Garden Route District Climate Change Adaptation Needs and Response Assessment

2025 / 2026 – 2030/2031

Acknowledgements:

- Department of Forestry, Fisheries and the Environmental (DFFE)
- Department of Environmental Affairs & Development Planning (DEA&DP)

Document Development and Review		
Version	**Document Title**	**Developed/Reviewed By:**
Developed:	Eden District Municipality Climate Change Adaptation Plan, Garden Route District Municipality Climate Change Needs and Response Assessment, 2014	• Garden Route District Municipality (GRDM) • Department of Environmental Affairs and Development Planning (DEA&DP): Climate Change
First Review:	Garden Route District Climate Change Adaptation Strategy, 2019	• Garden Route District Municipality (GRDM) • Department of Forestry, Fisheries and the Environment (DFFE) • Department of Environmental Affairs and Development Planning (DEA&DP): Climate Change
Second Review:	• Garden Route District Climate Change Adaptation Needs and Response Assessment, 2025/2026 – 2030/2031	• Garden Route District Municipality (GRDM) • Department of Environmental Affairs and Development Planning (DEA&DP): Climate Change • Department of Forestry, Fisheries and the Environment (DFFE)

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Table of Contents

1 Introduction 7
2 The Nature and Characteristics of the Garden Route District Municipality 9
_2.1 The Garden Route District Municipal Area 9
_2.2 Key Garden Route District Characteristics 9
2.2.1 Population and Demographics 10
2.2.2 Level of Urbanisation and Population Density 11
2.2.3 Population and Household Growth 12
2.2.4 Gender and Age Breakdown 12
2.2.5 Socio-economic Profile 13
2.2.6 Poverty and Inequality 13
2.2.7 Employment and Labor Market 14
2.2.8 Social Aspects 15
2.2.9 Risk and Vulnerability Factors 15
3. Future Climate Change Projections for the Garden Route District 19
_3.1 Temperature 19
_3.2 Rainfall 20
_3.3 Evaporation and Drought 23
4. Garden Route District Sector Summaries 24
_4.1 Agriculture 24
4.1.1 Agricultural Activities 24
4.1.2 Garden Route District Agro-climate Zones 25
4.1.3 Impacts of Climate Change 26
_4.2 Land and Biodiversity 27
4.2.1 Biomes 27
4.2.2 Protected Areas 28
4.2.3 Biodiversity Spatial Plan 29
4.2.4 Impacts of Climate Change 30
_4.3 Water Resources 31
4.3.1 River Systems 31
4.3.2 River Health 32
4.3.3 Storage Dams in Garden Route District 34
4.3.4 Impacts of Climate Change 34
_4.4 Marine and Coastal 34
4.4.1 The Coastal Zone 34
4.4.2 Estuarine Systems 35

4.4.3 Impacts of Climate Change 36
_4.5 Energy 36
_4.6 Human Settlements and Well-Being 39
4.6.1 Climate Change Impacts on Urban Settlements 39
4.6.2 Climate Change Impacts on Rural Settlements 39
_4.7 Natural Disasters 40
_4.8 Health 41
_4.9 Air Quality 42
5. The Garden Route District Municipality Climate Change Vulnerability Assessment 43
_5.1 Environmental Vulnerability 43
5.1.1 Vulnerability Assessment Results 45
5.1.2 Vulnerability Assessment Methodology 46
5.1.3 What is a Vulnerability Assessment? 47
5.1.4 Steps involved in a Vulnerability Assessment 48
_5.2 Desired Adaptation Outcomes 50
_5.3 Vulnerability Indicator Tables for the Garden Route District Municipality 52
5.3.1 Agriculture 52
5.3.2 Biodiversity and Environment 61
5.3.3 Coastal and Marine 64
5.3.4 Human Health 68
5.3.5 Disaster Management, Infrastructure and Human Settlements 73
5.3.6 Water 78
5.3.7 Air Quality 81
6. References 82

Figures

Figure 1: The Garden Route District Municipal Area. 9
Figure 2: Summarised Garden Route district key indicators (Census, 2022; Western Cape National Treasury, 2023b). 10
Figure 3: A glance at the population and demographics of the Garden Route District Municipal area (Western Cape National Treasury, 2023a). 11
Figure 4: Bar chart below shows the age and gender breakdown of the population of the Garden Route district (Western Cape National Treasury, 2023a). 13
Figure 5: The Gini coefficient figures for the Garden Route district, compared to the Western Cape figures (S&P Global, 2022). 14
Figure 6: Distribution of indigent households in the Garden Route District (Provincial Treasury, 2023a) 15
Figure 7: The municipalities within the Garden Route district ranked according to their vulnerabilities. 16
Figure 8 (a and b): The risk / hazard indicators identified by a) the Western Cape Disaster Management Centre and b) the Department of Agriculture. 16
Figure 9: Projected changes in annual precipitation for a 2030-2060 mean as compared to a 1982-2020 mean (Jack et al., 2022). 21
Figure 10: Projected changes in annual average rainfall throughout Garden Route over the period 2021-2050 under the RCP 8.5 scenario (CSIR, 2019). 22
Figure 11: 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). 22
Figure 12: Crop census in the Garden Route district (DoA, 2023). 25
Figure 13: Wine of origin districts in the Garden Route district (DoA, 2024). 25
Figure 14: SmartAgri Zones in the Garden Route District Municipal Area (Western Cape Department of Agriculture, 2017). 26
Figure 15: The spatial distribution of biomes in the Garden Route district (SANBI, 2023; WC DMC). 27
Figure 16: Ecological status in the Garden Route district (SANBI, 2022). 28
Figure 17: River systems in the Garden Route district (PDMC, 2021). 32
Figure 18: River condition in the Garden Route District (SANBI, 2018). 33
Figure 19: Ecosystem Threat Status of Rivers (SANBI, 2018). 33
Figure 20: Coastal and marine ecosystem threat status (SANBI, 2018). 35
Figure 21: Energy use by fuel type for Garden Route District 2009 – 2018. 37
Figure 22: The energy use by sector within the Garden Route district. 37
Figure 23: Energy-related emissions by fuel type in the Garden Route district. 38
Figure 24: Count of fires (2000-2021) obtained from the MODIS active fire and burned area product (https://modis-fire.umd.edu/). 41
Figure 25: The climate change vulnerability assessment methodology (Available at: https://letsrespondtoolkit.org/resources/vulnerability-assessment-tool/). 48
Figure 26: A Dep. of Agriculture vulnerability indicator table for the Garden Route District Municipality (WC DoA, 2022). 52

Tables

Table 1: Projected changes in annual count of hot days by mid-century (Jack et. al, 2022). 19
Table 2: Key Vulnerability indicators for Garden Route District Municipality. 45
Table 3: Agriculture vulnerability indicator Table for the Garden Route District Municipality. 53
Table 4: Biodiversity Vulnerability Indicator Table for Garden Route District Municipality. ... 61
Table 5: Coastal and Marine Vulnerability Indicator Table for the Garden Route District Municipality. 64
Table 6: Health Vulnerability Indicator Table for the Garden Route District Municipality. 68
Table 7: Disaster Management, Infrastructure and Human Settlements Vulnerability Indicator Table for the Garden Route District Municipality. 73
Table 8: Water Vulnerability Indicator Table for the Garden Route District Municipality. 78
Table 9: Air Quality Vulnerability Indicator Table for the Garden Route District Municipality. 81

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 result 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 new National Climate Change Act, 2024 (Act 22 of 2024).

The National Climate Change Act, 2024 (Act 22 of 2024) 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 National Climate Change Act, 2024 (Act 22 of 2024) 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, 2024):

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 National Climate Change Act, 2024 (Act 22 of 2024), must (RSA, 2024) —

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 for the requirements of the Act, the Garden Route District Municipality GRDM developed this document, entitled the "*Garden Route District Climate Change Needs and Response Assessment, 2025/2026 – 2030/2031*", 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 inform 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 in the south-east of the province. The district occupies a total land area of 23 331km^2 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,namely the Bitou, Knysna, George, Mossel Bay, Oudtshoorn, Kannaland and Hessequa local Municipalities (Figure 1).



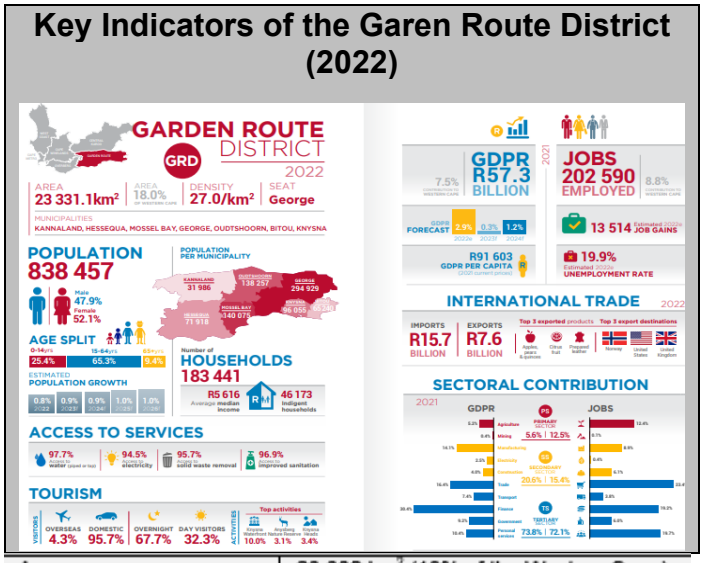
Figure 1: The Garden Route District Municipal Area.

The Garden Route district is a kaleidoscope of contrasts, and encompasses the ever-popular coastline of the Hessequa, Mossel Bay, George, Knysna and Bitou municipal areas, as well as the inland region where internationally renowned ostrich farms and the Swartberg mountains of the Oudtshoorn municipal area is located, and the rural expanse of the Kannaland municipal area, well known for its dairies, cheese factories, and wineries. Located halfway between the metropoles of Cape Town and Gqeberha, and strategically positioned along the N2 (a vital transport route for the Garden Route district), the George municipal area serves as the economic hub of the district. It is also the seat of the Garden Route district.

2.2 Key Garden Route District Characteristics

The information of the profile included in this section uses data primarily sourced from Statistics South Africa, administrative data from sector departments, the Municipal Review and Outlook (MERO), Global Insight Regional Explorer and Quantec. The data sourced from sector departments are the most recent that is available. The Statistics South Africa 2022 Census contains the latest survey data available at municipal level.

The Figure 2 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.



Area	23 332 km² (18% of the Western Cape)
Population	838 457 (255 977 households)[1]
Average median income	R5 616 (46 173 indigent households)
Access to services	Water: 97.7%, Electricity: 94.5%, Sanitation: 96.9%
GDP-R (2021)	R57.3 billion
Unemployment (estimate for 2022)	19.9%
International trade balance	Exports: R7.6 billion, Imports: R15.7 billion
Top export products	Apples, pears, quinces, citrus, leather
Economic sectors (GDP-R)	Tertiary (incl. tourism): 73.8% (72.1% of jobs), Secondary: 20.6% (15.4% of jobs), Primary (incl. agriculture): 5.6% (12.5% of jobs)
Gini coefficient (2022)	0.601 (0.26 improvement over 2021)

Figure 2: Summarised Garden Route district key indicators (Census, 2022; Western Cape National Treasury, 2023b).

2.2.1 Population and Demographics

According to the Statistics South Africa 2022 census data, the Garden Route District Municipal area had a population of 838,457 in 2022, and is the second fastest-growing region in the Western Cape Province. Within the district, the George and Mossel Bay Municipalities comprise of almost half of the total population of the district. Future predictions suggest continued growth within these towns, which will place immense pressure on the coastal ecosystems.

The Garden Route District Municipal area is the third most populated region in the Western Cape Province, after the City of Cape Town, and the Cape Winelands districts, representing 11.3%[1] of the Provincial population. The region is characterized by both highly urbanized coastal areas (like Knysna, Mossel Bay, and Bitou) and rural farmlands (like Kannaland, Hessequa, and Oudtshoorn). Population density in 2023 was 27.2 persons per km², with an

expectation of a slight increase to 27.8 by 2025. The working-age population (15-64 years) makes up a significant portion of the population in areas like Knysna.

2.2.2 Level of Urbanisation and Population Density

Spanning an expansive 23 331.1km^2 , the Garden Route district is the second most urbanised district in the Province at 87.9 per cent. It is a kaleidoscope of contrasts, with highly urbanised coastal areas such as Knysna (94.2 per cent), Mossel Bay (93.6 per cent) and Bitou (91.3 per cent), while the rural farmlands in Kannaland (62.4 per cent), Hessequa (71.5 per cent) and Oudtshoorn (87.4 per cent) (Figure 3) with greater agricultural activity contribute a larger share of rural population. The George municipal area stands out because of its unique circumstances. Although the urban population grew in this municipal area, certain developments around the town of George extended into the rural area, thereby raising the rural share. In 2023, the Garden Route district had a population density of 27.2 persons per km^2 and is expected to rise to 27.8 persons per km^2 by 2025. The concentration of the population gravitates toward the town of George and Mossel Bay, magnetised by the economic opportunities, social amenities, and connectivity advantages these municipal areas offer, while Bitou remains the fastest growing municipal area due to in-migration as the point of entry to the Western Cape along the N2. Distribution is sparser in the rural, less developed areas of the Garden Route district, namely the Hessequa and Kannaland municipal areas.

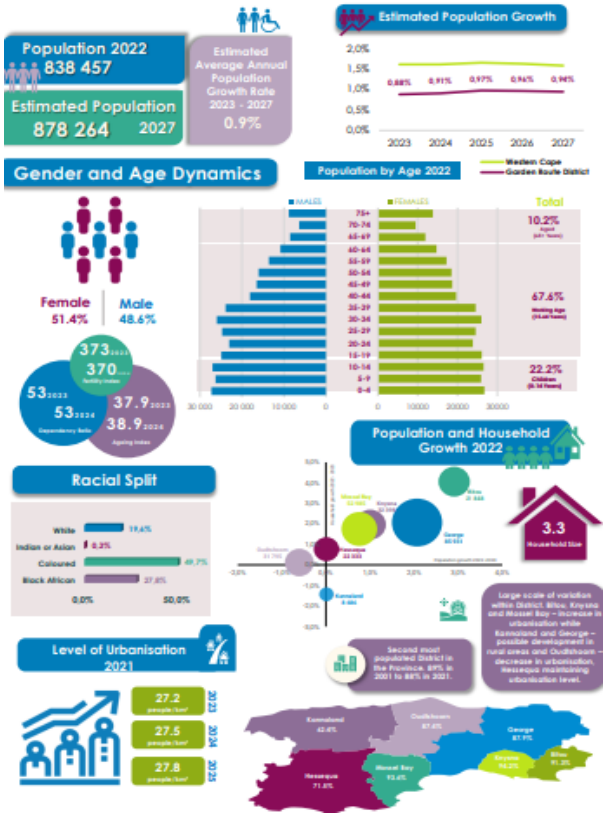


Figure 3: A glance at the population and demographics of the Garden Route District Municipal area (Western Cape National Treasury, 2023a).

