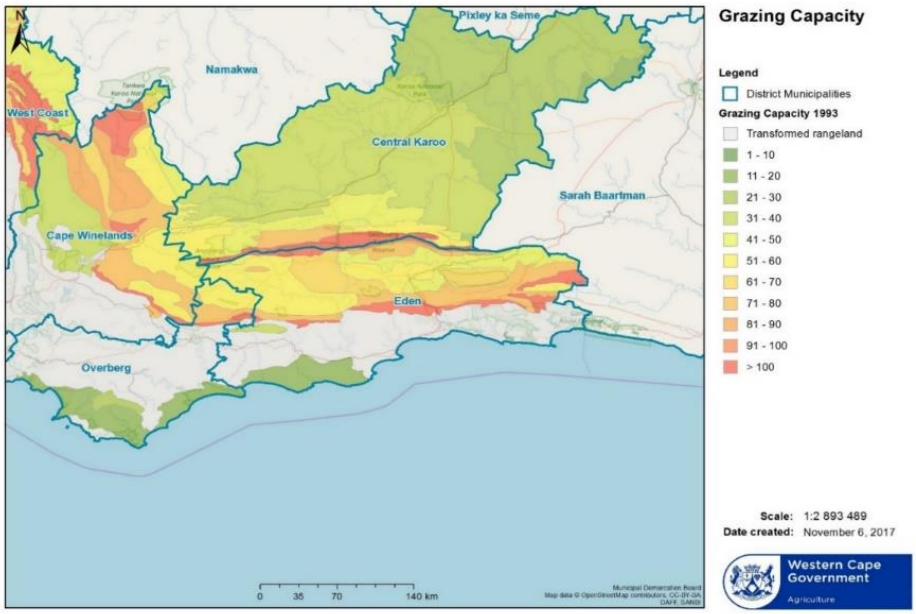

Figure 12: Grazing capacity in the Garden Route district (Western Cape Department of Agriculture, 2017)

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 13) (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).

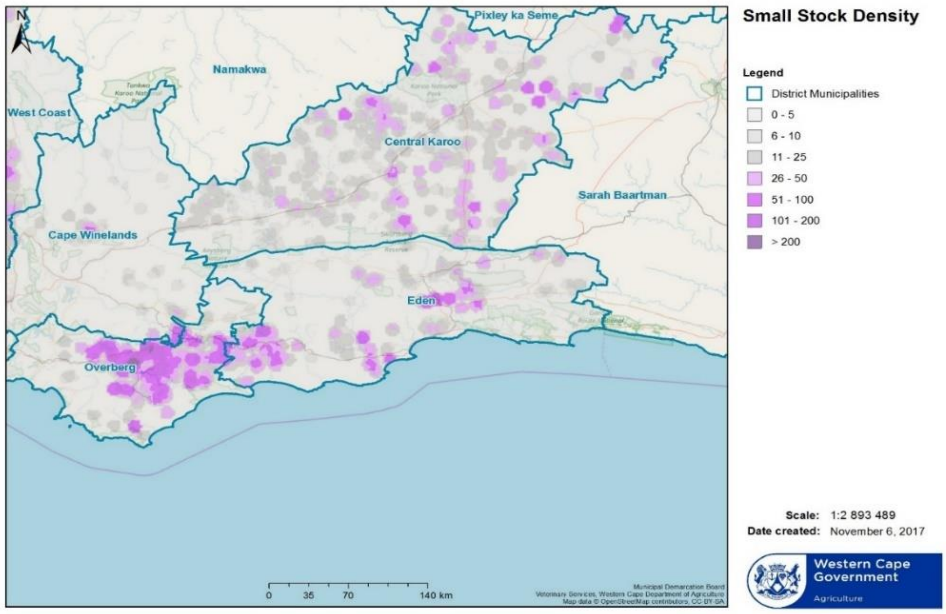

Figure 13: Small stock density levels in the Garden Route district (Western Cape Department of Agriculture, 2017).

Additionally, bovine density levels (Figure 14) 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).

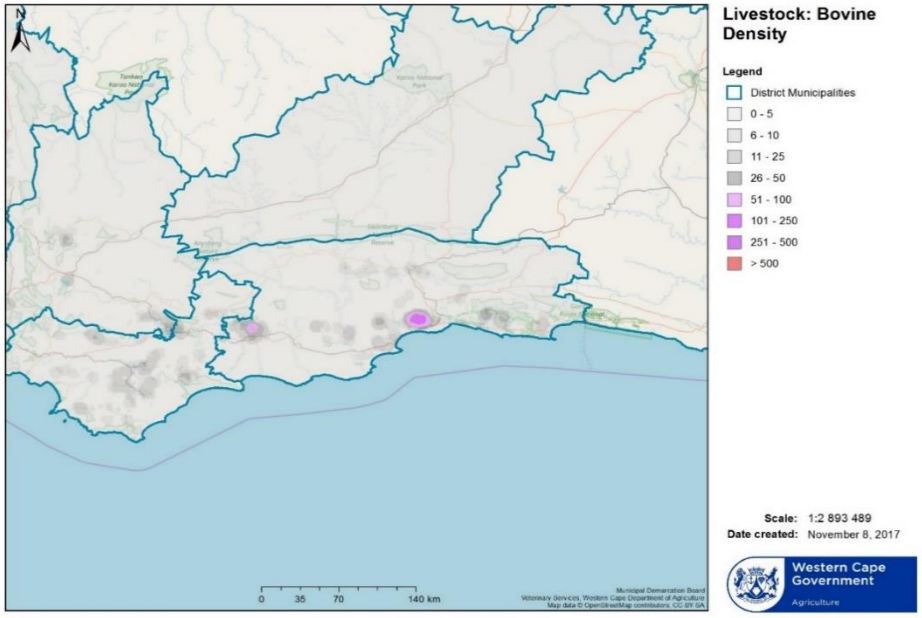

Figure 14: Bovine density levels in the Garden Route district (Western Cape Department of Agriculture, 2017)

Furthermore, ostrich farming (Figure 15) 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).

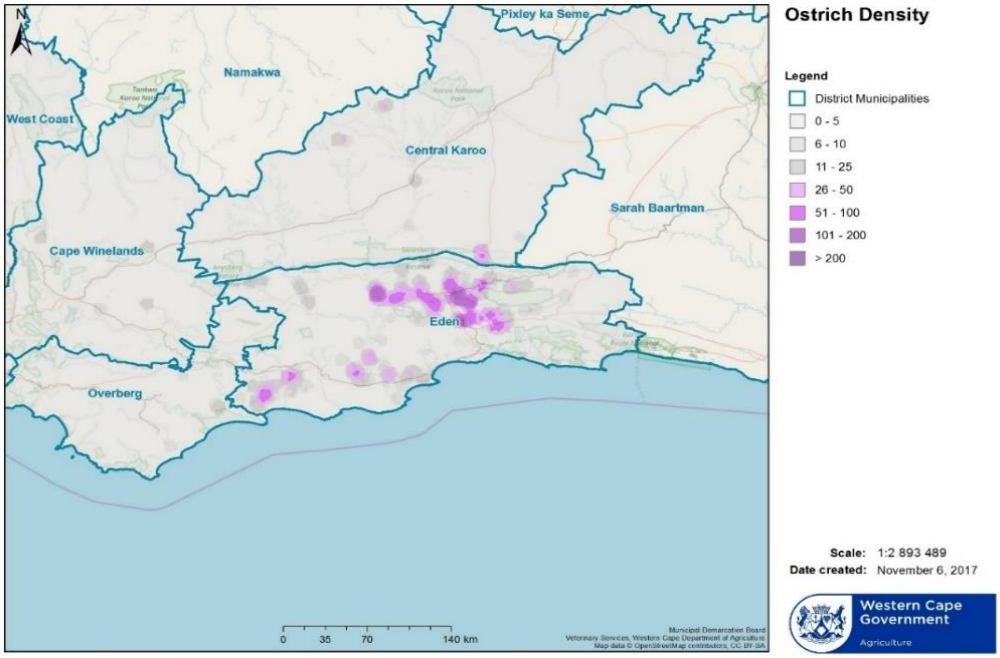

Figure 15: Ostrich density levels in the Garden Route district (Western Cape Department of Agriculture, 2017).

While there are varying grazing capacities in the Garden Route District Municipal Area, the crop census (Figure 16) 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).

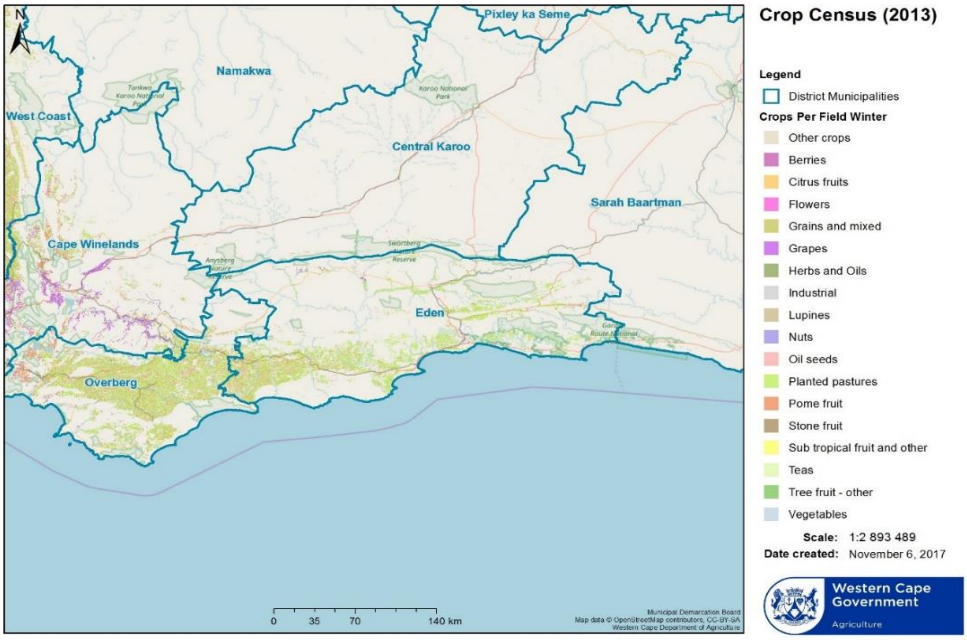

Figure 16: Crop census in the Garden Route district (Western Cape Department of Agriculture, 2017).

There are also three “Wine of Origin” districts within the Garden Route District Municipal area (Figure 17), namely, the Calitzdorp, Langeberg-Garcia and Plettenberg Bayenberg Bay districts (Western Cape Department of Agriculture, 2017). Wine of Origin districts are more specific that wine regions and they signify that all the grapes came from the same specific area (Western Cape Department of Agriculture, 2017).

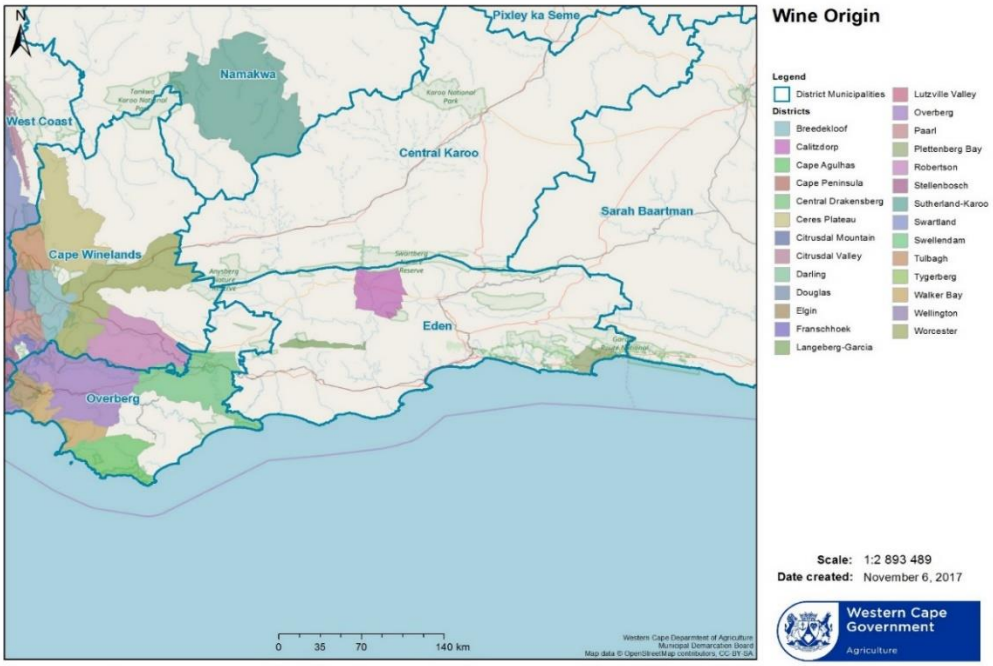

Figure 17: Wine of origin districts in the Garden Route district (Western Cape Department of Agriculture, 2017).

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 18) (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).

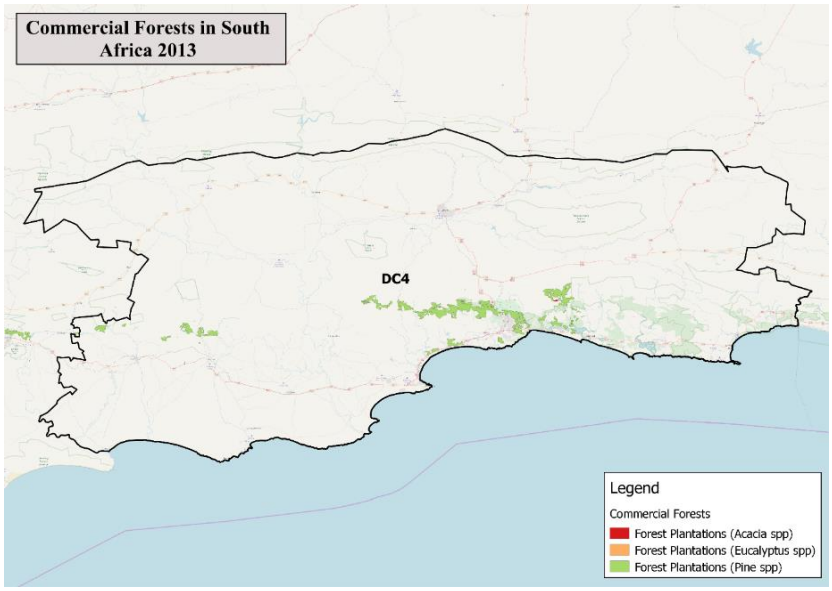

Figure 18: Commercial forestry distribution across the District Municipal Area (De Lange, 2013).

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).

2.4.2 Garden Route District Biodiversity Sector Summary

The Garden Route district has diverse natural landscapes, consisting of fynbos, forest, mountainous, and agricultural landscapes, estuaries and lagoons, and coastal settings, including the verdant landscapes of the coastal belt. Its bio-physical environment also supplies the economy with resources such as water, land, clean air, marine resources, and energy, amongst others. There are two major biodiversity corridors that span through the Garden Route district, namely the UNESCO Garden Route Biosphere Reserve, which connects the Western Cape and the Eastern Cape along the coast, and the Gouritz Cluster Biosphere Reserve corridor that covers a large portion of the district (Figure 19). Biodiversity corridors are extensive stretches of land that aim to conserve and protect biodiversity and ecological systems. The importance of these corridors is to ensure healthy, connected landscapes and habitats. In turn, these corridors support local industry (agriculture) and communities.

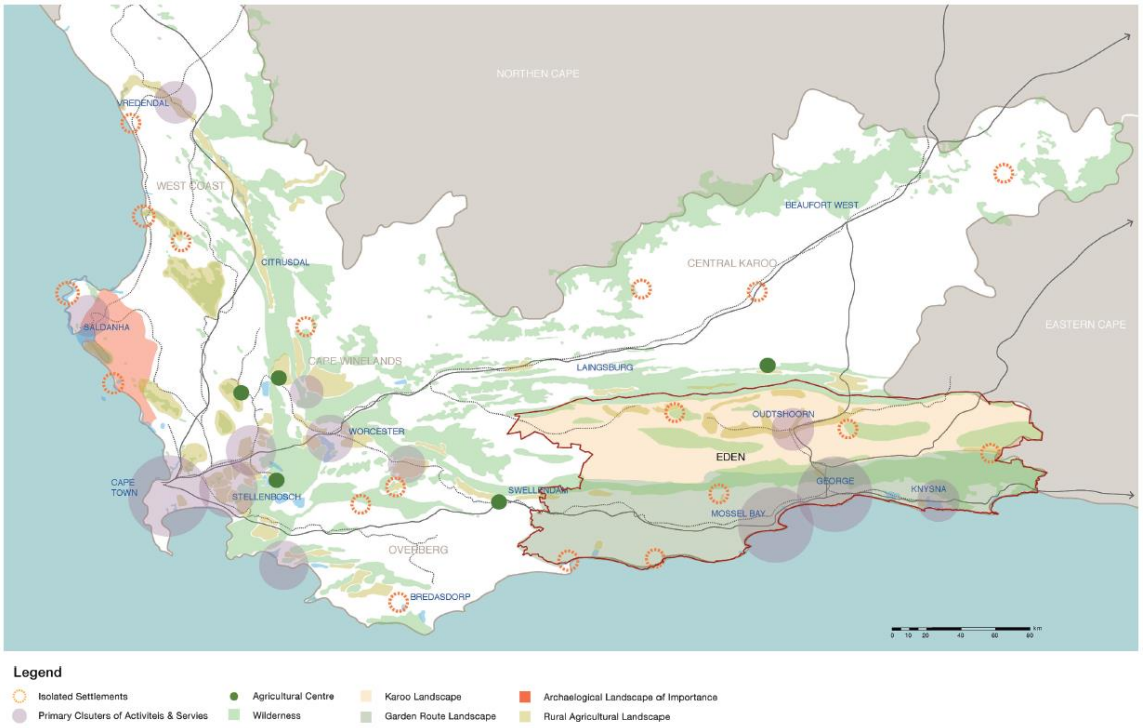

Figure 19: Western Cape biodiversity corridors (adapted from WCG, 2014).

The Garden Route district can be split into four main biome landscapes, namely the Fynbos biome, the Succulent Karoo biome, and the Albany Thicket and Forest biomes (Figure 20). The Western Cape Fynbos biomes is both fire prone and fire adaptive (Midgeley, et al., 2005). The region's fire interval under natural conditions is usually 12 – 18 years between fires. This number is expected to increase by 40% in the next 100 years (Midgeley, et al., 2005). Some of the knock on effects include increased wild fires in areas with adapted alien vegetation infestations, and therefore escalated densities of combustible materials. The loss of indigenous species is also expected to increase, which will make fires more frequent and more difficult to manage.

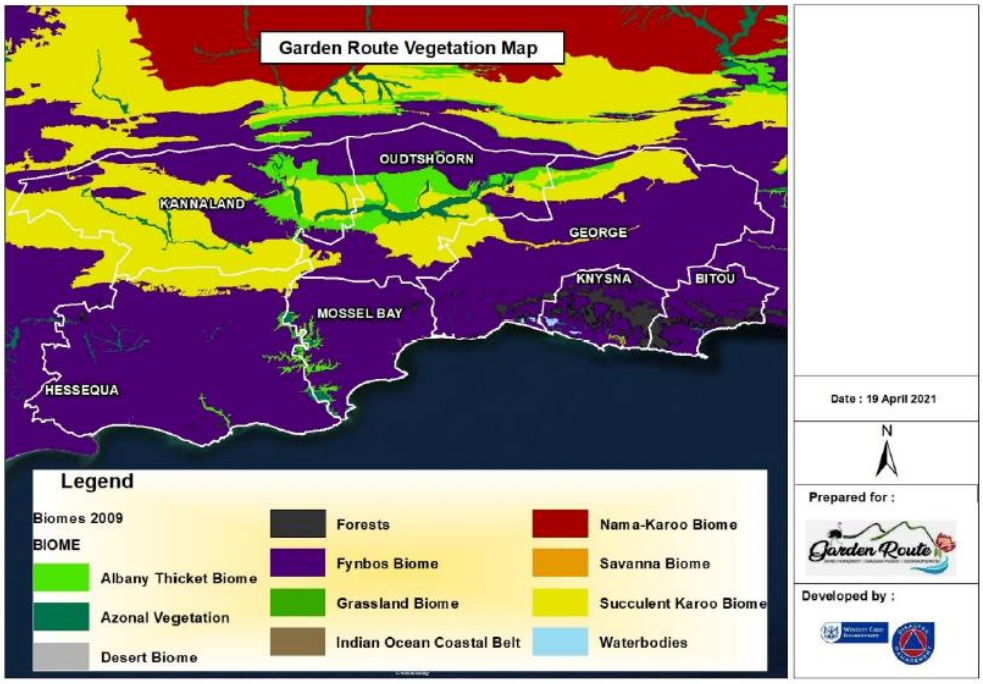

Figure 20: The spatial distribution of biomes in the Garden Route district (SANBI, 2023; WC DMC,

[34] https://www.sanbi.org/link/bgis-biodiversity-gis/

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 22). 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).

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 (Figures 21 and 22) 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.