Most of the district's population resides in the three local Municipalities of George (295 000), Mossel Bay (140 000) and Oudshoorn (138 000) (Provincial Treasury, 2023a). In absolute numbers, the district is the second most urbanised district at 87.9%, but it also has many dispersed hamlets and small towns which are relatively isolated from each other.

There are 255 977 households and on average 3.3 individuals per household in the Garden Route District Municipality (StatsSA, 2023). The majority (8%) of the district's dwellings are formal (house), while 9.6% are informal, 1.2% are traditional and 0.2% have not been specified (StatsSA, 2023).

2.2.3 Population and Household Growth

In 2022, the Garden Route district was home to 838 457 individuals. At 11.3 per cent of the Provincial population, it is the third most populated region in the Western Cape. This demographic prominence can be attributed to its pivotal role as a growing economic hub. Notably, the Garden Route district stands as the second fastest growing region in the Province, expanding its share of the Provincial population from 9.9 per cent in 2011. Projections suggest that the populace will experience an average annual growth rate of 0.9 per cent during the 2023 to 2027 period, predominantly driven by semigration into this locale. With a total of 255 977 households recorded in 2022, the region exhibits an average household size of 3.3 persons declining from 3.5 in 2011, potentially due to a surge of single working-age individuals relocating to the municipal area and shrinking family sizes. Consequently, the expansion of households is forecast to surpass the growth of the overall population. Furthermore, it is noteworthy that the number of households recorded during the 2022 Census exceeds the count utilised in the Local Government Equitable Share for each of the Garden Route district municipalities, excluding only Bitou, signifying a higher-than-projected rise of households over the interval 2011 to 2022. This divergence bears implications for the provisioning of municipal services and the requisite infrastructure. (Western Cape National Treasury, 2023a).

2.2.4 Gender and Age Breakdown

A more in-depth analysis of the demographic composition within the region reveals that 67.6 per cent of its residents fall within the economically active age group of 15 to 64 years. The presence of a substantial working-age population is of particular significance within a burgeoning economic hub. While the overall population distribution leans slightly in favour of females, there is a notable surplus of males within the 25 to 34 age brackets, indicative of an influx of working-age males migrating to the municipal area, ostensibly in pursuit of employment opportunities. Moreover, a segment comprising 22.2 per cent of the population is aged below 14 years, thereby engendering a comparatively high dependency on the working-age cohort. This sizable youth contingent underscores a mounting demand for educational resources and future employment prospects within the Garden Route district.

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 ((Western Cape National Treasury, 2023a).

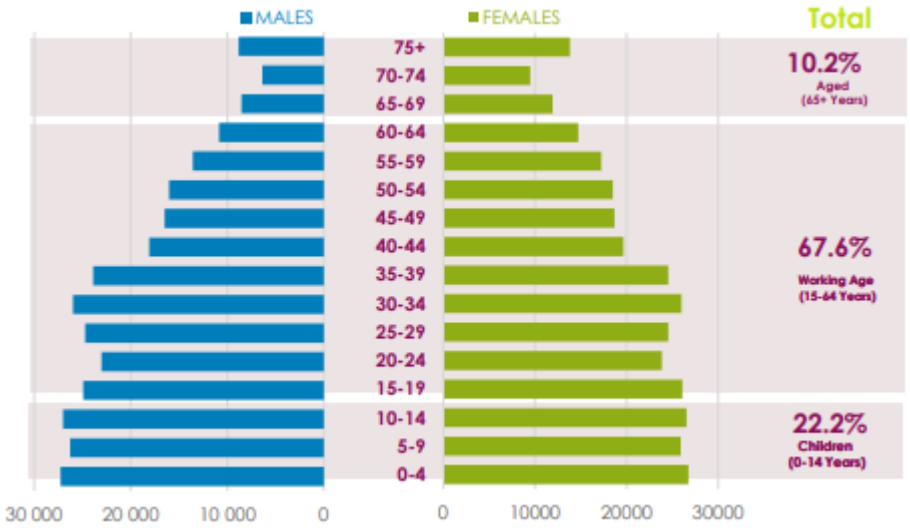


Figure 4: Bar chart below shows the age and gender breakdown of the population of the Garden Route district (Western Cape National Treasury, 2023a).

2.2.5 Socio-economic Profile

The Garden Route district economy is heavily influenced by tourism, which is supported by coastal resources and attractions. Agriculture, particularly in areas like Kannaland, Hessequa, and Oudtshoorn, plays a significant role, with activities ranging from traditional farming to unique products like ostriches. Forestry and agro-processing also contribute to the manufacturing base.

The construction industry is supported by tourism and real estate investments, with improvements to facilities driving growth. In 2023, the Garden Route economy grew by 1.0% year-on-year, reaching a RGVA value of ZAR45.08 billion (Western Cape National Treasury, 2023a).

However, the Garden Route District Municipality faces significant socio-economic challenges, including high poverty rates, unemployment, and inequality, even within the same communities, where residents can have varying needs and priorities. The district's economy is diverse, with tourism and agriculture being key sectors, but job creation and economic growth are lagging. While the region has strong infrastructure and natural resources, addressing these challenges is crucial for sustainable development.

According to the Western Cape Government, Provincial Treasury (2023a) the main socio-economic risks in the Garden Route District are job losses, low learner retention and a low labour skills base.

2.2.6 Poverty and Inequality

Income Inequality South Africa suffers among the highest levels of inequality in the world when measured by the commonly used Gini index. Inequality manifests itself through a skewed income distribution, unequal access to opportunities, and regional disparities. The National Development Plan (NDP) has set a target of reducing income inequality in South Africa, endeavouring to lower the Gini coefficient, a measure of income inequality, from 0.7 in 2010 to 0.6 by 2030. The Garden Route district nearly meets that goal with a Gini coefficient of 0.61

(Figure 5), but along with the Overberg District (0.61), has amongst the most unequal distributions of income in the province (0.60). This reflects the discrepancy between persons with well renumerated jobs in George as well as affluent households living along the coast, compared to the lower incomes earned by rural farm workers as well as households residing in the numerous informal settlements across the region.

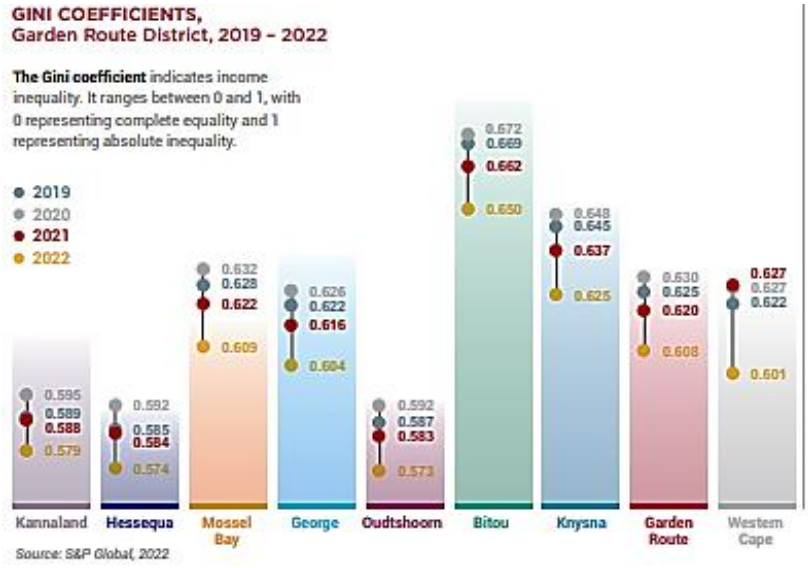


Figure 5: The Gini coefficient figures for the Garden Route district, compared to the Western Cape figures (S&P Global, 2022).

The poverty rates in the Garden Route district are high, with a significant portion of the population living below the poverty line. The dependency ratio, the ratio of people in a population who are not working to those who are, is high, further exacerbating poverty. There is a large gap between indigent and non-indigent households within the Garden Route district, with a total of 46 174 indigent households. In 2022, 61.0 per cent of the Garden Route district's population fell below the Upper Bound Poverty Line (UBPL) head count ratio, which is the proportion of the population living below the UBPL. This figure improved marginally from the 62.2 per cent recorded in 2019, indicating progress despite the challenging economic conditions facing households across the country. Poverty is concentrated in specific areas, with some local municipalities facing more severe challenges. Areas with more indigent households face limited access to essential services, highlighting the need for targeted interventions to address socio-economic inequalities and improve residents' wellbeing (Western Cape National Treasury, 2023a).

2.2.7 Employment and Labor Market

The Garden Route district has a high unemployment rate, particularly in the informal sector. The wholesale and retail trade, catering, and accommodation sectors are major employers, but the informal sector also plays a significant role. There is a large working-age population, but not all are employed. The labour force participation rate, the percentage of the population actively seeking work, is relatively high, but the unemployment rate remains a concern (Western Cape National Treasury, 2023a).

2.2.8 Social Aspects

More than 46 000 households in the Garden Route are registered as indigent (Figure 6, and the estimated unemployment rate for 2022 was 19.9% (Provincial Treasury, 2023a).

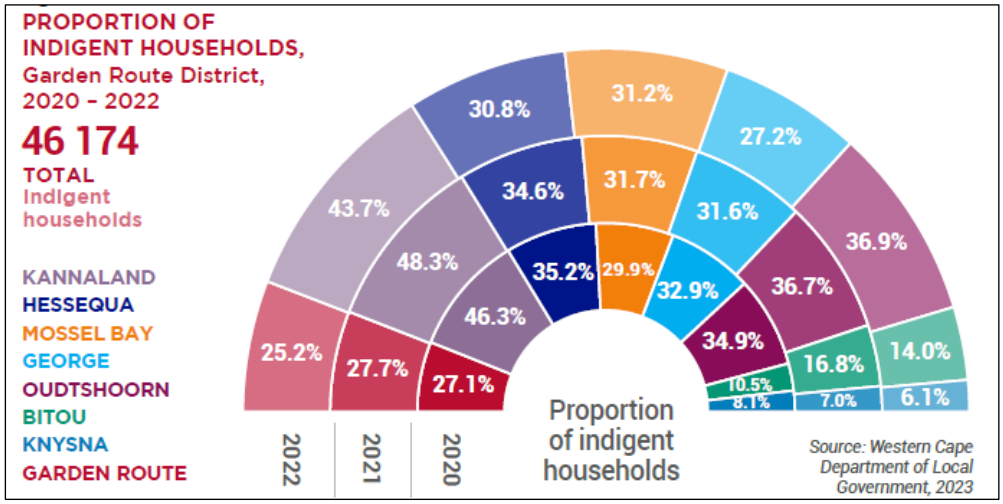


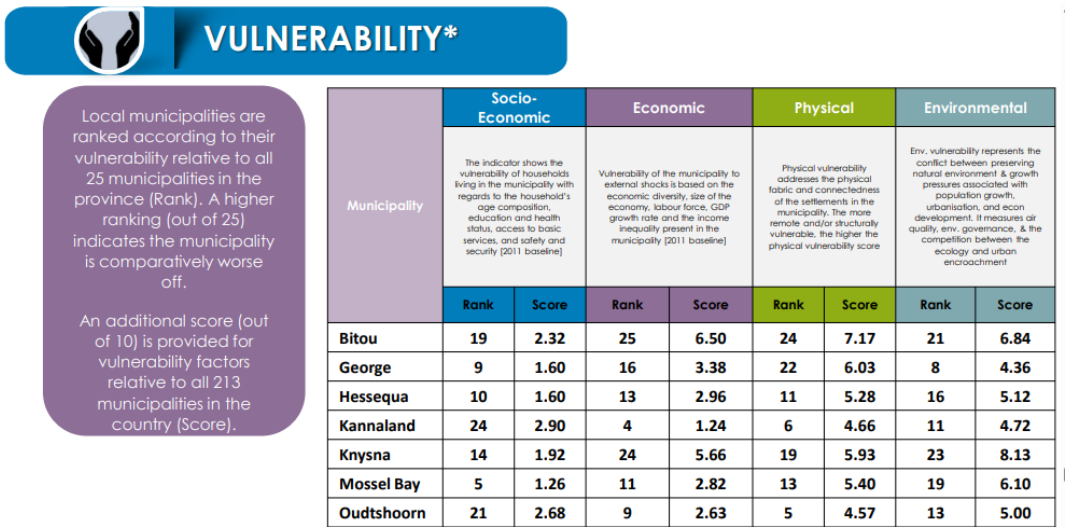
Figure 6: Distribution of indigent households in the Garden Route District (Provincial Treasury, 2023a).

The following social aspects were identified for the Garden Route district (Western Cape National Treasury, 2023a):

- The district experiences both challenges and opportunities in terms of social development.
- Challenges include unemployment, poverty, and teenage pregnancies, which can impact learner retention rates.
- The region also faces challenges related to affordable housing and access to quality healthcare and education.
- Opportunities exist in leveraging the region's natural beauty and attractions to foster sustainable tourism and economic growth.
- The focus on infrastructure development, particularly roads and recreational ports, is aimed at improving accessibility and promoting investment.

2.2.9 Risk and Vulnerability Factors

The vulnerability factors and scores for the Garden Route district can be seen in Figures 7 and 8 below, as well as the risk / hazard indicators for the Garden Route district, which were identified by the Western Cape Disaster Management Centre and the Department of Agriculture respectively.



Municipality	Socio-Economic		Economic		Physical		Environmental	
	The indicator shows the vulnerability of households living in the municipality with regards to the household's age composition, education and health status, access to basic services, and safety and security (2011 baseline)		Vulnerability of the municipality to external shocks is based on the economic diversity, size of the economy, labour force, GDP growth rate and the income inequality present in the municipality (2011 baseline)		Physical vulnerability addresses the physical fabric and connectedness of the settlements in the municipality. The more remote and/or structurally vulnerable, the higher the physical vulnerability score		Env. vulnerability represents the conflict between preserving natural environment & growth pressures associated with population growth, urbanisation, and econ development. It measures air quality, env. governance, & the competition between the ecology and urban encroachment	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Bitou	19	2.32	25	6.50	24	7.17	21	6.84
George	9	1.60	16	3.38	22	6.03	8	4.36
Hessequa	10	1.60	13	2.96	11	5.28	16	5.12
Kannaland	24	2.90	4	1.24	6	4.66	11	4.72
Knysna	14	1.92	24	5.66	19	5.93	23	8.13
Mossel Bay	5	1.26	11	2.82	13	5.40	19	6.10
Oudtshoorn	21	2.68	9	2.63	5	4.57	13	5.00

Figure 7: The municipalities within the Garden Route district ranked according to their vulnerabilities.

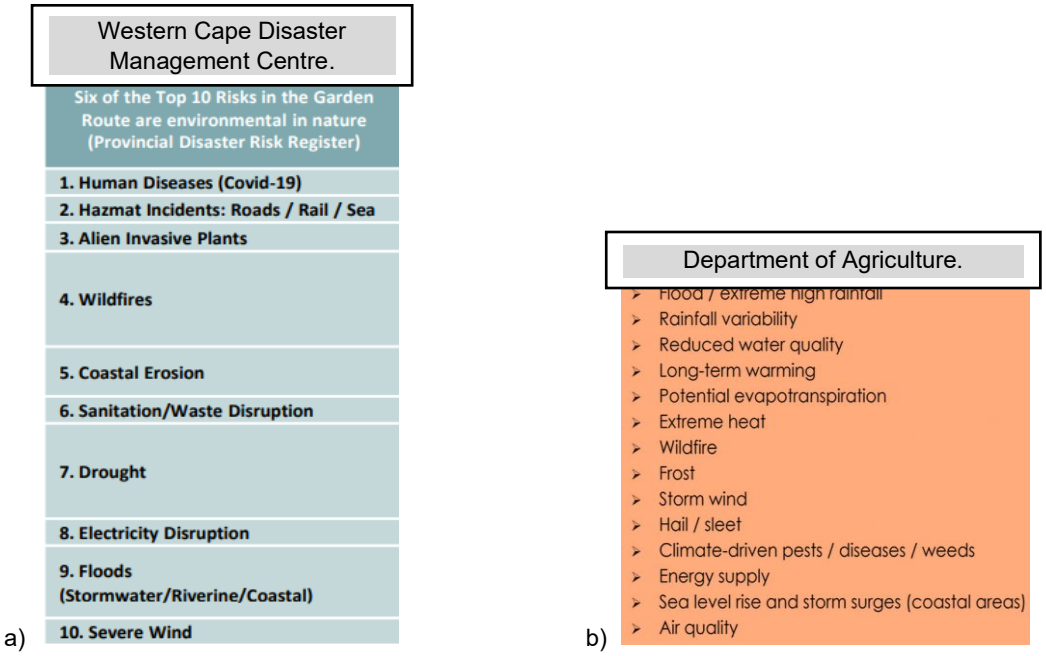


Figure 8l (a and b): The risk / hazard indicators identified by a) the Western Cape Disaster Management Centre and b) the Department of Agriculture.

- **Key Vulnerability: Sea Level Rise and Storm Surges**

  Although we expect fewer storm systems to reach the Western Cape in future, increased sea temperatures could mean increased storm activity and slightly stronger winds. At the same time the thermal expansion of the oceans will result in 0.25m – 0.75m of sea level rise by 2050, with associated swash run up of roughly 3.0m – 3.5m above the mean sea level (excluding tidal influence) (Figure 9).

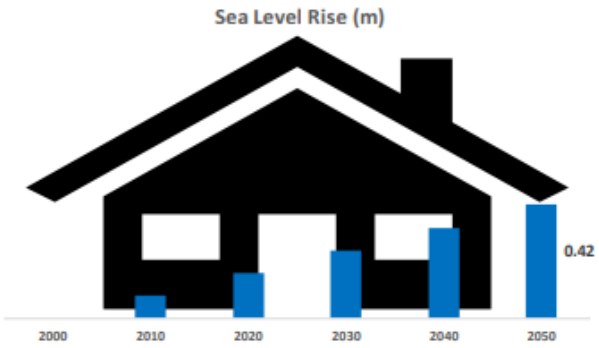


Figure 9: Historic and projected sea level rise figures for the Garden Route district (Western Cape Disaster Management Centre; Jack et al., 2022).

Sandy shores are most affected by sea level rise, and some areas in the Garden Route have seen beaches retreat landward at a rate of 0.6 m per year. This directly affects infrastructure and detracts from the amenity value of the coastline (Western Cape Disaster Management Centre; Western Cape National Treasury, 2023a).

- **Key Vulnerability: Drought**

  According to the CSIR Green Book, Garden Route has a high potential exposure to an increase in drought. Currently 1.9 years per decade are at risk of drought, and this will increase to 3.1 out of every 10 years by 2050. Water, and related sanitation services, is a key ingredient for socioeconomic development, food security and healthy ecosystems, and is vital for reducing the burden of disease and improving the health, welfare and productivity of populations. A deteriorating water catchment system, through ecosystem loss (transformation or land use change) and alien infestation, or watercourse and wetland modification, will lead to lower inputs into the water supply systems, and a lower overall water security due to lower natural retention and lower quality of water. During extended drought periods, even end users far from major source areas are likely to experience shortages as the overall system runs low (Western Cape Disaster Management Centre).

- **Key Vulnerability: Temperatures**

  Average temperature has been increasing since the 1900s. Projections indicate that Garden Route can expect an additional 15-21 hot days per year by 2050, which will affect food security, exposure to extreme heat, health and water quality (Western Cape Disaster Management Centre; Western Cape National Treasury, 2023a).

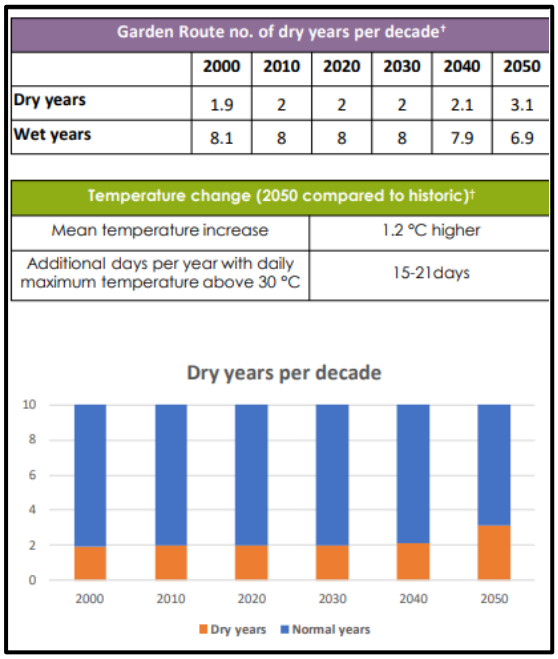
- **Key Vulnerability: Vegetation Fires**

  Although critical for a healthy ecosystem, fire is a significant threat to human lives, food security, socioeconomic activities and livelihoods, as well as infrastructure and other assets. Furthermore, in many areas land has been converted from natural vegetation

to other land-cover types - some of which significantly modify the fuel loads (e.g., the establishment of forest plantations and the spread of several introduced tree species such as pines, hakea, wattles and eucalypts). Fires in vegetation with high fuel loads increase soil erosion and run-off, which negatively affects ecosystem services and increases the impact of floods, among other factors. Where severe fires have occurred due to high fuel loads, resulting soil erosion leads to the sedimentation of rivers and dams and therefore declining water quality (and increased water treatment costs) (Western Cape Disaster Management Centre).

- **Key Vulnerability: Floods**

  Floods result in millions or billions of Rands' damage to built structures or lost productivity, the loss of livelihoods and in some cases the loss of lives. A 2016 report calculated that four severe weather events between 2011 and 2014 caused more than R1.6 billion worth of damage in the Western Cape, and in the recent September 2023 severe weather event, flood-related infrastructure damage alone amounted to R2 billion. Flooding is also one of the main disaster risks affected by climate change. Changes in rainfall volume, intensity and timing will alter flood risk profiles, and necessitate a constant reconsideration of risks and risk reduction measures (Western Cape Disaster Management Centre) (Figure 10).



Garden Route no. of dry years per decade†						
	2000	2010	2020	2030	2040	2050
Dry years	1.9	2	2	2	2.1	3.1
Wet years	8.1	8	8	8	7.9	6.9

Temperature change (2050 compared to historic)†	
Mean temperature increase	1.2 °C higher
Additional days per year with daily maximum temperature above 30 °C	15-21days

Figure 10: Historic and projected number of dry years for the Garden Route district (Western Cape Disaster Management Centre; Jack et al., 2022).

3. Future Climate Change Projections for the Garden Route District

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. Western Cape-specific assessments of modelling results from Global Circulation Models applicable to the Western Southern African region have been produced for the Western Cape Government by the Climate System Analysis Group (CSAG) and African Climate & Development Initiative of the University of Cape Town in recent years to inform the Western Cape Climate Change Response Framework and Implementation Plan for the Agricultural Sector (SmartAgri) plan[1] (Jack *et al*., 2022). The most recent product, an update of the 2016 Status Quo assessment, was released to the public in 2022[2]. The findings of this assessment, and its predecessors, are incorporated in the information below[3].

The projections of future climate indicate that mean annual temperatures will continue to increase, and that the rising temperatures will drive an accompanying increase in evapotranspiration. Combined with a suggestion of decreasing rainfall (although this trend is an uncertain projection at this point), the province can expect a steady decrease in the overall availability of moisture, resulting in a doubling of the likelihood of droughts in any given decade. Maximum temperatures will increase, more so in autumn and spring than winter and summer. With a rise in minimum temperatures will come a decrease in frost days and positive chill units, which has important implications for agricultural production.

3.1 Temperature

Figure 11 below shows projected changes in annual average temperatures, highlighting increasing temperatures throughout the district for the mid-century period (2030-2060) under the SSP2-4.5 climate change scenario. Around mid-century, projected increases in mean temperature averaged over the whole province are of the order of 1°C to 1.8°C by 2060 compared to the recent past (1981 – 2010). The Garden Route district is projected to be experience 1.2°C higher mean annual temperatures, which will manifest as higher minimum and maximum temperatures. The inland areas of Hessequa and the Kannaland municipality will experience the highest overall increases in the district.

Increases in temperature also result in an increase in the number of hot days (days with temperatures above 30°C. The projected increase in the number of days exceeding 30°C ranges from as few as 15 more days/year through to as many as 21 more days/year for inland zones (**Error! Reference source not found.**1).

Table 1: Projected changes in annual count of hot days by mid-century (Jack et. al, 2022).

Additional days per year with daily maximum temperature above 30 deg Celsius (2050 compared to 1902-2020 mean)	
Kannaland	21
Mossel Bay	20

[1] https://www.greenagri.org.za/smartagri-2/about/

[2] https://www.elsenburg.com/wp-content/uploads/2022/08/SmartAgri-Climate-Change.pdf. The Department of Agriculture can be contacted for more detail.

[3] The text on climate projections is used with permission from the 2023 Monitoring & Evaluation Report produced by the Department of Environmental Affairs and Development Planning (DEA&DP, 2023).

Oudshoorn	20
George	19
Bitou	19
Knysna	18
Hessequa	15

This will affect water and food security. Evaporation rates will also likely increase, and agricultural outputs may decline.

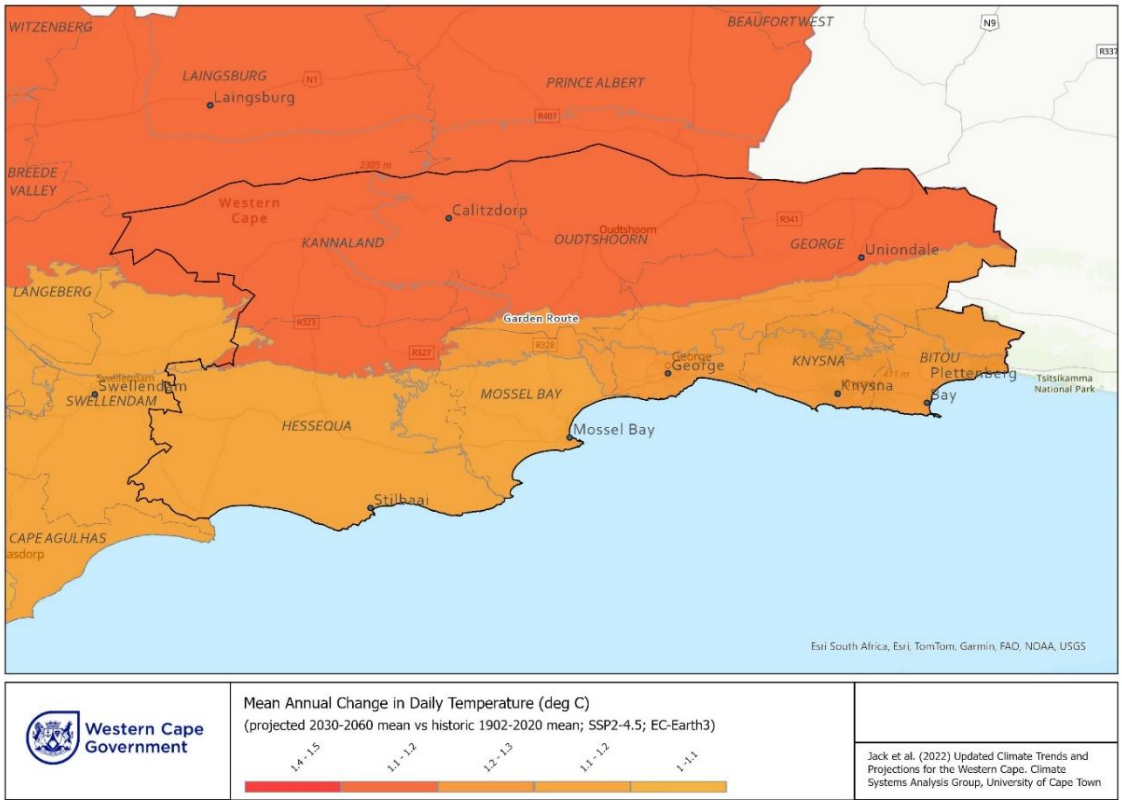


Figure 11: Projected mean annual change in daily temperature by mid-century (Jack et al, 2022).

3.2 Rainfall

Climate change is predicted to have an impact on rainfall patterns in South Africa. Climate change impacts for the Western Cape, however, carry a high degree of uncertainty due to the complexity of the frontal systems and their interaction with the complex topography of the region. Nevertheless, 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.

Figure 912 illustrates the projected annual rainfall for the Garden Route District around mid-century for a middle-of-the-road climate forcing scenario[4]. The overall change in precipitation is minor, with a stronger drying inland. A slight wetting trend is evident in winter (June-August) but this is cancelled out by drying in other seasons, especially summer. Uncertainty, however, remains high in all seasons, except in Spring when a drying is expected.

Little change is expected in terms of extreme rainfall – possibly one additional day per year with more than 10mm rain in 24 hours, and no change in the maximum amount of rain expected during a 5-day wet spell. The overall reduction in rainfall without a commensurate decline in rainfall days suggests that rainfall events will remain static, but the amount of rainfall per event will decline.