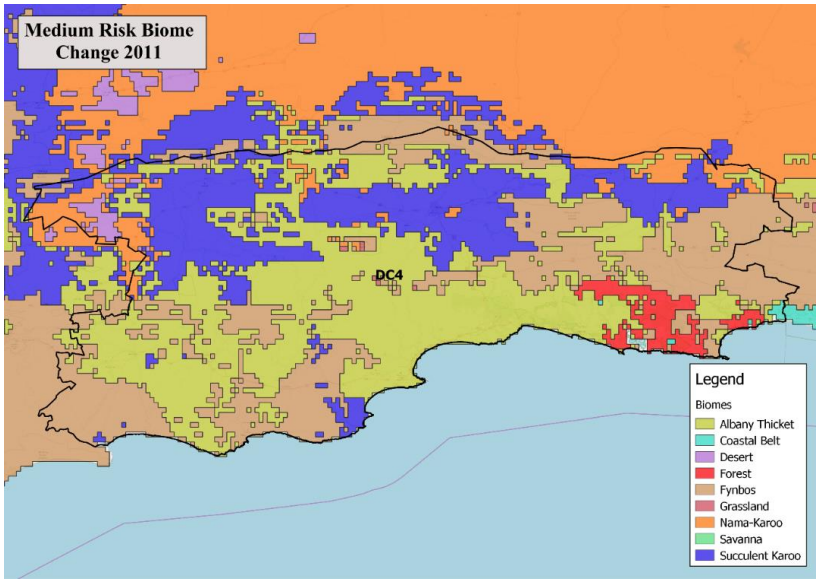

Figure 21: Predicted shift in biomes in the Garden Route district using a medium risk scenario (South African National Parks, 2011c).

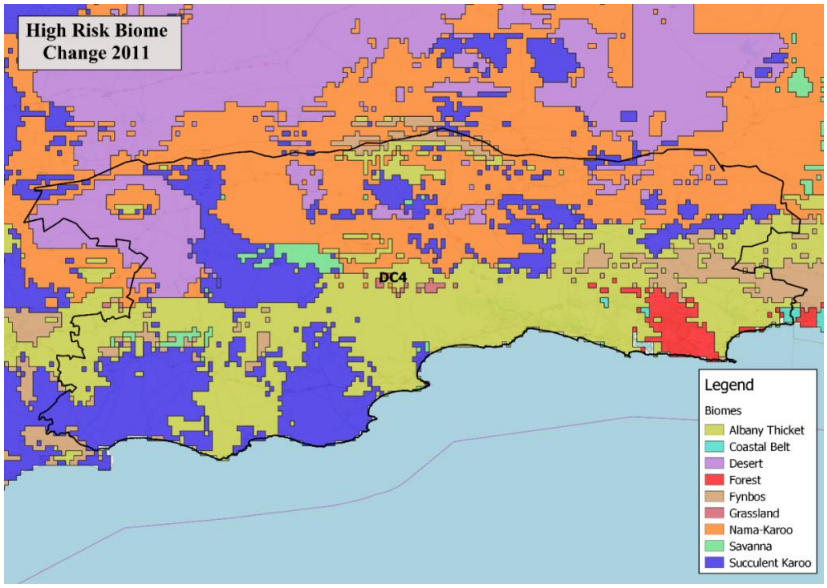

Figure 222: Predicted shift in biomes in the Garden Route district using a high risk scenario (South African National Parks, 2011b).

Within the Biomes found in the Garden Route District Municipal Area, there are numerous threatened ecosystems types (Figure 23). 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).

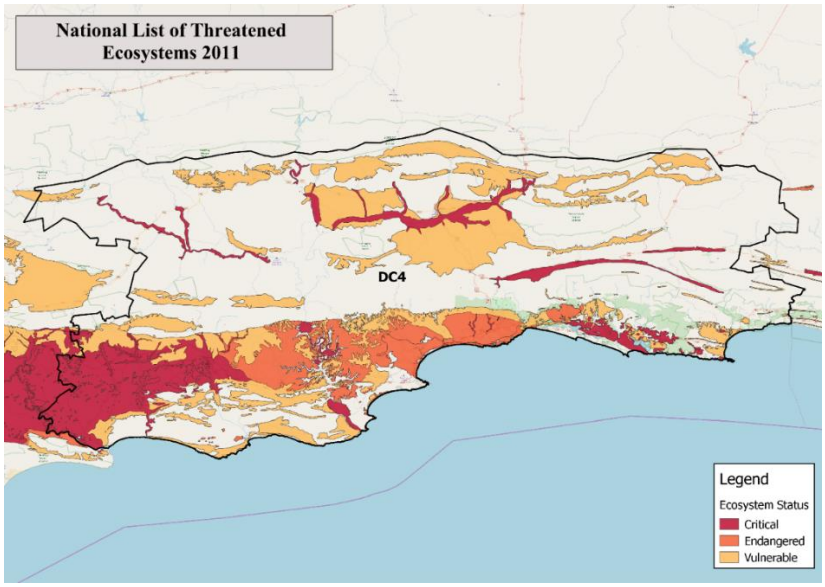

Figure 233: Threatened ecosystem types in the Garden Route district (South African National Biodiversity Institute, 2011b).

The Garden Route district is host to an extraordinary legacy of formally and informally conserved areas including National Parks, Provincial Nature Reserves, Protected Areas, Marine Protected Areas, World Heritage Sites, Biosphere Reserves and RAMSAR sites.

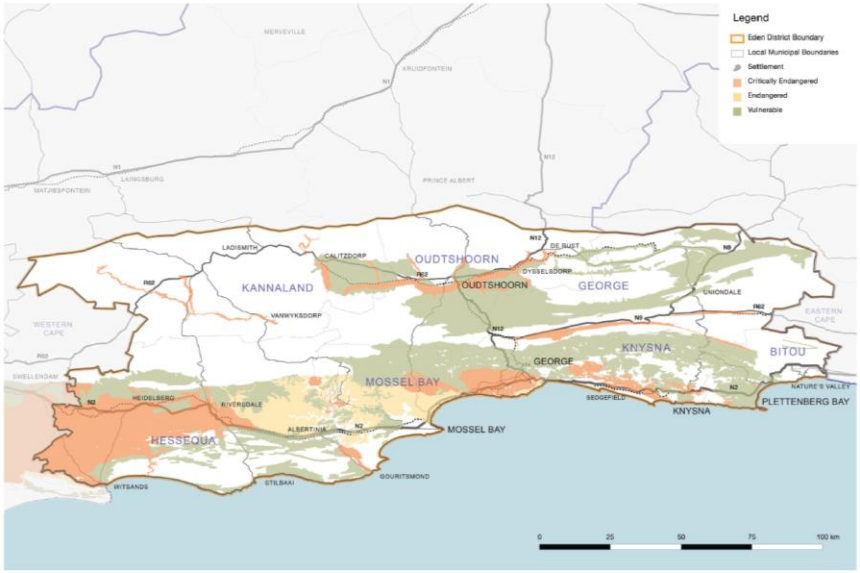

Figure 244: Ecological status in the Garden Route district (GRDM, 2017).

2.4.3 Protected Areas

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 25).

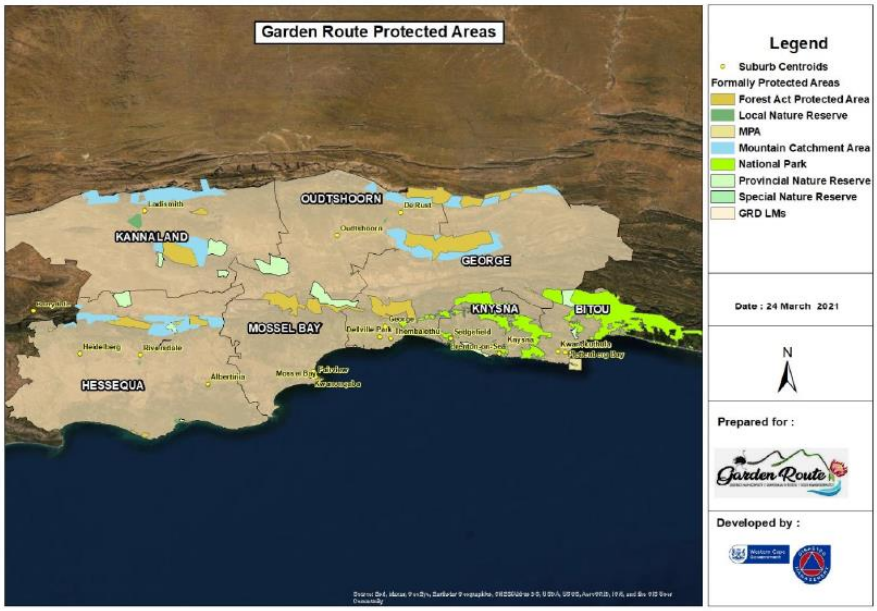

Figure 25: The protected areas within the Garden Route district (WC DMC, 2021).

Eleven nature reserves make up some of these protected areas (Table 4), which include unique marine reserves that are a host of diverse marine life. The Garden Route National Park (GRNP) is situated in the local municipal boundaries of George, Knysna and Bitou within the GRDM.

Table 3: The eleven land-based protected areas within the Garden Route District Municipality.

Protected areas

Land-based protected areas (formal)

Name	NSBA Category	Size (ha)	Size (%)
Baviaanskloof Nature Reserve	Provincial Nature Reserve	16041,4 ha	3,85%
Die Fort Local Nature Reserve	Local Authority Nature Reserve	114,4 ha	0,03%
EC Soetkraal Provincial Nature Reserve	Provincial Nature Reserve	34 ha	0,01%
Formosa Nature Reserve	Provincial Nature Reserve	4,9 ha	0%
Garden Route National Park	National Park	4366,6 ha	1,05%
Kammanassie Mountain Catchment Area	Mountain Catchment Area	16457,7 ha	3,95%
Kammanassie Nature Reserve	State Forest Nature Reserve	16842,6 ha	4,04%
Millwood Nature Reserve	State Forest Nature Reserve	57,7 ha	0,01%
Swartberg East Nature Reserve	State Forest Nature Reserve	5153,1 ha	1,24%
Swartberg-Oos Mountain Catchment Area	Mountain Catchment Area	8348,5 ha	2%
Witfontein Nature Reserve	State Forest Nature Reserve	2,4 ha	0%
11 reserves covering 67423,2 ha (16,17 %)			

Ramsar sites

There are no Ramsar sites in the municipality.

Within the coastal zone, the Garden Route district has four marine protected areas, namely the Tsitsikamma marine protected area, Robberg marine protected area, Goukamma marine protected area and the Stilbaai marine protected area, which are dealt with in more detail under the Coastal and Marine sector section in this document.

The Garden Route National Park

The South African National Parks'(SANParks) Garden Route National Park (GRNP) is a coastal reserve known for its indigenous forests, dramatic coastline and the Otter Trail. The GRNP is the result of the amalgamation of the existing Tsitsikamma and Wilderness National Parks, the Knysna National Lake Area and various other state-owned land.