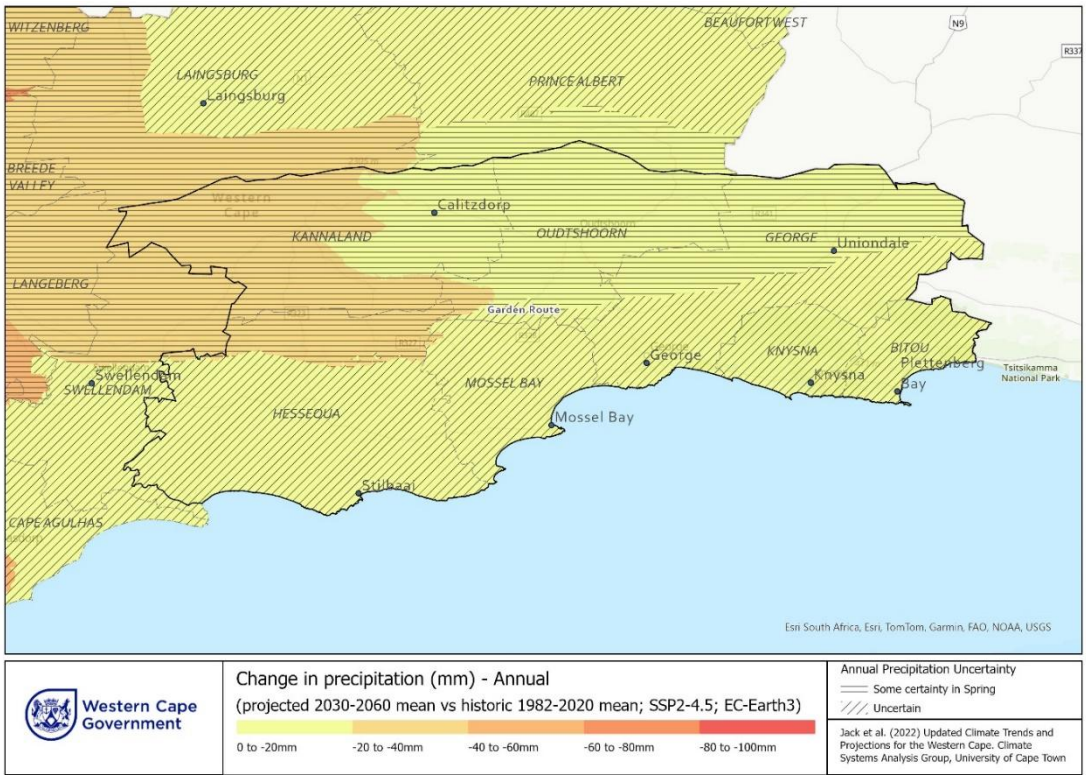


Figure 92: Projected changes in annual precipitation for a 2030-2060 mean as compared to a 1982-2020 mean (Jack et al., 2022).

Under a more extreme climate change scenario where little mitigation of global change takes place (the so-called RCP8.5 scenario), the drying trend becomes more pronounced as per projections from the CSIR's Green Book (greenbook.co.za). Figure 13 indicates how the annual mean precipitation changes by mid-century, and Figure 14 shows projected changes in the annual average number of extreme rainfall days. As is evident, less rainfall, and generally fewer extreme rainfall events can be expected (CSIR, 2019).

[4] The map is representative of the outputs of a group of broadly agreeing global climate models that avoid extreme temperature and precipitation outputs, for the so-called SSP2-4.5 scenario of the Intergovernmental Panel on Climate Change. See Jack et. al, 2022, for more detail.

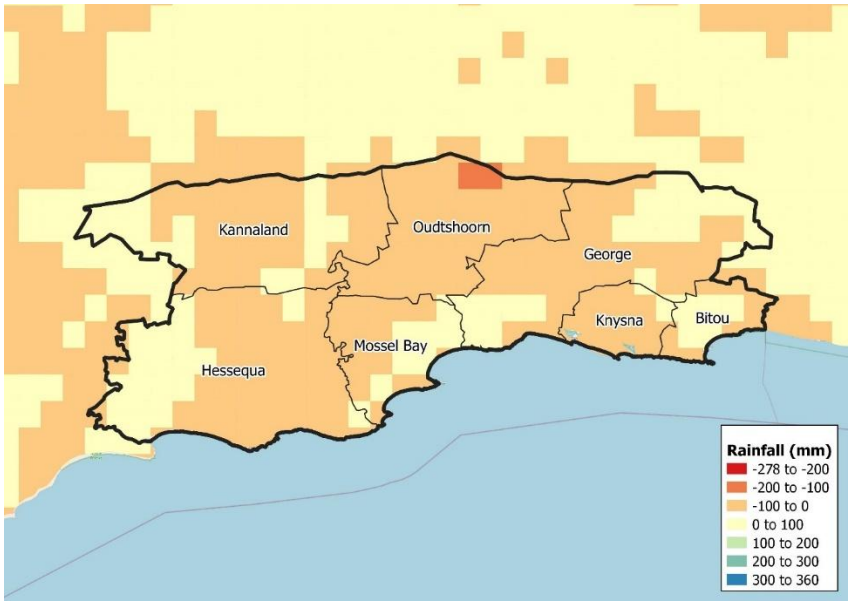


Figure 103: Projected changes in annual average rainfall throughout Garden Route over the period 2021-2050 under the RCP 8.5 scenario (CSIR, 2019).

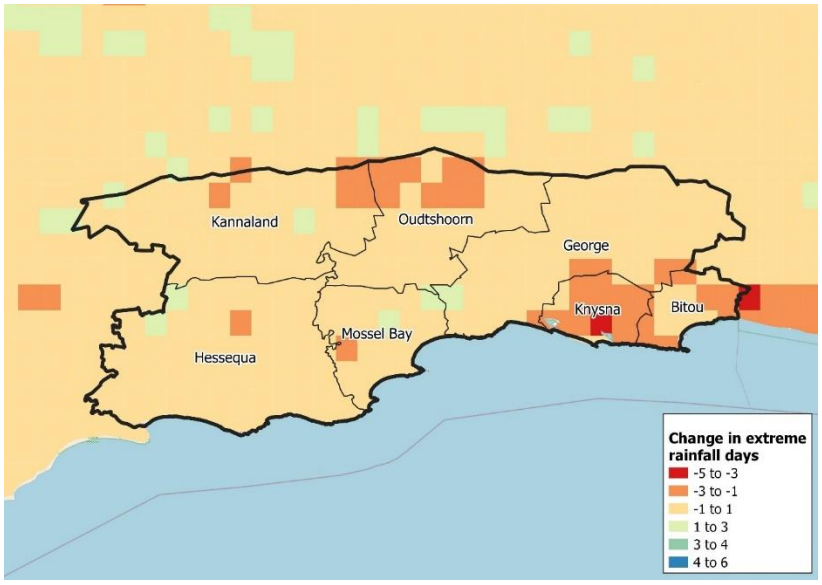


Figure 114: Projected changes in the annual average number of extreme rainfall days throughout Garden Route over the period 2021-2050 under the RCP 8.5 scenario (CSIR 2019).

In general, climate change is predicted to increase the number and severity of droughts, fires and floods in the in the Garden Route District area. 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.

3.3 Evaporation and Drought

Projected drought risk, as indicated by Potential Evapotranspiration, increases consistently throughout the province as it is largely driven by consistent increases in temperature. Projected changes in frequency of drought events as determined by Standardised Precipitation Index (SPI) and Standardised Precipitation Evaporation Index (SPEI) threshold exceedance (SPI or SPEI < -1) indicate consistent increases in frequency of drought events towards the end of the century with more rapid increases for SPEI based drought due to the inclusion of temperature driven evaporation.

For the Garden Route, it is projected that the current risk of 2 years per decade likely being drought years increase to more than 3 years per decade by mid-century.

4. Garden Route District Sector Summaries

Climate change is already harming food production, and these impacts are projected to increase over time, with potentially devastating effects. The impacts also include increasingly severe 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.

The most frequent climate related disasters in the Garden Route District are drought, floods, storm damage, wildfires, structural fires (especially informal settlements), sea level rise, animal diseases and environmental degradation.

The section below describes the current state of some of the sectors most affected by climate change, and some of the anticipated effects that climate change will have on those sectors.

4.1 Agriculture

4.1.1 Agricultural Activities

The agricultural sector is an important sector in the Garden Route District Municipal area, with "mixed farming", "non-perennial crops" and "perennial crops" being three of the top 10 sectors by number of employment opportunities in 2022 (Provincial Treasury, 2023[5]). The sector accounts for 5.2 % of the Gross Domestic Product of the region, and is the fourth highest employer in the Garden Route district, at 12.4% of jobs being found in agriculture (Provincial Treasury, 2023a). It is characterised by irrigated and rainfed pastures and crops as well as intensive livestock farming along the coastal plains (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) (Figure 1215). Intensive agricultural activities in the coastal areas are attributed to the higher levels of rainfall and soil fertility that occur there. Away from the coast, agriculture strongly corresponds to where rivers occur, especially in the drier Oudtshoorn Local Municipal Area.

Additionally, some commercial forestry occurs in the District Municipal Area in the areas around Tsitsikamma and George. Commercial agriculture and forestry in the District Municipal area are said to be the main drivers of the loss of biological diversity in the District Municipal area. 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.

[5] 2023-24 Municipal Economic Review and Outlook: Garden Route, Provincial Treasury, 2023 (https://www.westerncape.gov.za/provincial-treasury/files/atoms/files/2023-24%20MERO%20Garden%20Route%20District.pdf)

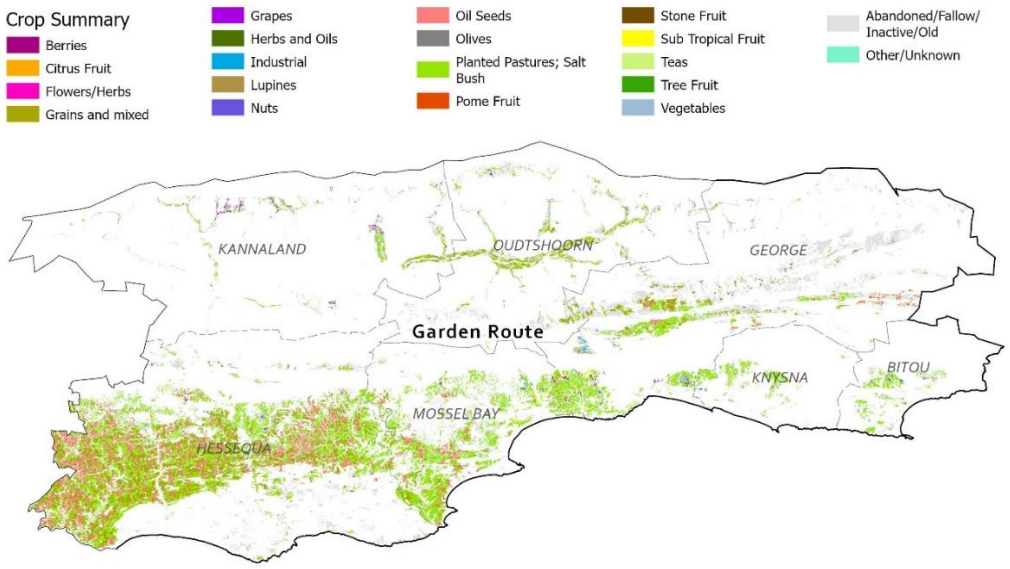


Figure 125: Crop census in the Garden Route district (DoA, 2023).

There are also four “Wine of Origin” districts within the Garden Route District Municipal area (Figure 16), namely, the Calitzdorp, Langeberg-Garcia, Lower Duiwenhoks River and Plettenberg Bayenberg Bay districts (DoA, 2024). Wine of Origin districts are more specific than wine regions, and they signify that all the grapes came from the same specific area.

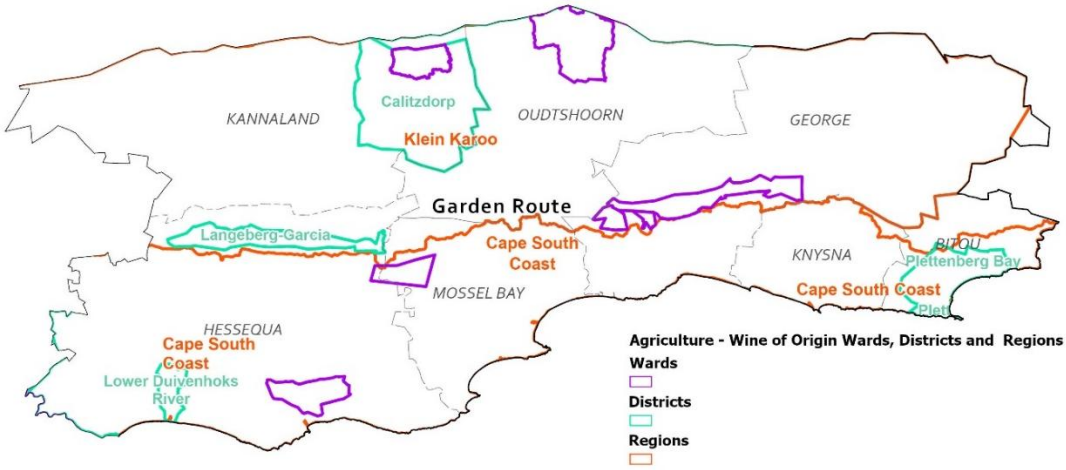


Figure 136: Wine of origin districts in the Garden Route district (DoA, 2024).

4.1.2 Garden Route District Agro-climate Zones

To understand impacts on 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 17) (DoA, 2016c). There are seven SmartAgri Zones in the District Municipal Area, three of which fall entirely in the district.

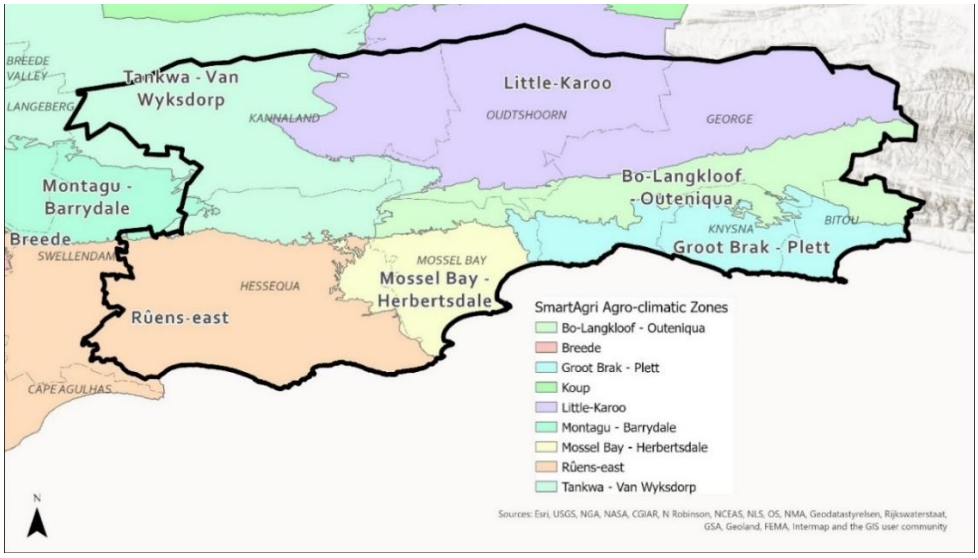


Figure 147: SmartAgri Zones in the Garden Route District Municipal Area (Western Cape Department of Agriculture, 2017).

The Bo-Langkloof-Outeniqua, Groot Brak-Plettenberg Bay, Mossel Bay-Herbertsdale, Rûens-east and Tankwa-van Wyksdorp SmartAgri Zones (the south-eastern coastal zone) are all predicted to be affected somewhat less by the prevailing mild drought projections for the province (Jack *et al*., 2022). This is however still consistent with the consistent trend of decreasing rainfall across all regions of the province (Jack *et al*., 2022).

For agri-zone specific projections, sector briefings by the Department of Agriculture in 2016 provide more contextual detail, but the time elapsed since these briefings should be considered. 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 (DoA, 2016a). Additionally, the future agricultural potential of the Klein-Karoo Zone is predicted to maintain 'moderately high' agricultural potential as long as there is sufficient water available in dams (DoA, 2016b).

4.1.3 Impacts of Climate Change

According to the DEA&DP (2022b) 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. A reduction in rainfall (and runoff) is forecast to reduce the yields of fruit, vegetables and rain-fed wheat production in the Western Cape. Furthermore, the production of fruit (such as apples and pears) will be increasingly vulnerable to damage from a predicted expansion of the areas affected by agricultural pests and fewer cold nights.

Through the predicted agricultural yield reductions, climate change could also impact the agriculture sector by reducing profitability and job opportunities in the sector. This would also result in increasing food security risks, especially amongst subsistence farmers and their dependents (DEA&DP, 2022b).

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. 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 (GRDM, 2017).

Specifically, it is anticipated that climate change will result in higher temperatures, lower rainfall and increased rainfall variability in the Garden Route District Municipality. 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. Nevertheless, the Garden Route District Municipality's Integrated Development Plan has noted that agriculture in the District Municipal Area has high adaptive capacity on a production level (GRDM, 2024).

4.2 Land and Biodiversity

The Garden Route district has diverse natural landscapes, consisting of fynbos, forest, mountains, estuaries, lagoons and coastal settings. Its bio-physical environment also underpins the economy with resources such as water, land, clean air, marine resources and energy, amongst others.

4.2.1 Biomes

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 18). The Western Cape Fynbos biomes are both fire prone and fire adaptive (Mosher *et al.*, 2024).

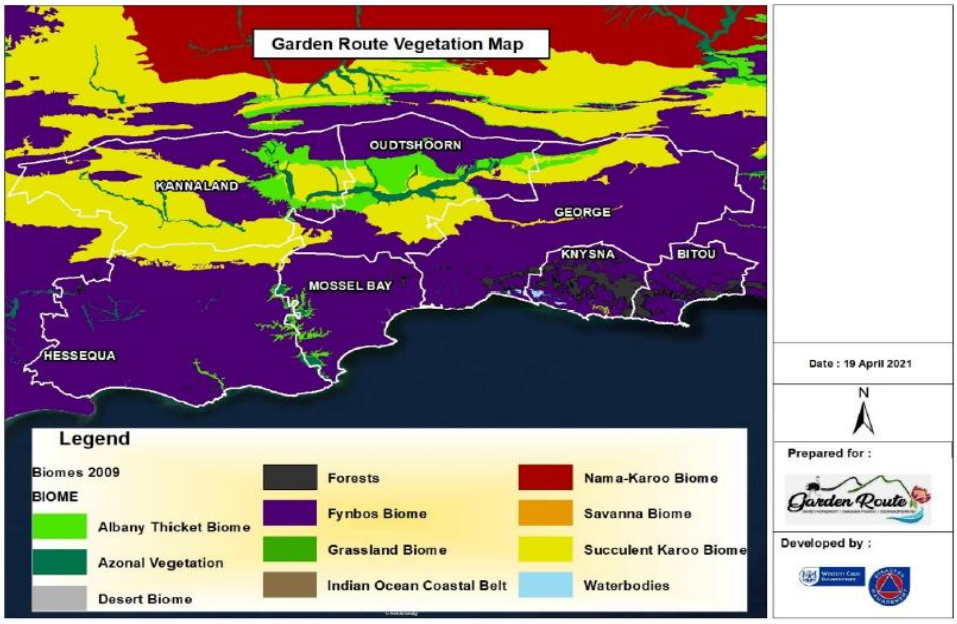


Figure 158: The spatial distribution of biomes in the Garden Route district (SANBI, 2023; WC DMC).

Within the Biomes, there are several threatened ecosystem types (Figure 19). The Garden Route Granite Fynbos, Gouritz Valley Thicket, Groot Brak Dune Strandveld, Knysna Sand Fynbos and Mossel Bay Shale Renosterveld are all categorised as critically endangered ecosystem types. Additionally, 12 ecosystems are categorised as endangered (SANBI, 2022).

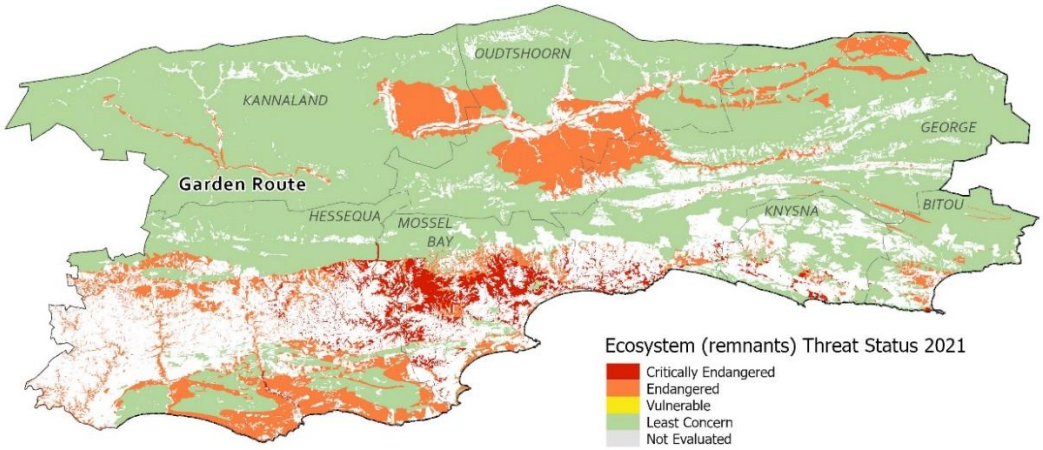


Figure 169: Ecological status in the Garden Route district (SANBI, 2022).

4.2.2 Protected Areas

The Garden Route district is also 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.

There are two major biodiversity corridors that run 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. 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.

Scattered throughout the Garden Route District Municipal area are 55 protected areas (Figure 20). This includes eleven formal nature reserves, which include unique marine reserves that are a host of diverse marine life. The largest of these, the Garden Route National Park (GRNP) is situated in the local municipal boundaries of George, Knysna and Bitou within the Garden Route district.

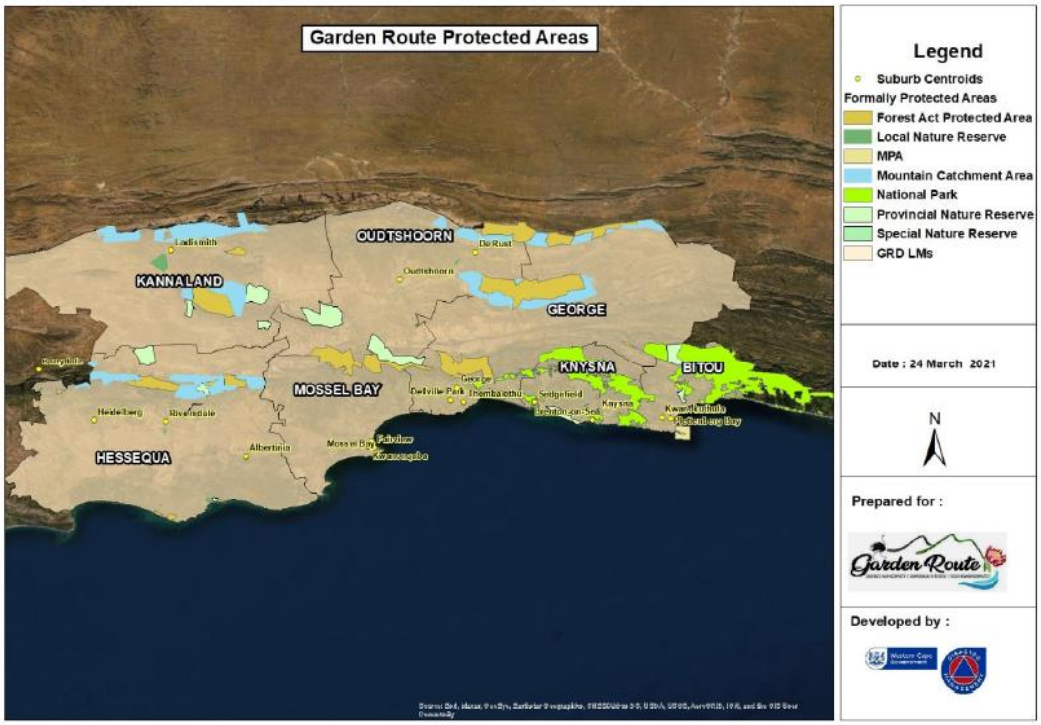


Figure 20: The protected areas within the Garden Route district (PDMC, 2021).

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. Three of the marine protected areas are managed by CapeNature and one by SANParks (the Tsitsikamma marine protected area).

4.2.3 Biodiversity Spatial Plan

Spatial biodiversity planning in the Western Cape is captured in the Biodiversity Spatial Plan (BSP), compiled from time to time by CapeNature. The most current available version of the BSP is dated 2017, and it indicates all biodiversity resources in the province that are required to maintain functional ecosystems.

The Figure 21 below illustrates the spatial distribution of the following:

- Protected Areas – Terrestrial Areas which include world heritage sites, Ramsar sites, national parks, natural reserves and forest nature reserves and mountain catchment areas, as well as 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.

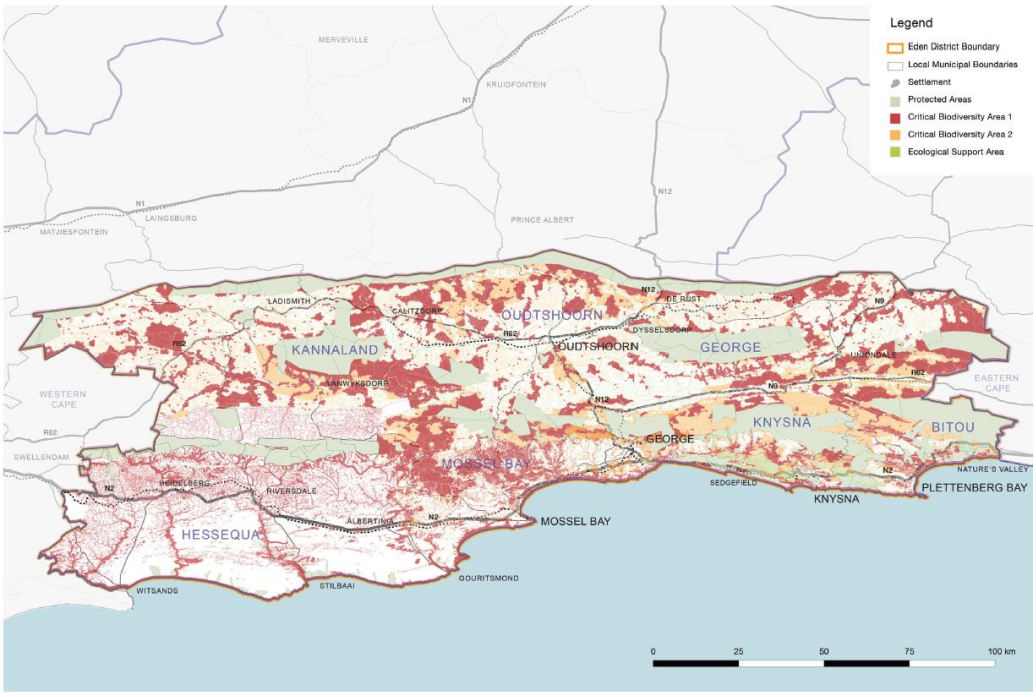


Figure 21: Critical biodiversity areas in Garden Route district (GRDM, 2017).

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 (PDMC, 2021):

- 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 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 alien invasive plants, 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.

4.2.4 Impacts of Climate Change

Climate change is broadly predicted to shift the ranges of biomes in South Africa, resulting in a change to the ecosystems and vegetation. Previously, concern was raised that the fynbos vegetation found in the Garden Route District Municipal area will be invaded by thicket, Karoo

and desert biomes (Department of Environmental Affairs, 2013b). Recent modelling that takes geology and soils into consideration has, however, found that the climate change effects are secondary to the control that geology exerts on the biomes (Guo *et al*., 2017). The research finds that "*Due to geological barriers and also human activities such as urbanization, farming and mining, which all play a critical role in how the biomes react to climate changes, the biomes doesn't often "shift" to a different region*" (Guo *et al*., 2017).

Nevertheless, biomes can degrade in a number of ways, including through a shrinkage in area. According to Guo, Desmet & Powrie (2017): "*The Fynbos Biome is maintained well in spite of changing climate, but the Succulent Karoo biome faces major loss of habitat*." Degradation and loss of species and/or functional ecosystems should therefore be guarded against. It is also important to note that a key vulnerability for fynbos ecosystems is invasion by alien plants (Higgins *et al*., 2024) before any sort of biome shifting or in-situ die-back processes can take precedence.

Anticipated changes in the region's fire regime are very important to note. The region's fire interval under natural conditions is usually 12 – 18 years between fires. This number is expected to increase in the next 100 years due to the increase in temperatures and decrease in moisture availability. Some of the knock-on effects include increased wildfires in areas with adapted alien vegetation infestations and, therefore, escalated densities of combustible material. The loss of indigenous species is also expected to increase which will make fires more frequent and more difficult to manage.

4.3 Water Resources

4.3.1 River Systems

The Garden Route district is predominantly located within the Breede-Gouritz Water Management Area (BGWMA) and its concurrent hydrological zone, 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 and hydrological zone to the east.

The Breede River and its main tributary the Riviersonderend River are located on the eastern boundary of the district, and play a significant role in the agricultural activities of the area (Figure 22).

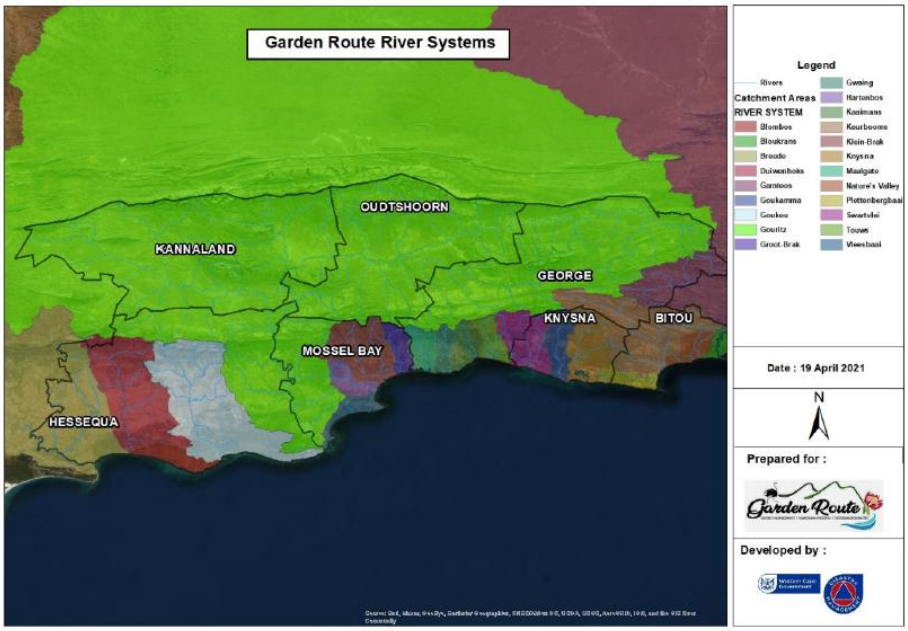


Figure 172: River systems in the Garden Route district (PDMC, 2021).