The Garden Route Biosphere Reserve (GRBR)

The Garden Route Biosphere Reserve (GRBR) was designated in June 2017 by UNESCO as South Africa's 9th biosphere reserve and falls within the Cape Floristic Region (CFR) along the southern coast and includes the Goukamma and Robberg Marine Protected Areas, the Nelson Bay Cave situated in Robberg sector, the Wilderness Lake RAMSAR site, the Garden Route National Park and the Langkloof Valley. The GRBR's surface area totals 698 363 ha and contains high species diversity.

The region in which the GRBR is located is threatened by climate change, rapid urbanisation, poor land use practices and associated waste, uncontrolled spread of AIP and unsustainable

use of natural resources. These ecological drivers coupled with social drivers (poverty, unemployment and inequality) threaten the sustainability of the region, and have served to inform the key focus areas of the GRBR. These focus areas include landscape management coordination, green enterprise mentorship development, school youth biosphere programme, biosphere membership, water pollution and town/land use planning capacity development.

The Gouritz Cluster Biosphere Reserve

The Gouritz Cluster Biosphere Reserve (GCBR), a landscape-scale initiative aimed to create a biodiversity corridor along the Gouritz River, where naturally occurring indigenous plants and animals could disperse freely from conservation areas of the inland mountains to the coastal mountains resulted in the designation of South Africa's 7th biosphere reserve in June 2015, totalling 3 187 893 ha. The GCBR is characterised by high levels of plant endemism and is the only area in the world where three global biodiversity hotspots, the Fynbos, Succulent Karoo and Maputoland-Tongoland-Albany Subtropical Thicket biomes, converge. Doringrivier, Ruitersbos and Zebraskop sectors form part of the Core Areas of the GCBR.

The Cape Floristic Region

The Cape Floristic Region (CFR) is one of the six Floral Kingdoms of the world and is therefore recognised globally as one of the richest plant areas and a hotspot in terms of diversity, density and number of endemic species. This diverse kingdom of plant life and associated fauna is represented by 13 protected area clusters, part of the CFR Protected Areas World Heritage Site. The Garden Route, Swartberg and parts of the Anysberg and Baviaanskloof complexes fall within the boundaries of the GRDM.

The Wilderness Lakes Ramsar Site

The Wilderness Lakes Ramsar site falls within the GRNP, covering an area of 1 300 hectares and includes estuarine lakes of Rondevlei, Langvlei and Eilandvlei, the Serpentine channel, and a dune system. A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention, and intergovernmental environmental treaty established in 1971 by UNESCO. The treaty provides for national action and international cooperation regarding the conservation of wetlands, as well as sustainable use of their resources. The Wilderness Lakes Ramsar Site supports over 285 native plant species, 32 fish species and a diverse marine and estuarine invertebrate fauna.

2.4.4 Water Resources

The Garden Route district is predominantly located within the Breede-Gouritz Water Management Area (BGWMA), which is bounded by the Indian Ocean to the south, the Berg-Olifants Water Management Area (WMA) to the west, the Orange WMA to the north and the Mzimvubu-Tsitsikamma WMA to the east. There are two large rivers within the WMA, the Breede and Gouritz Rivers:

- The Breede River – its main tributary, the Riviersonderend River, discharges into the Indian Ocean; and
- The Gouritz – has three main tributaries, the Groot, Gamka and Olifants Rivers, and

includes a number of other smaller rivers in the WMA including the Touws, Duiwenhoks, Goukou, Hartenbos, Great Brak, Kaaimans, Knysna and Keurbooms Rivers, as well as the Palmiet, Kars, Sout, Uylenkraals, Klein, Onrus and Bot-Swart Rivers.

The local municipalities within the Garden Route district that fall under the Breede-Gouritz WMA include the George, Kannaland, Knysna, Bitou, Hessequa, Mossel Bay, and Oudtshoorn Municipalities. The Gouritz River is the main river, contributing 41% of the surface flow in the WMA. The other main rivers, which drain the inland area, are the Buffels, Touws, Groot, Gamka, Olifants and Kammanassie Rivers. The Duiwenhoks River supplies more than 1.2 million m³ per annum to the Overberg Water Board potable Duiwenhoks Rural Water Supply Scheme (domestic supplies to Heidelberg, Slangriver, Witsand and other smaller settlements as well as domestic and stock water), of which 0.7 million m³ per annum is transferred into the Breede WMA to supply farmers (WC DMC, 2021).

There are three distinct water resource zones within the Gouritz WMA based on topography and climate, these include:

- The semi-arid Great Karoo consisting of the Gamka River catchment to the north of the Swartberg Mountains and the Touws/Buffels/Groot River catchments, to the west of the Klein Swartberg Mountains.
- The Olifants River which is fed by mountain streams rising in the Swartberg Mountains to the north, the central Kammanassie Mountains and the coastal Outeniqua Mountains in the south.
- The Coastal Belt, which includes the Gouritz/Goukou/Duiwenhoks catchments, extends from the western boundary of the WMA to (and including) the catchment of the lower Gouritz River, and the remaining coastal belt extends to the eastern boundary of the WMA.

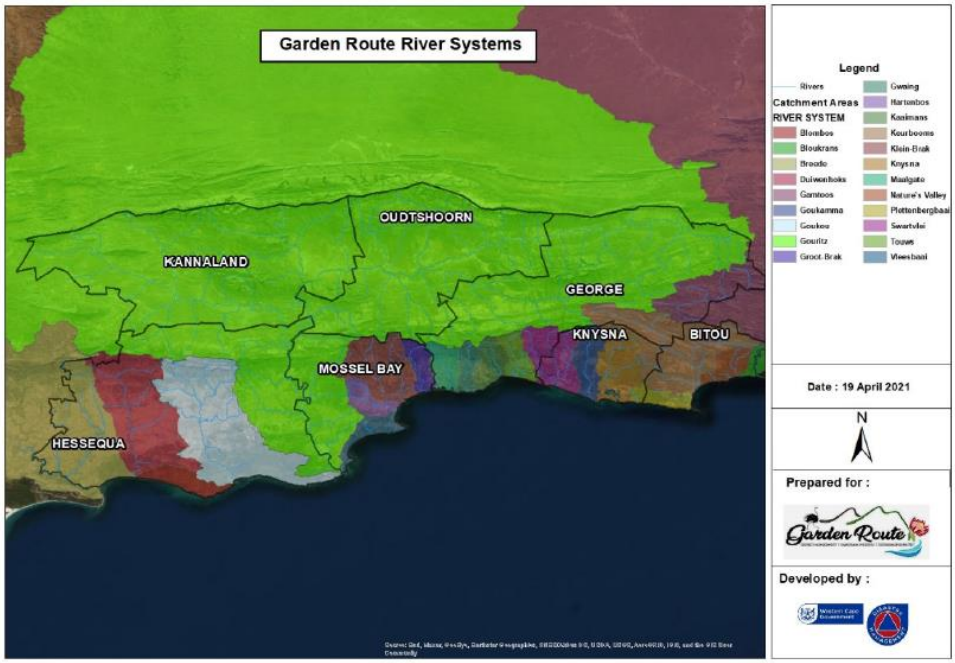

Figure 26: River systems in the Garden Route district (WC DMC, 2021).

The water quality of the Gouritz River is characterised by elevated salt concentrations. Water quality is good in the headwaters of the tributaries of the Gouritz River; however, it is characterised by elevated salt concentrations further downstream due to the geology of the

region, high evaporation, and agricultural impacts.

In terms of wetlands in the Garden Route district, according to the GRDM Climate Change Adaptation Summary Report (2018), 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) (Figure 27). (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).

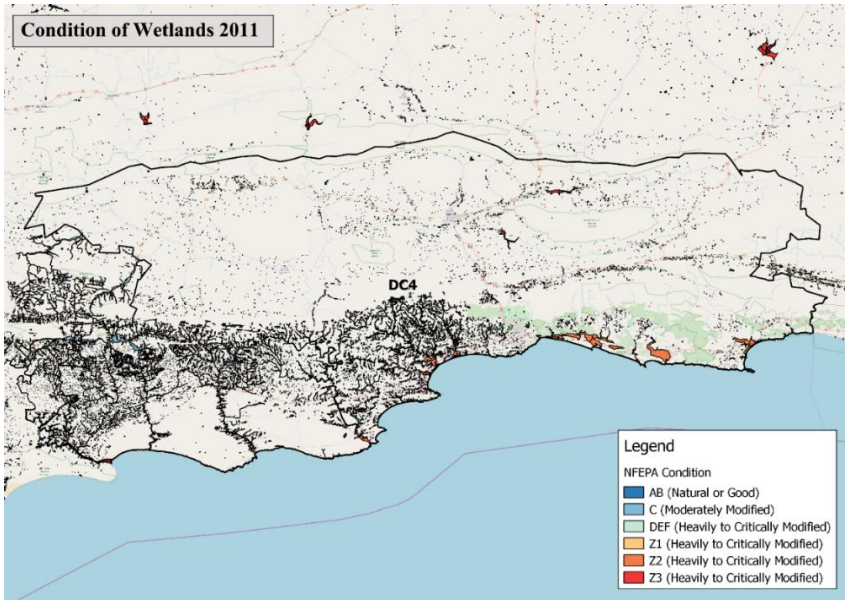

Figure 27: Condition of wetlands in the Garden Route district (Council for Scientific and Industrial Research, 2011).

The Garden Route Lake District also comprises five lakes and three lagoon estuaries, of which Swartvlei is the largest lake that is also a tidal lagoon. The other lakes include Groenvlei, Rondevlei and Upper Langvlei, which flows into Lower Langvlei (also known as Island Lake).

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*, et al*., 2012).

2.4.5 Land use and Biodiversity

The dominant land use types within the Garden Route district include agriculture, forestry (plantations), conservation areas, urban areas and smaller mining areas, each of which have had varying positive and negative impacts on the biodiversity of the District area (WC DMC, 2021:39):

- Cultivation of land is predominant in the southwestern portion of the Garden Route district (stretching between Mossel Bay and George), with key cultivation corridors also

in the Oudtshoorn valley and over the Outeniqua mountains, along the river corridors where irrigation is possible;

- Plantations occur in coastal mountainous areas, often competing with indigenous forests;
- Less modified, natural areas are predominant in the mountain catchment areas and drier veld areas where agriculture is not viable;
- The coastal belt is under greater development pressure; and
- The inland Klein Karoo experiences water stress related pressures.

The Figure 25 below illustrates the spatial distribution of the following:

- Protected Areas –
  o Terrestrial Areas which include world heritage sites, Ramsar sites, national parks, natural reserves and forest nature reserves and mountain catchment areas ; and
  o Marine which includes marine protected areas.
- Critical biodiversity areas – these include any terrestrial, freshwater aquatic or marine area required to meet biodiversity pattern and/or process thresholds.
- Ecological support areas – supporting zone required to prevent degradation of critical biodiversity areas and protected areas.
- Other natural areas – natural areas not included in the above listed categories.

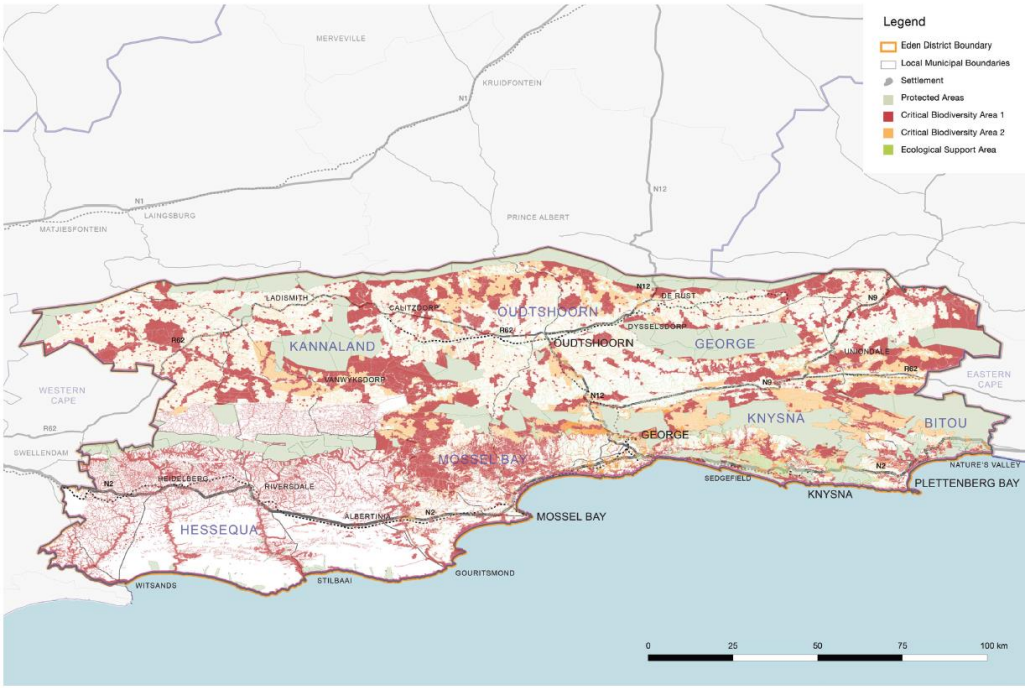

Figure 28: Critical biodiversity areas in Garden Route district (GRDM, 2017).

The biodiversity in the Garden Route district has been positively influenced by conservation areas such as the GRNP. However, dynamic pressures in the District also negatively influence biodiversity. These include land degradation, soil erosion, coastal erosion, frequent fires, the spread of AIPs, population growth, rapid urbanisation, increased pollution, poor waste management and climate change. Of note is the slow erosion and fragmentation of critical

biodiversity corridors in agricultural and urban development areas. These negative influences on biodiversity have knock-on effects, including detrimental effects on attempts to reduce poverty, inequality and unemployment, all of which may be further aggravated by the impact of climate change in the District.

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.

2.4.6 Environmental Vulnerability

According to the GreenBook (CSIR, 2019), the environmental dimension of vulnerability can be defined as the vulnerability and risk to the natural environment, and in the case of settlements, the impacts on the ecological infrastructure on which settlements are dependent. The environments at risk include populations and communities of organisms, ecosystems, habitats, physical and biological processes such as reproduction, diversity, energy flows, ecological resilience and natural selection (WC DMC, 2021).

The CSIR Green Book has developed an Environmental Vulnerability Index that is measured on a scale from 1 (low vulnerability) to 10 (high vulnerability). The map below (Figure 29) shows the environmental vulnerability score of each municipality in the district visually. A high score (closer to 10) reflects significantly high conflict between preserving the environment and allowing land-use change to occur. Criteria used to measure environmental vulnerability include air quality, environmental governance, and competition between ecology and urban encroachment.

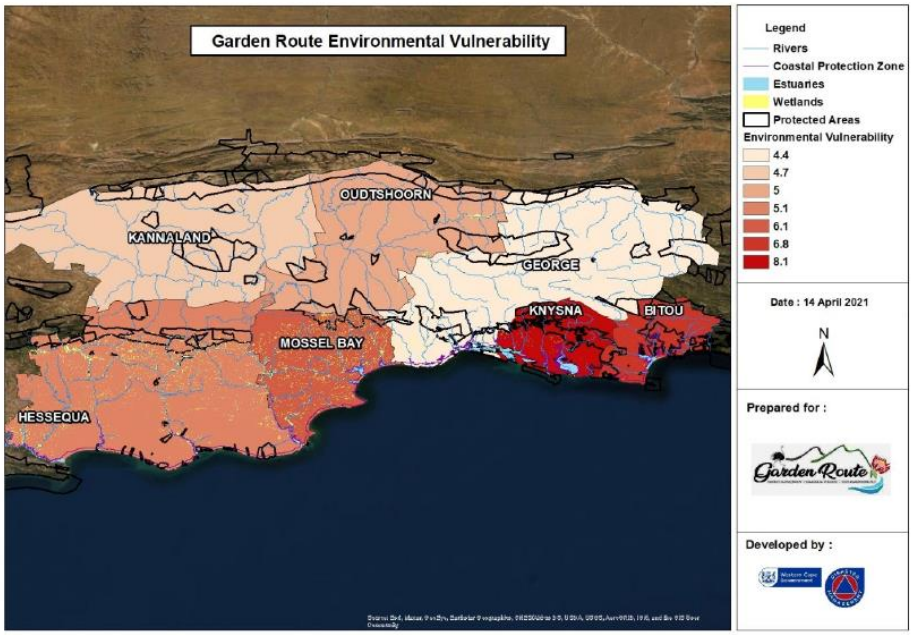

Figure 29: The environmental vulnerability in the Garden Route district (WC DMC, 2021).

Given the rich environmental diversity in the Garden Route district, the environmental vulnerability within district varies between relatively low (4.4) to very high (8.1). Knysna Local Municipality, characterised by a high number of protected areas and estuaries and has the highest level of environmental vulnerability, followed by Bitou and Mossel Bay Local Municipalities respectively. George is considered to have the lowest level of environmental vulnerability relative to other Local Municipalities in the District, followed by Kannaland and Oudtshoorn respectively.

Municipalities' Spatial Development Frameworks will need to realise the intrinsic and economic value of the regions biodiversity and natural resources and consider hazard zones that buffer settlements and natural areas, as well as provide clear guidance on land use management of the district's biodiversity assets. Appropriate land use of Critical Biodiversity and Ecological Support areas and Spatial Planning categories could contribute to environmental ecosystem rehabilitation, protection and enhancement.

2.4.7 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:

- increase impacts on marine and benthic ecosystems;
- increase impacts on estuary ecosystems;
- increase impacts on coastal livelihoods, and;
- 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 32). 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.

2.4.7.1 Marine Protected Areas

The Garden Route District Municipality currently has four 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).

Three of the marine protected areas are managed by CapeNature and one by SANParks (Tunley, 2009).

SANParks

- Tsitsikamma National Park – Proclaimed in 1964, the MLRA and NEM: PAA are both applicable to the MPA section. The original MPA extends 57 km from Groot River (East) to Die Punt at Nature's Valley; only the eastern section between Bloukrans and Nature's Valley fall within Garden Route's boundaries. The seaward boundary is 3 nm offshore from Groot (East) to the Bloukrans River and 0.5 nm offshore from there to Nature's Valley. The entire area is no-take, with the original open area (shore-based angling) west of Storms River being closed in 2001. Transit by vessels through the Park is also prohibited. An additional marine section (De Vasselot) to the west of Nature's Valley extends 0.5 nm offshore and acts as a buffer; it is a controlled zone, but fishing is allowed.

CapeNature

- Goukamma – initially proclaimed in 1990 and re-declared under the MLRA in 2000, it extends 14 km between Buffalo Bay and Platbank just east of Sedgefield and 1nm offshore. The offshore area is no-take but shore angling (with restrictions) is allowed.

There is a proposal being considered by the MPA Expansion Group via the MPA Forum with the involvement of WWF-SA to realign the MPA boundary to include additional sub-tidal reef areas and to rezone the shoreline and Goukamma Estuary to increase the protection of key fish species.

- Robberg – proclaimed in 2000 under the MLRA. Extends for 9.5 km along the Robberg Peninsula and 1nm offshore. The offshore area is no-take but shore angling (with restrictions) is allowed. Consideration is also being given to rezoning the southern shoreline portion of the MPA as no-take.
- Stilbaai – proclaimed in 2008 under the MLRA. It comprises 13.5 km of coastline between Bosbokduin (Noordkapperspunt) and the Rietvlei *vywers* and extends from the highwater mark to 4.2 km offshore; it also comprises a large part of the Goukou Estuary. There are three restricted zones (see below) with the remaining area being a controlled zone; - Geelkrans is the eastern part of the MPA adjacent to the Geelkrans Nature reserve and the *vywers*.
    - Skulpiesbaai in the extreme southwest in the vicinity of Noordkapperspunt.
    - Goukou Estuary (between 4 and 15 km from the mouth).

2.4.7.2 Estuarian Systems

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 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).

There are 22 estuarian systems in the Garden Route District Municipal Area (Figure 30) 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).

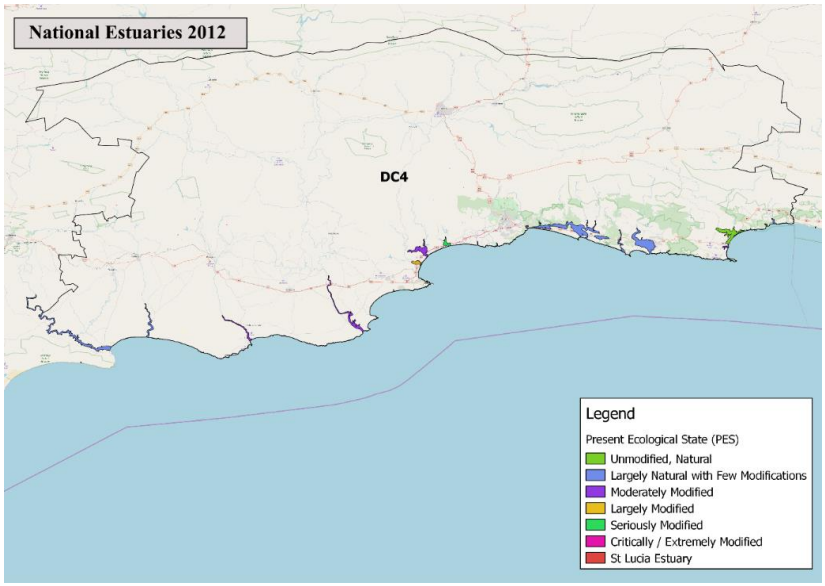

Figure 30: Estuaries in the Garden Route district area (South African National Biodiversity Institute and CSIR, 2012).

Table 5 below provides details of the levels of modifications of these estuarine systems. There are no estuaries in the District that are classified as 'critically/extremely modified').