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 in this WMA, 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 (PDMC, 2021).

4.3.2 River Health

The health of a river system is graded into one of several categories as listed in Text Box 1. Many of the mid-reach sections of rivers in the Garden Route District Municipality Area (Figure 23) are classified as 'largely modified' or worse. This is most evident in the Hessequa and Mossel Bay Municipalities. Understandably, the higher reaches of rivers in mountainous areas classify as 'Natural' or 'Largely Natural' (SANBI, 2018).

Text Box 1: Freshwater Ecosystem Priority Areas (FEPAs) classification for river ecosystem conditions (SANBI, 2018)

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

A = Unmodified, Natural
B = Largely Natural with Few Modifications
C = Moderately Modified
D = Largely Modified
E = Seriously Modified

F = Critically/Extremely Modified

Rivers that are unmodified or in their natural state are able to contribute towards river ecosystems biodiversity targets. 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.

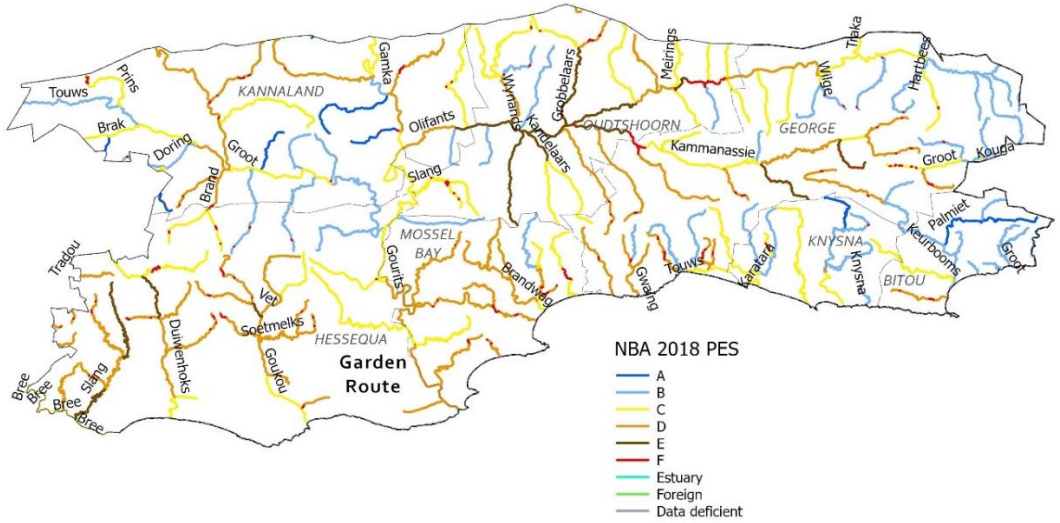


Figure 183: River condition in the Garden Route District (SANBI, 2018).

The distribution of river condition is correlated with a classification of ecosystem threat status (Figure 24). Again, according to SANBI (2018), the lower reaches of rivers in the agricultural areas of Hessequa and Mossel Bay and in the coastal resort towns are of most concern – i.e. classified as 'critically endangered' and 'endangered'.

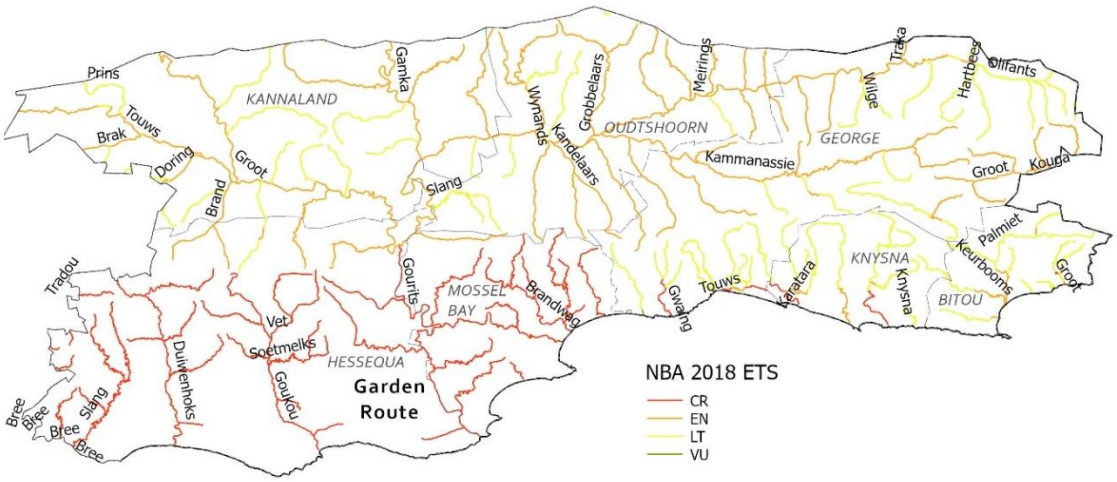


Figure 194: Ecosystem Threat Status of Rivers (SANBI, 2018).

In terms of wetlands in the Garden Route district, 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) (CSIR, 2011). Wetlands classified as 'mostly natural or good' (more than 75% of the wetland land cover is natural) are much fewer in number (CSIR, 2011).

Wetland degradation is caused by inter alia: poor land management practises, spatial developments near urban areas, the spread of invasive alien plants, agricultural practices, pollution and the building of dams.

4.3.3 Storage Dams in Garden Route District

The storage dams that service the towns of the Garden Route district with drinking water are as follows (GRDM, 2021):

- George: Garden Route dam
- Mossel Bay: Wolwedans dam
- Oudtshoorn: Koos Raubenheimer dam
- Riversdale: Korente Vet/Poort dam
- Heidelberg: Duiwenhoks dam
- Bitou: Roodefontein dam
- Calitzdorp: Calitzdorp dam

4.3.4 Impacts of Climate Change

Water resources in any catchment are largely dependent on rainfall. Climate projections indicate that the district will become drier, with less rainfall per rainfall event and higher general temperatures. By implication, pressure will mount on watercourses and water supply systems.

Climate change is also predicted to increase the number and severity of droughts and fires in the Garden Route District Municipal area. 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 and fires. This is particularly pertinent given the recent devastating fires in and around the Garden Route as well as the regular droughts in Western Cape.

4.4 Marine and Coastal

4.4.1 The Coastal Zone

The coastal zone in South Africa includes the inshore, offshore and estuarine ecosystems. 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 above the high-water mark (DEA, 2017). Four coastal Marine Protected Areas, namely Stilbaai, Goukamma, Robberg and Tsitsikamma, are located in or partially in the Garden Route district.

There are several threatened ecosystem types in the coastal zone of the Garden Route District Municipal area (Figure 205). The ‘Mossel Bay Shale Renosterveld’, ‘Garden Route Granite Fynbos’, ‘Knysna Sand Fynbos’ and ‘Agulhas Muddy Inner Shelf’ are all categorised as critically endangered ecosystem types. Other coastal ecosystems classified as endangered are ‘Agulhas Sheltered Rocky Shore’, ‘Eastern Coastal Shale Band Vegetation’, ‘Overberg Dune Strandveld’, ‘Warm Temperate Estuarine Lake’ and ‘Western Agulhas Bay’ (SANBI, 2018). Some of these threatened ecosystems are partially being conserved in marine protected areas.

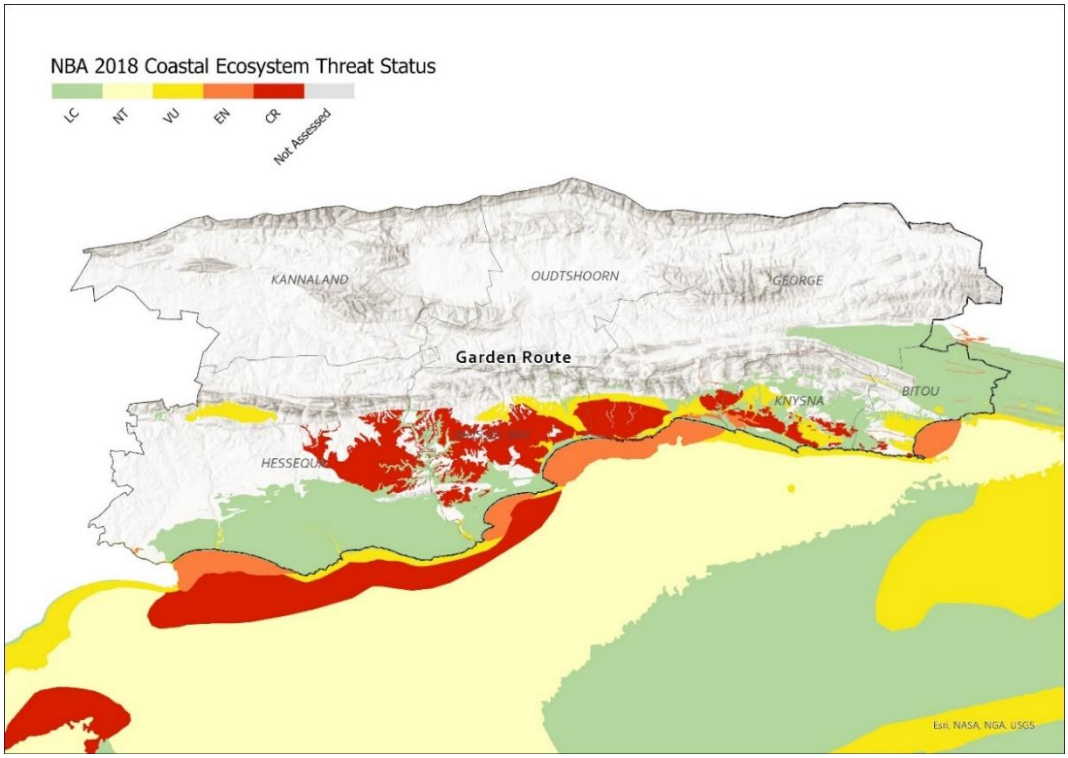


Figure 205: Coastal and marine ecosystem threat status (SANBI, 2018).

4.4.2 Estuarine Systems

The NBA 2018 (SANBI, 2018) concludes that less than half (44%) of the 54 estuarine systems in the Western Cape are in a 'fair' state, 15% are ranked as excellent and 26% ranked as 'good'. This indicates an improvement in the ecological health of Western Cape estuaries (9% improvement to those ranked as 'excellent' and a 6% improvement to those ranked as 'good') when compared to the 2011 NBA.

There are 22 estuarian systems in the Garden Route District Municipal Area and two (the Breede and Bloukrans estuaries) that mark the borders of the Garden Route District Municipal Area. Estuaries along the south and southeast coast tend to be healthier than those in the rest of the Province, with the estuaries around towns of George and Mossel Bay experiencing pressure from development and associated pollution impacts. The majority of the estuaries in this region are characterised by low levels of modification and pollution, while more than half of the estuaries are considered to be well protected, respectively. Twelve estuaries are identified as being of high biodiversity priority.

Estuary ecosystems are experiencing increasing pressure from human related activities that are decreasing the quantity and quality of available estuarian ecosystem services. 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 as well as poor land use practises and degradation higher up in the catchment. Estuary ecosystems are also impacted by artificial breaches of 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.

4.4.3 Impacts of Climate Change

Climate change is predicted to impact many facets of the coast, including marine and benthic ecosystems, estuary ecosystems, coastal livelihoods, as well as infrastructure and property due to sea level rise.

In 2018, the Department of Environmental Affairs and Development Planning (DEA&DP) conducted a study on coastal erosion and flooding, in anticipation of the proclamation of coastal management lines for regulation of development. This study identified areas at risk of flooding and/or erosion, due to increased wave impact or progressive sea level rise (DEA&DP, 2018). Flooding risks within the estuarine systems have 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.

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 in land and sea surface temperatures, frequency and distribution of precipitation, water runoff patterns, coastal storm frequency and intensity, oxygen levels and wind. This may affect migration patterns, increased or decreased biological activity, as well as changes to estuarine dynamics (SANBI, 2018). Sea level rise may also cause saltwater 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, coastal and marine tourism and food security (DEA&DP, 2022b). For example, 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 (DEA&DP, 2022b).

Over and above the effects of climate change, the estuarine systems within the Garden Route district are 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 wastewater treatment works and increased nutrient loads from coastal developments and upstream farming practices (PDMC, 2021).

4.5 Energy

Energy consumption in the Garden Route is dominated by liquid fuels (petrol and diesel) at 55% (Figure 26) of total energy consumption of the province. This is following by electricity at 32% (DEA&DP, 2022b).

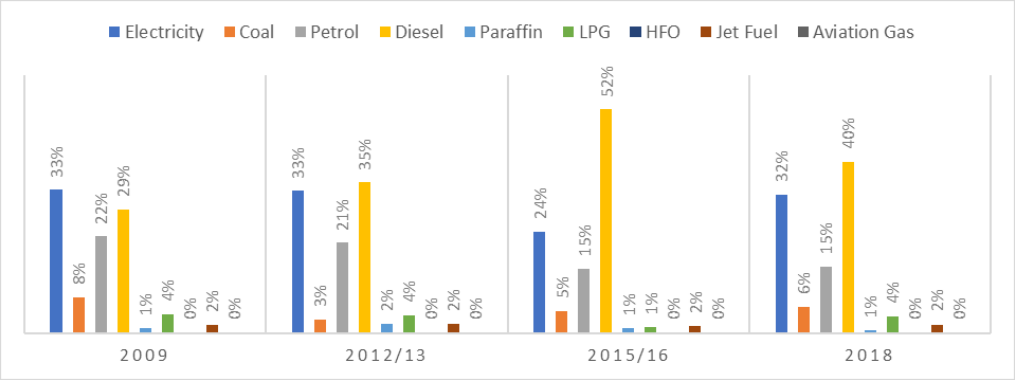


Figure 216: Energy use by fuel type for Garden Route District 2009 – 2018.

Note that as the transport data is calculated in terms of liquid fuel sales, it can give a slightly skewed picture of liquid fuel use in the region as some of this can be allocated to through-travel to and from the Eastern Cape and other provinces as well as freight travel, but it is still a significant contribution to the total consumption of the district.

It is notable that the energy (electricity in particular) use profile of the Garden Route (Figure 27) is also different to that of other regions around the province as there are big peaks of consumption felt in the holiday periods, particularly during December and January. This makes planning for electricity supply and management difficult when compared to regions with more consistent consumption across the year.