Table 4: Levels of modification of estuary systems in the Garden Route district.

Unmodified, Natural	**Largely Natural, Few Modifications**	**Moderately Modified**	**Largely Modified**	**Seriously Modified**
Bloukrans	Groot (Wes)	Piesang	Hartenbos	Groot Brak
Sout (Oos)	Matjies	Klein Brak		

Keurbooms	Noetzie	Gouritz		
	Knysna	Goukou		
	Goukamma			
	Swartvlei			
	Wilderness			
	Kaaimans			
	Gwaiing			
	Maalgate			
	Blinde			
	Duiwenhoks			
	Breede			

Over and above the effects of climate change, the estuarine systems within the Garden Route district is vulnerable to anthropogenic impacts to varying degrees, which negatively affect biodiversity and ecosystem services in these systems. These impacts include ecosystem overuse (e.g. uncontrolled fishing and practices, uncontrolled bait collection, uncontrolled recreational use, amongst others), degradation, pollution from waste water treatment works, and increased nutrient loads from coastal developments and upstream farming practices (WCG: PDMC, 2021).

Flooding risks within the estuarine systems has also been identified by the Garden Route District Municipality Disaster Risk Assessment of 2021, particularly during the winter months (WCG: PDMC, 2021). This impact is worsened by increasingly degraded water systems, such as wetlands, with ongoing encroachment of urban development in these areas.

Within the Garden Route District Municipal area, 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 (Figure 34) (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).

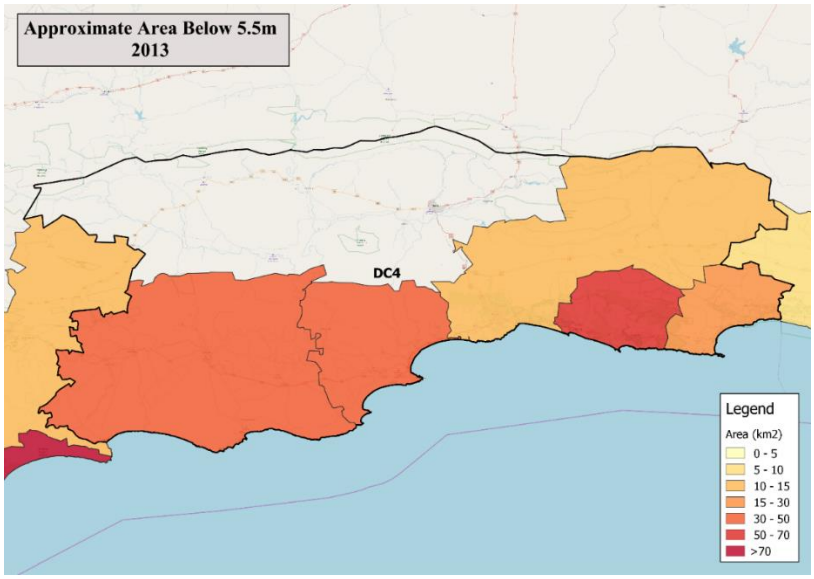

Figure 31: Approximate area below 5.5m in the Garden Route district (Department of Environmental Affairs, 2013f).

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).

2.4.8 The Garden Route District Energy Sector Summary

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 35). 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.

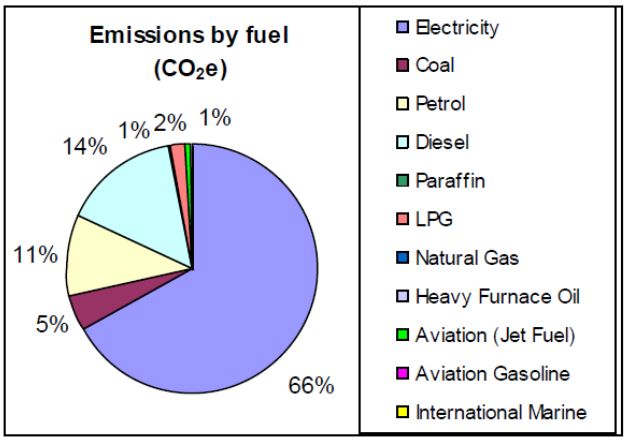

Figure 32: Energy-related emissions by fuel type in the Garden Route district.

The transport sector accounts for the largest proportion of energy consumption in the district (54%), followed by the industrial sector at 27% (Figure 36). 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.

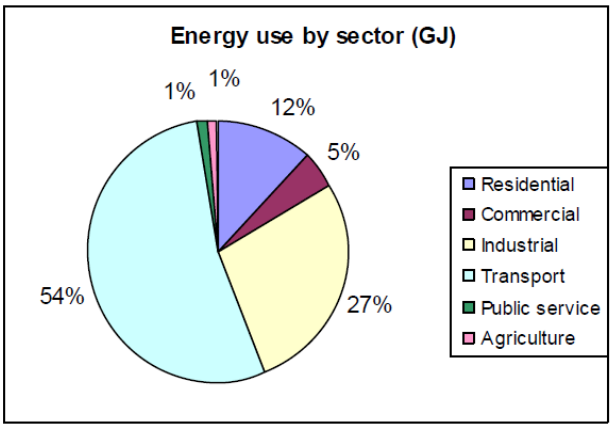

Figure 33: The energy use by sector within the Garden Route district.

Street and traffic lights make up the majority of total energy consumption in the district (Figure 37). 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. 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.

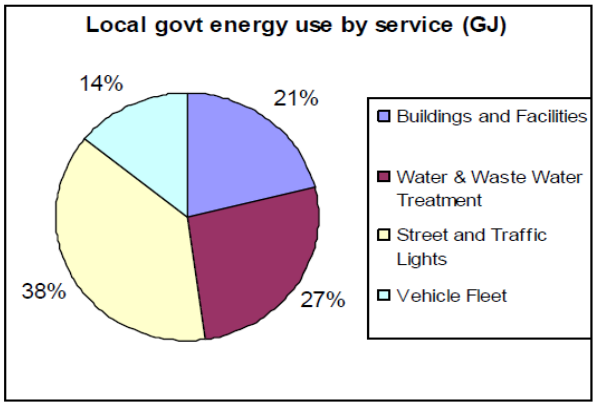

Figure 34: The local government energy use by sector (GJ) within the Garden Route district.

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.

Understanding sectoral contributions to district emissions enables effective management for reducing sectoral carbon emissions. Sector carbon emissions in the Garden Route district 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.

There is also a scope to improve the efficiency of water treatment. Substantial energy savings within building and facilities sector can also be achieved. 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 climate and proximity to the national power grid, means that the Oudtshoorn and Kannaland areas offer real potential for energy security projects in the form of either solar or wind energy. This could create employment opportunities in the renewable energy sector and improve the ecological resilience of the region.

2.4.9 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).

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.

2.4.10 Garden Route District Human Settlements Sector Summary

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). The 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 Garden Route District Municipality (Statistics South Africa, 2011). The majority (73.1%) of the District's dwellings are formal (house) (Figure 38), while 13.9% are informal, 2.2% are apartments and 10.8% have not been specified (Statistics South Africa, 2011).

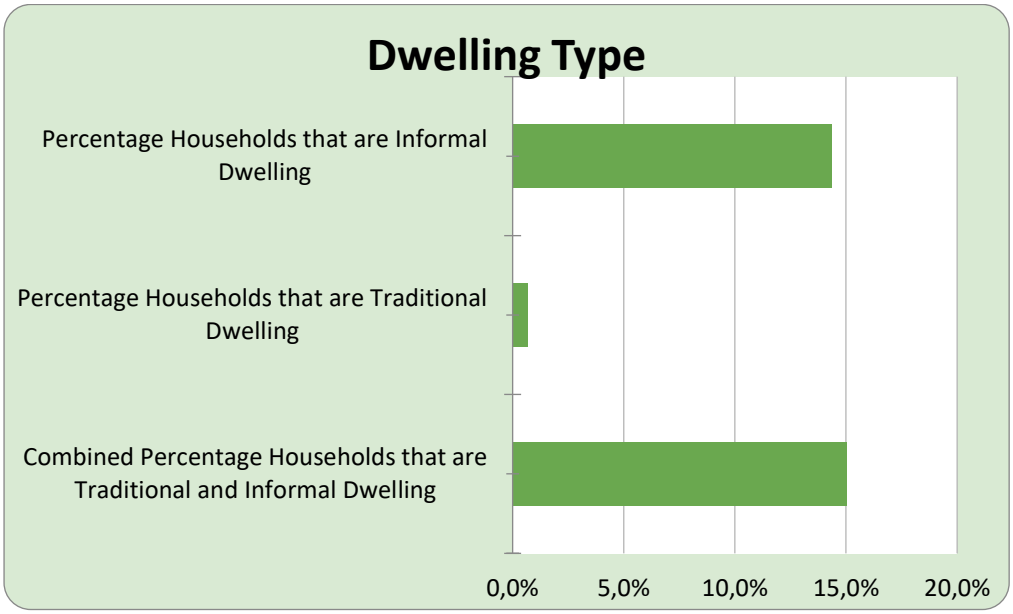

Figure 35: Households by type of dwelling in the District Municipal Area (Statistics South Africa, 2011)

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 39) 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 40), 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).

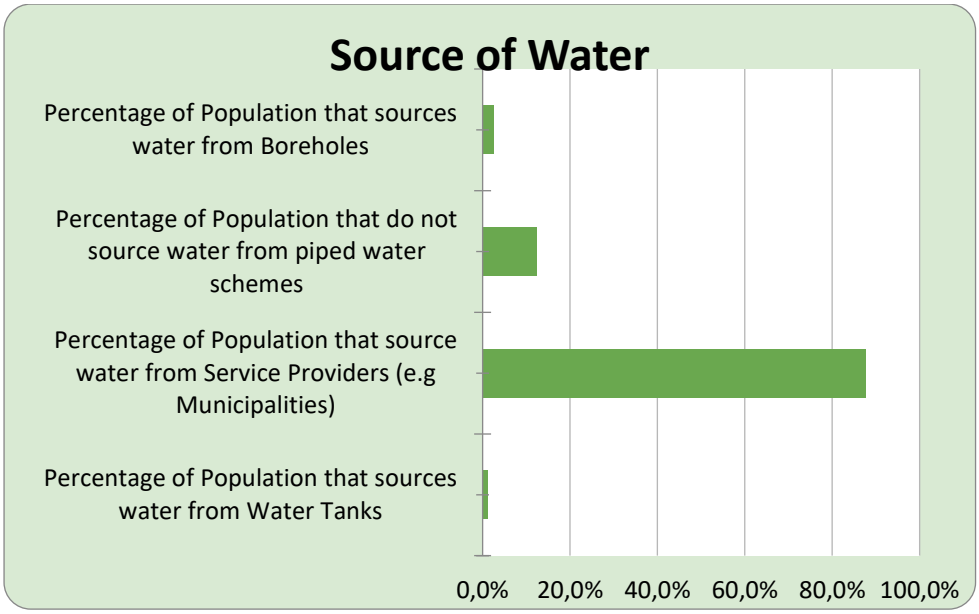

Figure 36: Household water sources in the Garden Route district (Statistics South Africa, 2011).

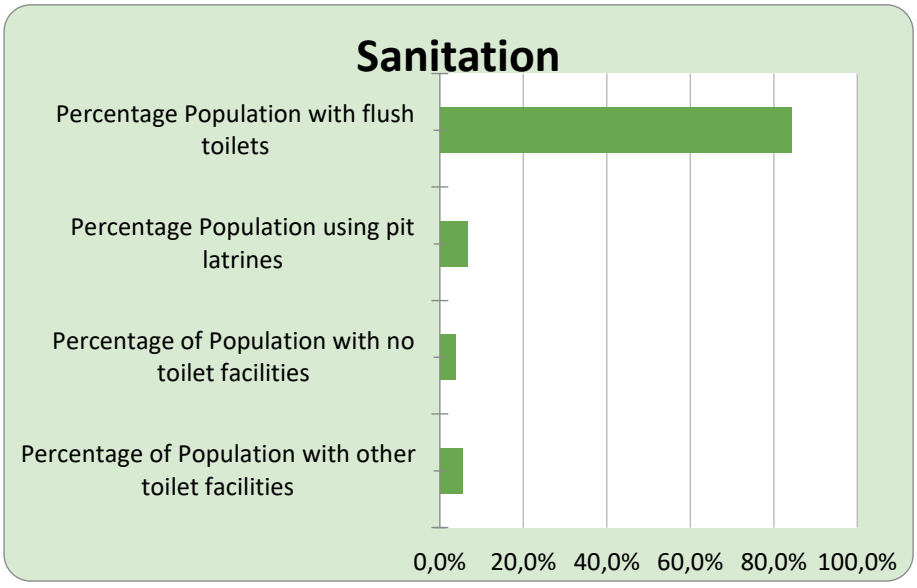

Figure 37: Sanitation facilities in the Garden Route district (Statistics South Africa, 2011).

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 Bayenberg 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 41) (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).

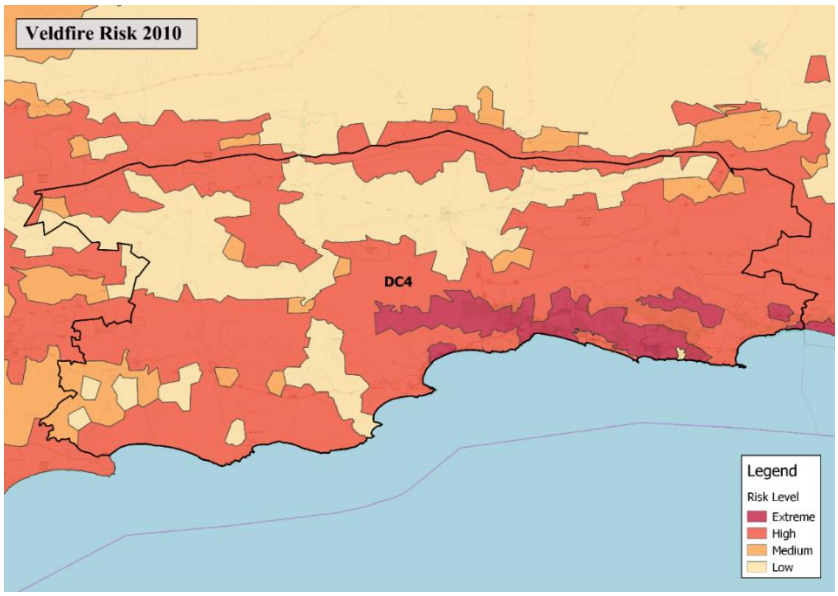

Figure 38: *Veld fire risk for the Garden Route district (Department of Agriculture, Forestry and Fisheries, 2010).*

2.4.11 Garden Route District Water Sector Summary

The Garden Route District Municipality falls mainly under the Breede-Gouritz/Berg Hydrological Zone (Figure 42), while small areas in the east fall within the Mzimvubu-Tsitsikama Hydrological Zone (Department of Environmental Affairs, 2013d). 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).

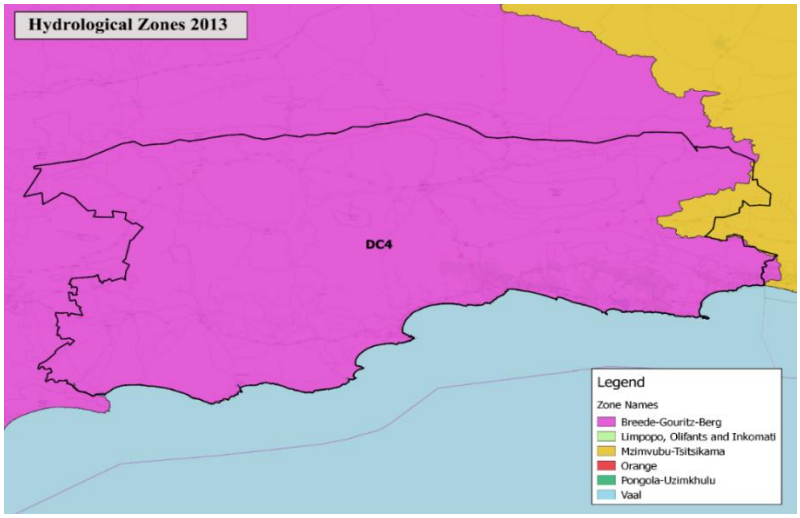

Figure 39: Hydrological Zone for the Garden Route district (Department of Environmental Affairs, 2013d).

Most of the Garden Route District Municipality falls under the Breede-Gouritz Water Management Area (Figure 43), 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 44), they are mostly found in the south of the district (Department of Water and Sanitation, 2016b).

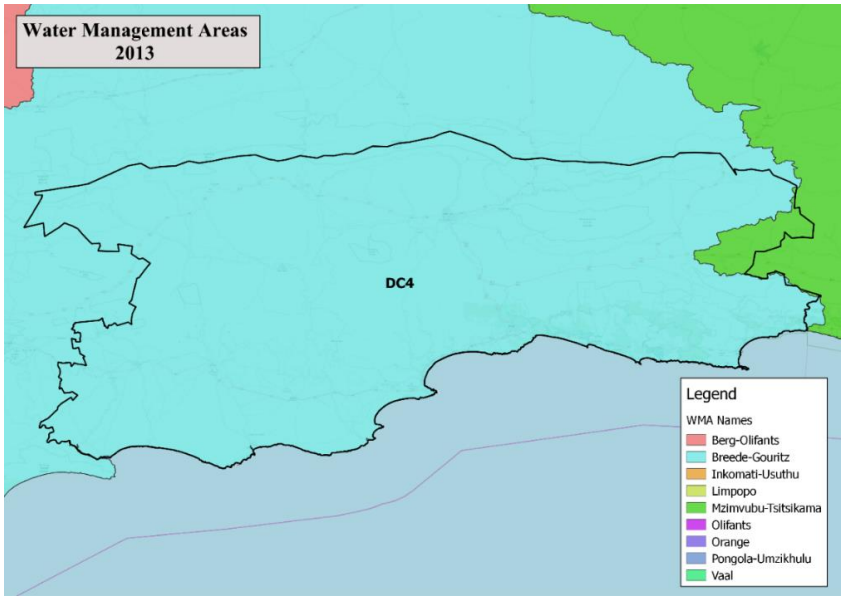

Figure 40: Water management area for the Garden Route district (Department of Water Affairs, 2013).

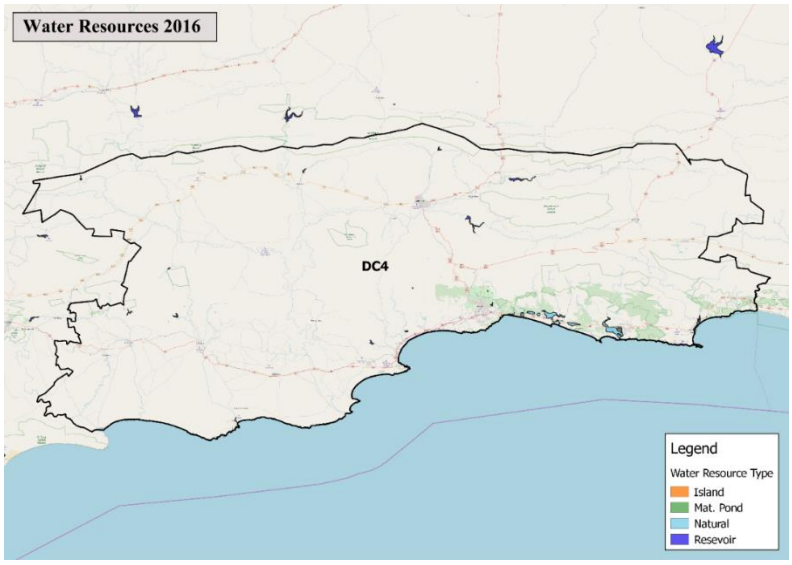

Figure 41: Water resources within the Garden Route district (Department of Water and Sanitation, 2016b).

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 (SANBI, 2011).

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 45) 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).

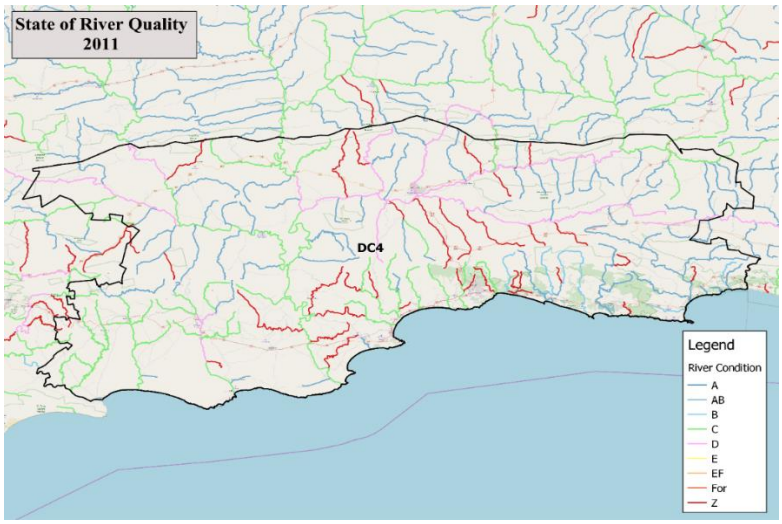

Figure 42: State of water quality in rivers in the Garden Route district (SANBI, 2011).

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). The graph (Figure 42) 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).