Much of the planning and regulatory frameworks for electricity and liquid fuels takes place at the national level, so it can be difficult for municipalities to make significant changes to large scale, but there are a number of opportunities to facilitate change at the local level within their own operations and by creating an enabling environment to take up opportunities around renewable energy, electric vehicles and others.

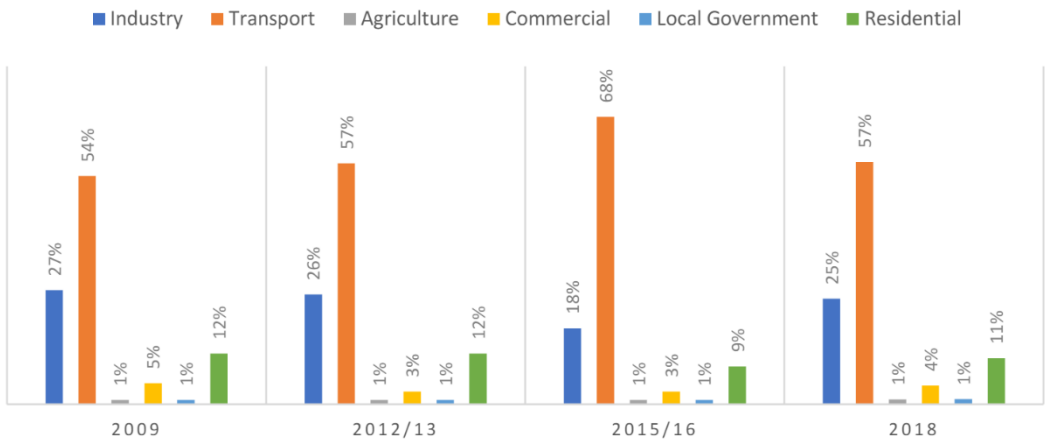


Figure 227: The energy use by sector within the Garden Route district.

As mentioned above, the transport sector (including aviation fuels) accounted for the largest proportion of energy consumption in the district (57%) in 2018, followed by the industrial sector at 25% (Figure 28). The high use of energy in the industrial sector can be attributed to PetroSA

as well as other industrial and manufacturing activities in Mossel Bay and the fact that the Western Cape's second-largest town (George) is located in the Garden Route District.

It should be noted that the refinery at the PetroSA site has not been in use since November 2020, so this has led to a reduction in energy consumption in the District. This information will be captured in the latest iteration of the Western Cape GHG Inventory currently in development. There are plans to resume full production once new sources of offshore gas are available, but there is nothing confirmed at this stage.

The residential sector accounts for 11% of energy consumption in the district, which is also a significant contribution to consumption and can be linked to the tourism industry, where houses are rented out and holiday houses are used during peak seasons.

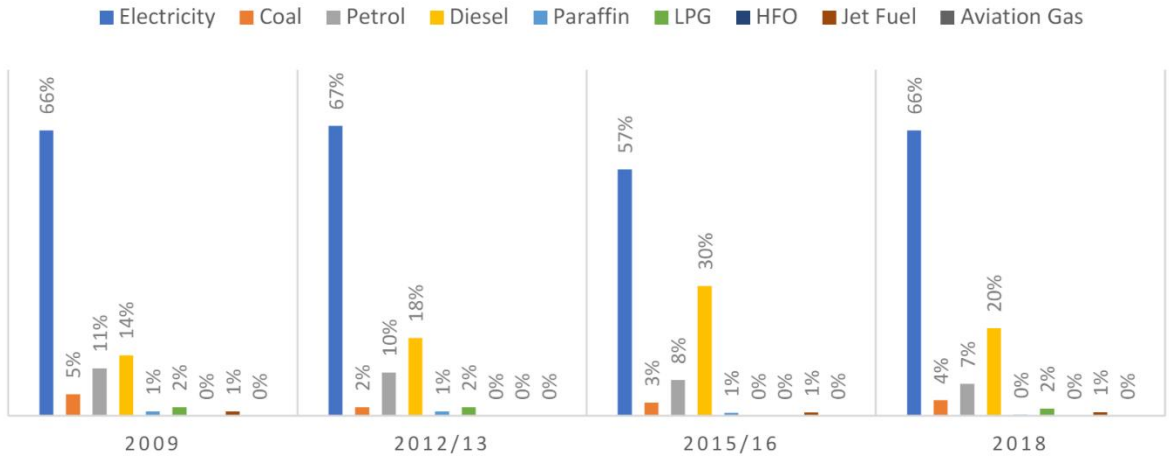


Figure 238: Energy-related emissions by fuel type in the Garden Route district.

Understanding sector 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. A lot of efficiencies in terms of municipal operations, particularly around building efficiencies, street and traffic lights and investment in renewable energy have already been put in place. Mossel Bay and George municipalities have also been some of the leading Western Cape municipalities to implement innovative energy programmes, with George municipality successfully running a wheeling programme for renewable energy for a number of years now.

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. A lot of work has also been undertaken around Shale Gas extraction in the Karoo region and although this falls predominantly in the boundaries of Central Karoo district, there may be implications and / opportunities for the Garden Route district to consider. More recently, challenges with transmission network capacity constraints have led to a decrease in uptake of renewable energy in the Western

Cape as part of the REIPPPP programme, but there are still a lot of opportunities for private sector led or supply for municipal operations generation.

4.6 Human Settlements and Well-Being

Human settlements in the Garden Route district face severe challenges, even before climate change is taken into account. The implications of the compounding impacts of climate change will be profound, and human settlements therefore represent a crucial part of adaptation strategies.

Urban, rural and coastal human settlements face particular environmental and social challenges in relation to climate change. The projected impacts of climate change on urban settlements are complex and diverse, and both direct and indirect. Uniform solutions are unlikely to be appropriate in all situations, particularly when exacerbated by climate change. Many other drivers of social vulnerability identified in the context of urban settlements are particularly prevalent in rural communities.

Adaptation to climate change needs to be viewed as an integral part of the broader developmental challenges facing the Garden Route district's human settlements, in that effective adaptation can closely resemble non-climate related development. Addressing existing deficits in the provision for water, sanitation, drainage, electricity, tenure, healthcare, emergency services, schools and public transport backlogs is fundamental to building climate resilience in vulnerable human settlements. With well-designed institutional arrangements and mandates, development and adaptation objectives can be combined along with the resources necessary for each. Adaptation could thus be 'mainstreamed' into economic, spatial and infrastructure policy implementation.

4.6.1 Climate Change Impacts on Urban Settlements

The following climate change impacts are affecting rural settlements:

- Increased costs of water, liquid fuels and electricity as industrial inputs.
- Increased costs of labour linked to food, energy, water and transport costs.
- Direct impacts of weather on construction, electricity generation and other industries, resulting in loss of productivity.
- Increased risk of lack of water delivery as a result of increased demand because of higher temperatures and drying conditions.
- Increased population size in urban and peri-urban areas, leading to increased pressure on service delivery and competition for resources, as a result of migration from rural areas affected by climate change.
- Increased disruptions to transport infrastructure (roads, rails, bridges, airports, tunnels) as a result of extreme weather events.
- Increased threat to human health through, for example, increased spread of malaria.
- Increased risk of extreme weather events to already vulnerable informal settlements, that are often unplanned, and without extensive service or infrastructure.

4.6.2 Climate Change Impacts on Rural Settlements

The following climate change impacts are affecting rural settlements:

- Reduced productivity of subsistence farmlands as a result of rising temperatures, unreliable rainfall, water scarcity and bush encroachment.
- Reduced productivity of rangelands as a result of drought, bush encroachment, malnutrition and disease.
- Increased vulnerability to water shortages because of increased evaporation, changes in rainfall, damage to infrastructure from floods and storm surges, and reduction in groundwater recharge.
- Reduced availability of natural resources on which many rural communities depend, because of diminished biodiversity in already degraded ecosystems.
- Physical isolation of rural communities as a result poor rural roads and increased flooding and erosion.
- Reduced food security, particularly of subsistence farmers, and resultant increase in malnutrition.
- Increased migration from rural settlements to urban and peri-urban settlements.

4.7 Natural Disasters

The district's vulnerability to climate change impacts is partly attributed to its physical location, topography and general climate conditions (GRDM, 2017). In addition, increased vulnerability to climate change has been caused by rapid urbanisation and informal developments (DEA&DP, 2022b). Urbanisation has increased because of in-migration of youth and elderly from the Eastern Cape to the coastal towns of the Garden Route district. However, housing delivery has not been able to keep up with the migration, hence the ongoing increase in informal dwellings in the district (Provincial Treasury, 2023a).

Additionally, financial losses in the district, due to these climate related hazards, has already been high. For example, the 2014 Garden Route District Municipality's Climate Change Adaptation Plan 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 (GRDM, 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 (GRDM, 2014).

Veld fires occur mainly between November and February. Increases in the frequency and intensity of veld fires have had negative impacts in the agricultural, forestry and tourism sectors (GRDM, 2014). The risk of veld fires is high for most of the District Municipal Area, however, there are areas of increased veld fire risk (Figure 249). As per the climate change projections, it can be expected that more high fire risk days will occur in the mountainous and inland regions in future.

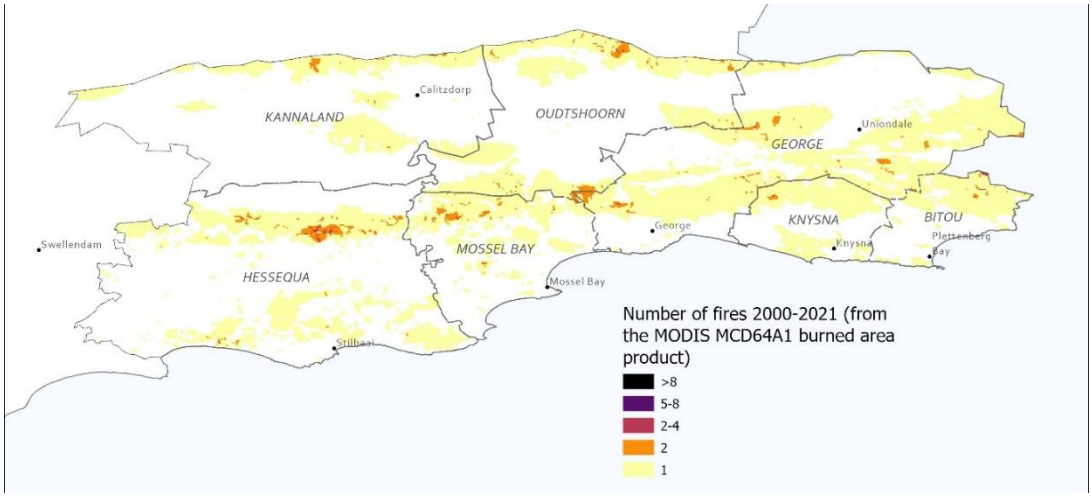


Figure 249: Count of fires (2000-2021) obtained from the MODIS active fire and burned area product (https://modis-fire.umd.edu/).

4.8 Health

Garden Route is host to 40 Primary Healthcare Facilities, 37 Mobile Clinics, 6 District Hospitals and 1 Regional Hospital. Due to its location and population size, 20.8% of the healthcare facilities are in the George Municipality.

The prevalence of malnourished children under the age of five, particularly those suffering from severe acute malnutrition, per 100 000 individuals in the region, saw a marginal increase from 2021/22 to 2022/23. Fortunately, the percentage of infants born with a birth weight of less than 2.5 kilograms decreased over this period. In both cases, the region exhibited higher rates when compared to the Provincial average. Despite reductions in poverty and government feeding schemes, there remains a continued challenge in terms of households' access to nourishing food (Provincial Treasury, 2023b).

With 6 maternal deaths and 74 babies dying between 6 and 28 days of life, the region has amongst the highest maternal and neonatal mortality rates in the Province, presenting a concerning development especially as these rates have increased from 2021/22 to 2022/23 This emphasises the need for improved antenatal and postnatal care (Provincial Treasury, 2023b).

Approximately 12 % of the Garden Route District Municipal Area's employed households are involved in agricultural activities (Provincial Treasury, 2023b). 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 (e.g., wildfires, drought, severe storms and floods). Consequently, predicted impacts for households involved in agriculture include reduced agricultural yields and water security as well as increased food insecurity.

4.9 Air Quality

Air pollution includes greenhouse gases such as carbon dioxide and methane. 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.

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 led 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.

5. 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.

5.1 Environmental Vulnerability

The latest IPCC (Intergovernmental Panel on Climate Change) report, which is the Sixth Assessment Report (AR6), defines climate change vulnerability as the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change,

including climate variability and extremes. Essentially, it's about how much a system is at risk from climate change impacts and how well it can handle them (IPCC, 2023).

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 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.

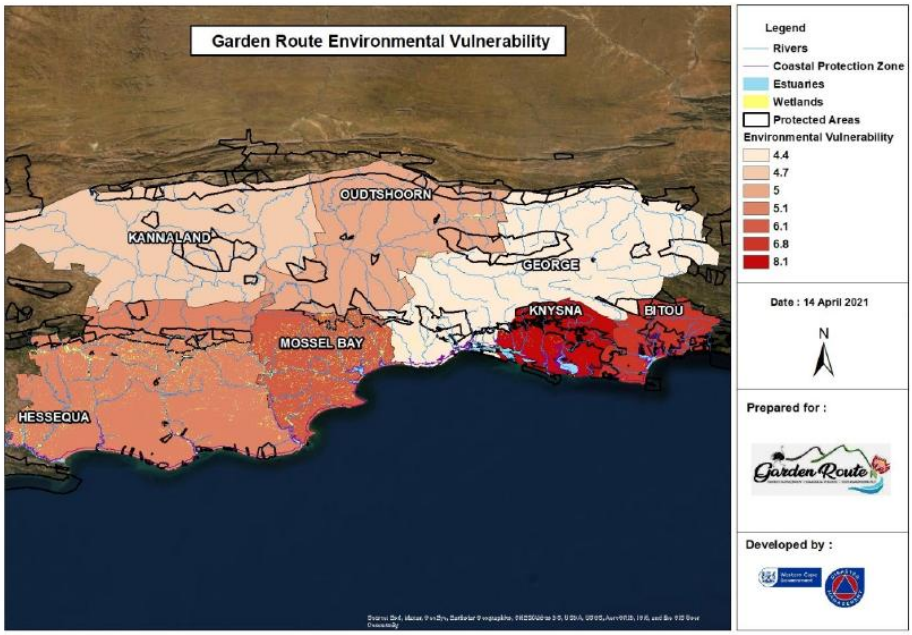


Figure 29: The environmental vulnerability in the Garden Route district (WC DMC, 2021).

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 integrate climate change considerations into existing development planning processes. This mainstreaming approach should lead to the effective realisation of the intrinsic and economic value of the region's 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.

5.1.1 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 2: 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.

5.1.2 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.

5.1.3 What is a Vulnerability Assessment?

A climate change vulnerability assessment is a process to evaluate the susceptibility of a system (like a community, ecosystem, or infrastructure) to the adverse effects of climate change. It analyzes how exposed a system is to climate hazards, its sensitivity to those hazards, and its capacity to adapt to changing conditions. The goal is to identify areas and populations most at risk and to inform adaptation strategies. Figure 31 indicates the relationship between vulnerabilities and disasters.