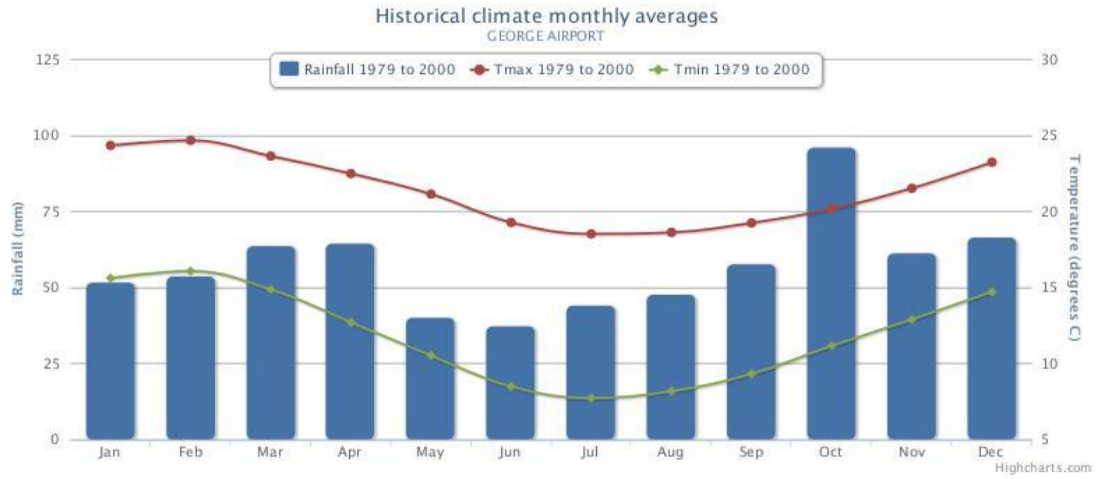

Figure 43: Historical climate monthly averages measured at George (Climate System Analysis Group, 2017b).

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, 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).

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).

2.4.12 Garden Route District Air Quality Sector Summary

Air pollution includes greenhouse gases such as carbon dioxide. Greenhouse gases cause the climate to warm by trapping heat from the Sun in the Earth's atmosphere. Greenhouse gases are a natural part of Earth's atmosphere, but their increasing amounts in our atmosphere since the early 1900s are causing the climate to warm. The increase comes from vehicle exhaust, pollutants released from smokestacks at factories and power plants, emissions from agriculture, and other sources. Scientists predict that Earth will warm more this century than it did in the 20th century.

The carbon dioxide in the atmosphere that causes the climate to warm also causes plants to grow. Research has shown that it has a direct impact on the growth rates, and vigour of growth, of alien invasive plant species, thereby directly exacerbating the infestations of invasive alien

vegetation within the Garden Route District. Increasing concentrations of carbon dioxide can also lead to an increase in the plants that cause allergies, which increases the amount of airborne allergen pollutants. The warming climate also extends the growing season in some areas, which increases the number of days with high pollen concentrations. Airborne allergens degrade both outdoor and indoor air quality and cause respiratory problems such as asthma and allergies. This establishes an unhealthy cycle where air pollution leads to climate warming, which then leads to more air pollution.

Higher pollen concentrations and longer pollen seasons are also influenced by the changing climate. Airborne allergens, like pollen, decrease air quality and cause health problems. During heat waves, areas of high pressure create stagnant air that concentrates air pollutants in one area. Prolonged high temperatures due to climate warming often lead to drought conditions where forest fires, which release carbon monoxide and particulates, are more common. Dry, dusty air during periods of hot weather also increases the amount of particulate pollution.

On a related note, the carbon dioxide in the atmosphere that causes the climate to warm also causes plants to grow. Research has shown that it has a direct impact on the growth rates, and vigour of growth, of alien invasive plant species, thereby directly exacerbating the infestations of invasive alien vegetation within the Garden Route District. Increasing concentrations of carbon dioxide can also lead to an increase in the plants that cause allergies, which increases the amount of airborne allergen pollutants. The warming climate also extends the growing season in some areas, which increases the number of days with high pollen concentrations. Airborne allergens degrade both outdoor and indoor air quality and cause respiratory problems such as asthma and allergies. This establishes an unhealthy cycle where air pollution leads to climate warming, which then leads to more air pollution.

The Garden Route District's Air Quality adaptation and mitigation activities should be linked to the National Climate Change Response White Paper. The purpose of the White Paper is to improve air and atmospheric quality, lead and support, inform, monitor and report efficient and effective international, national and significant provincial and local responses to climate change. Its functions are:

- To identify, gather, sort, collate, store, archive, analyse, synthesize, distribute and popularise complete, accurate, and current climate change and climate change response data and information that ensures informed climate change response decision-making;
- To lead and/or support, inform, monitor and report efficient and effective national, provincial and local climate change mitigation responses;
- To lead and/or support, inform, monitor and report efficient and effective national, provincial and local climate change adaptation responses;
- To prepare for, negotiate and inform the implementation of multi-lateral, mini-lateral and bilateral climate change agreements;
- To ensure that reasonable legislative and other measures are developed, implemented and maintained in such a way as to protect and defend the right of all to air and atmospheric quality that is not harmful to health and well-being.

3 The Garden Route District Municipality Climate Change Vulnerability Assessment

A Climate Change Vulnerability Assessment was developed for the Garden Route District Municipality, with the assistance of the Local Government Climate Change Support (LGCCS) Programme (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 the LGCCS Programme, 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. Indicators are a range of potential impacts which have been developed using the Long Term Adaptation Scenario (LTAS) reports (Department of Environmental Affairs, 2013g).

The LGCCS Toolkit was applied to the Garden Route District to assist with the development of its Climate Change Response Plan. The Vulnerability Assessment methodology included a Garden Route District workshop, which 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 (please refer to Annexure 1 for the detailed Vulnerability Assessment methodology used). The vulnerability assessment outlined the key climate change vulnerabilities, as well as the responses to address these vulnerabilities for Garden Route District Municipality.

The three primary objectives of the LGCCSP were 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.

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

Table 5: 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
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
40	Air Quality	Increase in Air Pollution	Yes	High	Low
41	Air Quality	Increase in odour complaints	Yes	High	Low
42	Air Quality	Increase in Brown haze	Yes	High	Low

Based on the 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. Indicators are grouped into the following themes:

- Agriculture
- Biodiversity and Environment
- Coastal and Marine
- Disaster Management, Infrastructure and Human Settlements
- Water
- Air Quality

The major climatic hazards in the Garden Route district as identified by the Vulnerability Assessment include: droughts, floods and veld fires. Climate change is also expected to incrementally increase the frequency and severity of these hazards. Additionally, financial losses in the district, due to these climate hazards, has already been high, and will increase going into the future.

It is therefore crucial to conserve our water resources, wetlands, marine and coastal environment, and our rich biodiversity. Land-use and settlement plans should be updated to take disaster risk management criteria into account, and by increasing public awareness regarding water conservation, droughts, fires and floods. This is particularly pertinent given the recent devastating fires in and around the Garden Route as well as the severe ongoing drought in the Garden Route district.

The results of the Vulnerability Assessment were used to guide the development of the Climate Change Response and Implementation Plan, in which the priority Climate Change Adaptation and Mitigation Responses, as well as various Sector Plans, was set for Garden Route District Municipality, based on this Garden Route District Municipality Climate Change Needs and Response Assessment document.

3.2 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.

3.2.1 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 Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2001; 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.

3.2.2 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).

Error! Reference source not found. Figure 43 below illustrates how the components of a Climate Change Vulnerability Assessment link to each other.

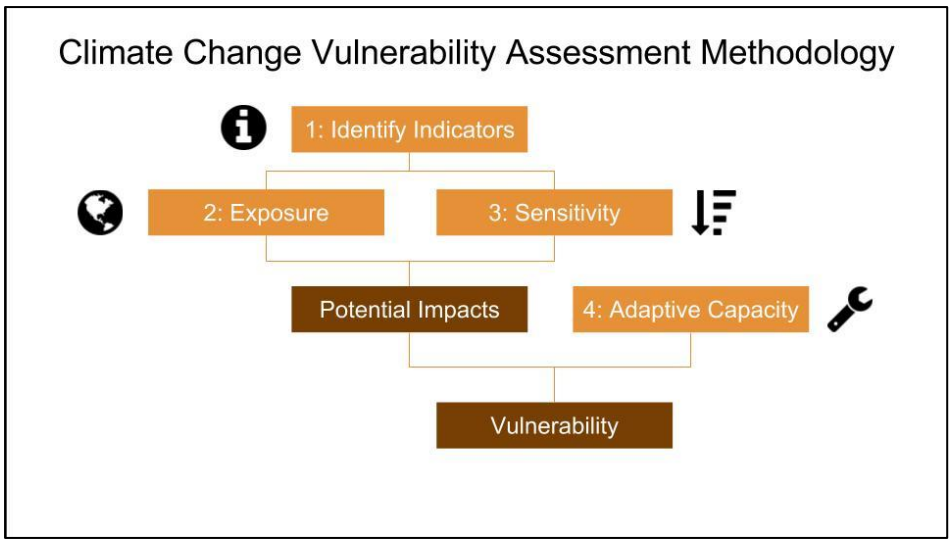

Figure 44: The climate change vulnerability assessment methodology.

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; water; and air pollution).

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 than 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.

3.2.3 Desired Adaptation Outcomes

The Department of Forestry, Fisheries and the Environment (DFFE) 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.

3.3 Vulnerability Indicator Tables for the Garden Route District Municipality

3.3.1 Agriculture

Table 6: Agriculture 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
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

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

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

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

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	ODW - Vegetables Vegetable seed Honey bush tea Aloe products Dried herbs Olives Macadamia nuts Lucerne seed Essential oils – Geranium, and Liquorice Honey, Propolis & Beeswax Summer vegetables: Green beans, sweet corn, onions, tomatoes, and pumpkin. Winter vegetables: Broccoli, cauliflower, brussels sprouts, cabbage, and carrots. Prepacked vegetables – celery, spinach, and lettuce.	How important are other crops to the local economy and livelihoods? High Priority Crop = High; Medium Priority Crop = Medium; Low/No Priority Crop = Low	High	Vegetables are important for sustaining livelihoods and for the local economy.	Medium	DRDLR Farmers and labourers DAFF and WC DA Department of Water Affairs and Water User Association Garden Route District Municipality Climate Change Adaptation Plan Garden Route District Municipality Regional Economic Development Strategy

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

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

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

3.3.2 Biodiversity and Environment

Table 4: Biodiversity 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
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

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

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
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

3.3.3 Coastal and Marine

Table 5: Coastal and Marine 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
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.

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 sceptic 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.

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.

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

3.3.4 Human Health

Table 6: 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
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

3.3.5 Disaster Management, Infrastructure and Human Settlements

Table 7: Disaster Management, Infrastructure and Human Settlements 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
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

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

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, Uniondale) 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

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

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

3.3.6 Water

Table 8: 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 Minos 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

3.3.7 Air Quality

Table 9: Air Quality 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
40	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
41	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.
42	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

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