Key Components:

- **Exposure:**

Refers to the degree to which a system is exposed to climate-related hazards, such as increased temperatures, sea-level rise, or extreme weather events.

- **Sensitivity:**

Describes how susceptible a system is to harm from these hazards. This includes factors like the physical characteristics of the system, its reliance on specific resources, and its ability to cope with changes.

- **Adaptive Capacity:**

Represents the ability of a system to adjust to climate change impacts, either by reducing negative effects or taking advantage of new opportunities. This includes factors like access to resources, technological capabilities, and social networks.

Why is it important?

- **Informs Adaptation Planning:**

Vulnerability assessments help prioritize areas and populations that need the most urgent adaptation measures.

- **Reduces Climate Risks and disasters:**

By identifying vulnerabilities, communities can implement strategies to reduce their exposure, sensitivity, or improve their adaptive capacity.

Hazard	**:**	**potential threat to humans and their welfare**
+		
vulnerability	**:**	**exposure and susceptibility to losses**
=		
risk	**:**	**probability of hazard occurrence**
disaster	**:**	**realization of a risk**

Figure 31: The relationship between vulnerabilities and disasters (IPCC Technical Paper 3, 2002).

- **Supports Sustainable Development:**

Understanding climate risks is crucial for ensuring long-term sustainability and resilience of social, economic, and ecological systems. 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.

5.1.4 Steps involved in a Vulnerability Assessment

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

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

Figure 30 below illustrates how the components of a Climate Change Vulnerability Assessment link to each other.

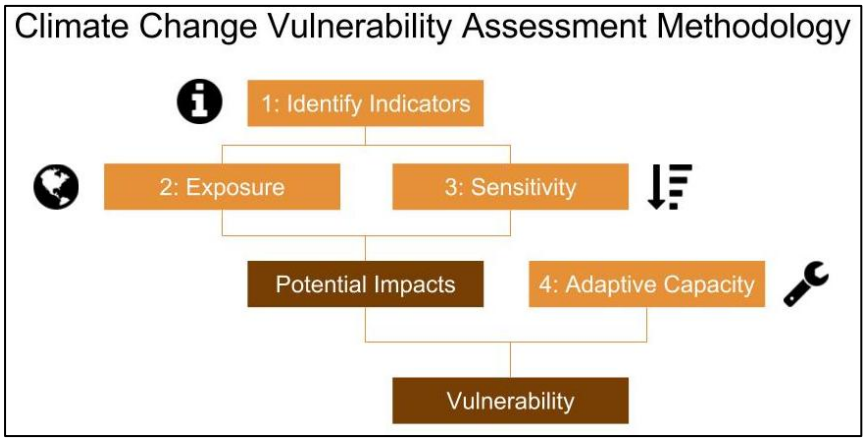


Figure 250: The climate change vulnerability assessment methodology (Available at: https://letsrespondtoolkit.org/resources/vulnerability-assessment-tool/).

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 a daptive 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 were 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.

5.2 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:

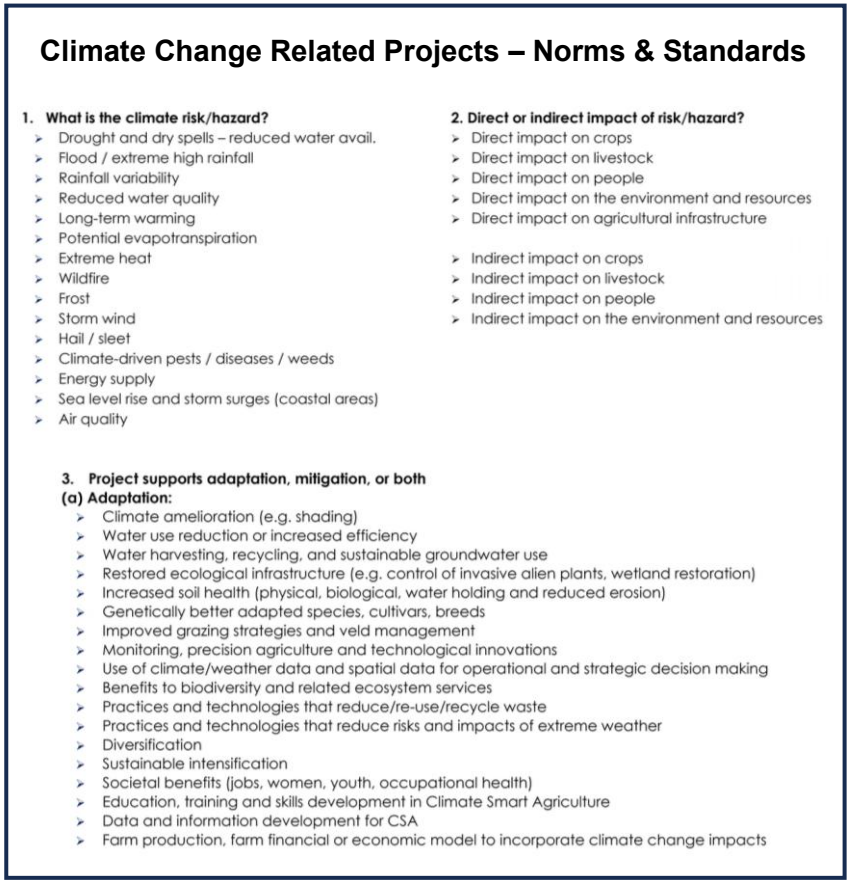
- G1 – Robust/integrated plans, policies and actions for effective delivery of climate change adaptation, together with monitoring, evaluation and review over the short, medium and longer-term.
- G2 – Appropriate resources (including current and past financial investments), capacity and processes (human, 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.

5.3 Vulnerability Indicator Tables for the Garden Route District Municipality

5.3.1 Agriculture

The Western Cape Government's Department of Agriculture has released the below vulnerability indicator table for the Garden Route District Municipality (Figure 31).



Climate Change Related Projects – Norms & Standards

1. What is the climate risk/hazard?

- Drought and dry spells – reduced water avail.
- Flood / extreme high rainfall
- Rainfall variability
- Reduced water quality
- Long-term warming
- Potential evapotranspiration
- Extreme heat
- Wildfire
- Frost
- Storm wind
- Hail / sleet
- Climate-driven pests / diseases / weeds
- Energy supply
- Sea level rise and storm surges (coastal areas)
- Air quality

2. Direct or indirect impact of risk/hazard?

- Direct impact on crops
- Direct impact on livestock
- Direct impact on people
- Direct impact on the environment and resources
- Direct impact on agricultural infrastructure

- Indirect impact on crops
- Indirect impact on livestock
- Indirect impact on people
- Indirect impact on the environment and resources

3. Project supports adaptation, mitigation, or both

(a) Adaptation:

- Climate amelioration (e.g. shading)
- Water use reduction or increased efficiency
- Water harvesting, recycling, and sustainable groundwater use
- Restored ecological infrastructure (e.g. control of invasive alien plants, wetland restoration)
- Increased soil health (physical, biological, water holding and reduced erosion)
- Genetically better adapted species, cultivars, breeds
- Improved grazing strategies and veld management
- Monitoring, precision agriculture and technological innovations
- Use of climate/weather data and spatial data for operational and strategic decision making
- Benefits to biodiversity and related ecosystem services
- Practices and technologies that reduce/re-use/recycle waste
- Practices and technologies that reduce risks and impacts of extreme weather
- Diversification
- Sustainable intensification
- Societal benefits (jobs, women, youth, occupational health)
- Education, training and skills development in Climate Smart Agriculture
- Data and information development for CSA
- Farm production, farm financial or economic model to incorporate climate change impacts

Figure 261: A Dep. of Agriculture vulnerability indicator table for the Garden Route District Municipality (WC DoA, 2022).

The following Table 3 was also drawn up for the agricultural sector as part of the Vulnerability Assessment which was conducted during the 2017 DFFE workshop.

Table 3: Agriculture vulnerability indicator Table for the 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 and Sanitation and Water User Associations. 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 DFFE 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	Sorghum is a low-priority crop.	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 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.	Low	Department of Water and Sanitation and water user's associations. Farmers and labourers, Department of Land Reform and Rural Development (DLRRD) and DFFE.

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 and Sanitation, and water user's associations, Department of Land Reform and Rural Development (DLRRD) and DFFE.
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 Bay and Langkloof. Port and wine.	Medium	Department of Water and Sanitation, and water user's associations, Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031, Garden Route District Municipality Regional Economic Development Strategy, Farmers and labourers, Department of Land Reform and Rural Development (DLRRD), and DFFE.

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, Kannaland, 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 GRDM's 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, DFFE and Department of Land Reform and Rural Development (DLRRD), Department of Water and Sanitation, and Water User Associations, BOCMA, Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031, 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	Department of Land Reform and Rural Development (DLRRD), Farmers and labourers, DFFE and Department of Water and Sanitation, Water User Associations, BOCMA, Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031, 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. SanParks and CapeNature

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 (*Eldana saccharina*) and Chilo (*Chilo* species like *Chilo partellus* or *Chilo sacchariphagus*), 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,. the Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031, 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 District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031
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 at the commercial and subsistence level. Avian flu for poultry.	Low	There are interventions, but they are insufficient. Farmers and labourers Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031, 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

5.3.2 Biodiversity and Environment

Table 4: Biodiversity Vulnerability Indicator Table for the 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 Biodiversity Directorate, Local Municipalities, Biodiversity Strategy, SANParks, SANBI, CapeNature, DFFE

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: Biodiversity Directorate, Local Municipalities, Biodiversity Strategy, SANParks, CapeNature, SANBI, DFFE.

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: Biodiversity Directorate, SANParks, SANBI, CapeNature, Local Municipalities, DFFE.
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, CapeNature SANParks, SANBI, DFFE, BOCMA, Local Municipalities.

5.3.3 Coastal and Marine

Table 5: Coastal and Marine Vulnerability Indicator Table for the 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. DFFE, CapeNature, DEADP: Coastal Management, , Biosphere Reserves, local Municipalities, Garden Route District Municipality, SANParks, Oceans and Coasts, 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, Duiwenhoks, 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	CapeNature, DFFE, DEADP: Coastal Management, Biosphere Reserves, local Municipalities SANParks, GRDM, Oceans 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	DFFE, DEADP: Coastal Management, GRDM, Biosphere Reserves, local Municipalities, SANParks, Oceans research academic institutions, Fishers, CapeNature.
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 District Coastal Management Programme, 2025/2026 - 2030/2031,. CML's. There's a need to exercise policy of retreat in SDF's.

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, Knysna, Danabaai Herolds Bay, Victoria Bay, Glentana, Groot Brak, Klein Brak, Hartenbos, 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, local Municipalities, Insurance Companies, Garden Route District Coastal Management Programme, 2025/2026 - 2030/2031. Legal weak in enforcing NEM: ICMA.

5.3.4 Human Health

Table 6: Health Vulnerability Indicator Table for the 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 Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031 highlights that the district has experienced frequent severe flooding events, which have affected infrastructure especially in floodplains.	High	Stormwater Master Plans, Stormwater improvements, Flood and fire awareness campaigns, District Municipality Environmental Health Practitioners, local Municipalities, Homeowners, Businesses Community members, the Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031 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, local Municipalities, Homeowners, Businesses, Community members, Good clinics and medical facilities, Midday non-work period, Sports cancelled.

No	Indicator Title	Indicator Description	Exposure Question	Exposure Answer	Exposure Comment	Sensitivity Question	Sensitivity Answer	Sensitivity Comment	Adaptive Capacity Answer	Adaptive Capacity Comment
23	Increased vector borne diseases from spread of mosquitoes, ticks, sandflies, and blackflies	Vector borne diseases such as malaria is projected to spread within regions bordering current malaria areas, which are presently too cold for transmission.	Are vector-borne diseases present or likely in your area?	Yes	District wide but prevalent inland. Ticks, flies, mosquitoes.	Are you in or neighbouring an area with vector borne diseases (e.g. malaria)? Already in a vector borne disease area = High; Neighbouring a vector borne disease area = Medium; Not near a vector borne disease area = Low	Medium	The District's Climate Change Adaptation Plan identifies weather induced diseases to be a challenge for the district. Avian flu is increasing. Avian flu research for human impact is needed.	Medium	Early warning and watch systems are in place, but improvements are needed. Health is not well represented. Garden Route District Municipality Health Practitioners, local Municipalities, Disaster Management, Homeowners, Businesses, Community members, Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031.

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 Kaaimans estuary, Increase temperature.	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, Disaster Management, local Municipalities, Homeowners, Businesses, Community members, DWS, Garden Route District Climate Change Response and Implementation Plan, 2025/2026 – 2030/2031.
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 cases / fatalities.		DFFE, DoA, 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	District Air Quality Management Plan, local Municipalities, Business Chambers, DEADP, and DFFE.
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.

5.3.5 Disaster Management, Infrastructure and Human Settlements

Table 7: Disaster Management, Infrastructure and Human Settlements Vulnerability Indicator Table for the 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	GRDM Disaster Management Centre, local Municipalities, Fire and Rescue, Emergency services, SAPS, Businesses, Communities, Unions, National, provincial and local government, Garden Route District Disaster Management Plan.

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	GRDM Disaster Management Centre, District's disaster relief allocating funds for the repair and maintenance of road infrastructure / after flood damage. Local Municipalities, emergency services, traffic, businesses, communities, unions, 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	GRDM Disaster Management Centre, district's disaster relief funds / NGO assistance, Local Municipalities, emergency services, traffic, businesses, communities, unions, 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. Dept. of Human Settlements, local 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	Increased immigration from Cape Town to the Garden Route 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	GRDM Disaster Management Centre and Fire Management Departments, local Municipal Disaster and Fire Departments, traffic, emergency services, 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 have led to negative impacts for the tourism sector.	Low	Tourism Industry, Municipalities, Property owners,

5.3.6 Water

Table 8: Water Vulnerability Indicator Table for the Garden Route District Municipality.

8: 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	Low Blue Drop Scores.	Medium	GRDM, Communities, BOCMA, DWS, Farm owners, local Municipalities, DFFE, DEA&DP, CapeNature, Blue Drop reports
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	Low Green Drop Scores.	Low	GRDM, Communities, BOCMA, DWS, Farm owners, local Municipalities, DFFE, DEA&DP, CapeNature, Blue Drop reports

8: 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 incidences = High; Between 7 & 2 incidences = Medium; Less than 2 incidences = 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	GRDM Disaster Management Centre, DoA,, Communities, BOCMA, DWS, Farm owners, local Municipalities, DFFE, DEA&DP, CapeNature, Blue Drop reports, 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's, local Municipalities, GRDM, DEA&DP, DFFE.

8: 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 freshwater fish in your area?	Yes	Redfin Minos Fresh Water System (Drought)	How significant is freshwater 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	GRDM Disaster Management Centre, CapeNature, DEA&DP, State of River Reports, DWS, Garden Route District Regional Economic Development Strategy, DFFE

5.3.7 Air Quality

Table 9: Air Quality Vulnerability Indicator Table for the 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.
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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