CEDERBERG MUNICIPALITY

CLIMATE CHANGE PLAN
2025

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Preamble

The Climate Change Plan provides an overview of the status quo of the climate of the municipal area, details the projected changes in the climate of the Cederberg and the expected impacts on natural and man-made resources. It then outlines mitigation and adaptation measures required to preserve and maintain these natural and man-made resources in the Cederberg municipal area by the Cederberg Municipality.

Three environments and their elements are providing structure to report on the status quo, projected changes and mitigation and adaptation measures. These are:

Biophysical Environment:

- Climate;
- Hydrology and Water Security;
- Biodiversity and Ecosystems;
- Air Quality;
- Coastal Zone and Fisheries;
- Wildfires.

Built Environment:

- Water and Sewerage Services;
- Energy Sector;
- Solid Waste Management.

Socio-Economic Environment:

- Municipal Capacity;
- Rural Settlements;
- Coastal Settlements;
- Terrestrial flooding;
- Disaster Risk Reduction and Management;
- Health;
- Agriculture.

1. Climate Change Plan

While weather changes daily, **climate** represents the **statistical distribution of weather patterns over time.**

The Climate Change Plan provides an overview of the status quo of the climate of the municipal area, details the projected changes in the climate of the Cederberg and the expected impacts on natural and man-made resources. It then outlines mitigation and adaptation measures required to preserve and maintain these natural and man-made resources in the Cederberg municipal area by the Cederberg Municipality.

2. Municipal Profile and Vision

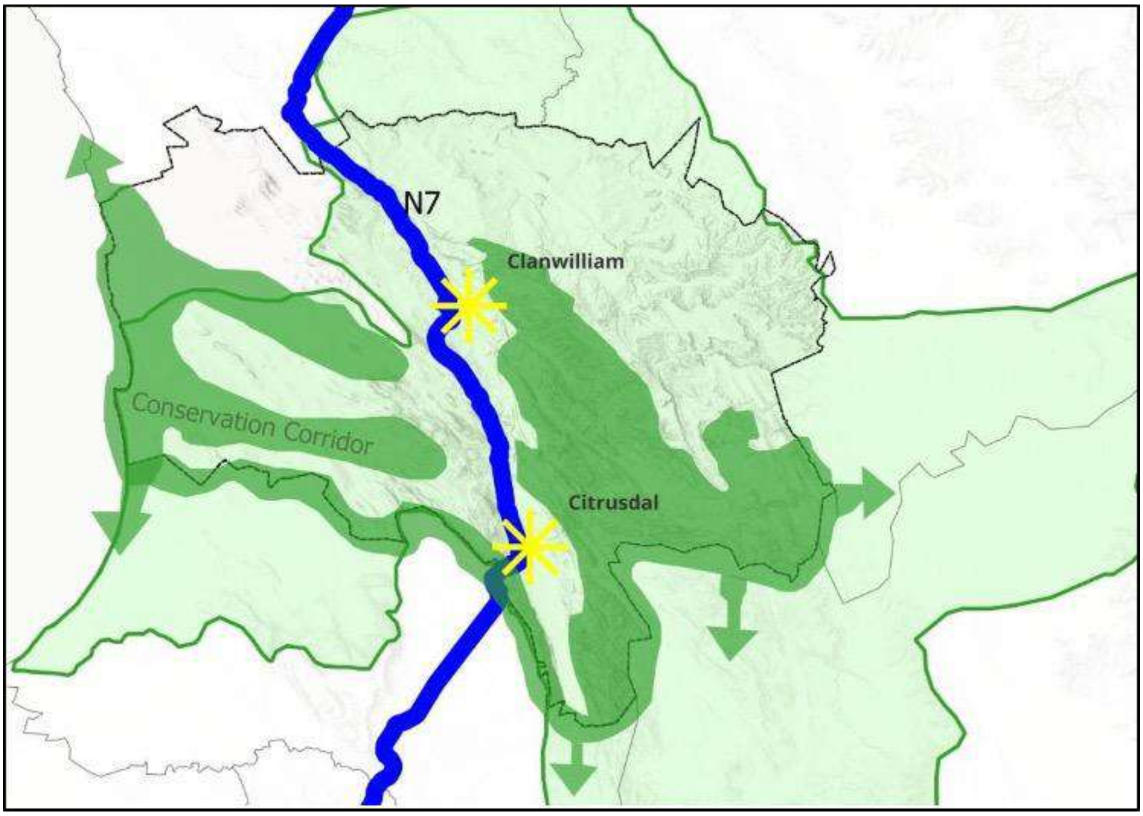
The Western Cape is home to almost 12% of the national population and its population has been increasing at a faster rate than the national level. Between 2019 and 2022 an additional 127 000 people were added to the province. In the past decade, national annual population growth was (1.5%) lower than provincial growth (2%). The three leading districts by population size are the City of Cape Town which accounts for 66%, followed by Cape Winelands at 13% and Garden Route (Eden) at 9%. The West Coast, which includes the Cederberg region, accounts for only 1.9% of the Western Cape population.

Cederberg has a population of 59 737 and 16 721 households and has an average of 50+ people per km² (Cederberg Socio-Economic Profile, 2021). Population growth rates of 1.1 percent per annum were projected in the SDF (Cederberg SDF, 2023-2027). The settlement footprints represent less than 1% (0.2% or 1 751 ha or 17,517km²) of the 8 007km² municipal area. Medium-sized towns, that is Clanwilliam and Citrusdal in sparsely populated areas of the country play a critical role as regional service centres. Towns in this category are bearing the brunt of employment seeker-linked migration, informal land occupation and high dependency ratios with the income of most households solely made up of government grants. The analysis suggests that these two regional service centres are home to at least 30% of the local population, the majority of whom are employed in agriculture, providing jobs to 42% of the working-age population. In 2019, agriculture was the third biggest job contributor (14.5%), together with manufacturing (contributed 22.4% to local GDP and generated 9% of jobs) and wholesale, retail trade, catering and accommodation (generated 15.5% of jobs) to the Cederberg economy.

Cederberg's spatial and land use vision (MSDF 2023 – 2028), ***"An economically prosperous region and sustainable liveable settlement environments for all Cederberg residents',*** aligns with that of the IDP (2022) "Cederberg municipality, your home of good governance, service excellence and opportunities for all".

Cederberg is home to two intensive agricultural corridors, one running North-South (N7) along the Olifants River and another running south-west, the Sandveld. These corridors link to a conservation (and tourism) corridor connecting the Cederberg Conservation area and the coast, all of which centres around Citrusdal and Clanwilliam. These intensive agricultural corridors are the basis of Cederberg's economic prosperity.

Map 1: Conceptual Map (Cederberg SDF, 2023-2027)



A closer look into the landscapes, natural environment and agricultural activities of these two corridors reveals seven bioregions in Cederberg. These bioregions each present an economy or value according to the natural environment and are:

- Coastal – tourism and fisheries;
- Lang and Verlorenvlei - potatoes;
- North-West Agriculture – small grain;
- Olifants River (Olifants Irrigation) – citrus;
- Nardouw Agricultural Area - sheep;
- Doring River- tourism and conservation;
- Cederberg Wilderness Area (Cederberg) – tourism and conservation.

Map 2: Cederberg Bioregions (Cederberg SDF, 2023-2027)

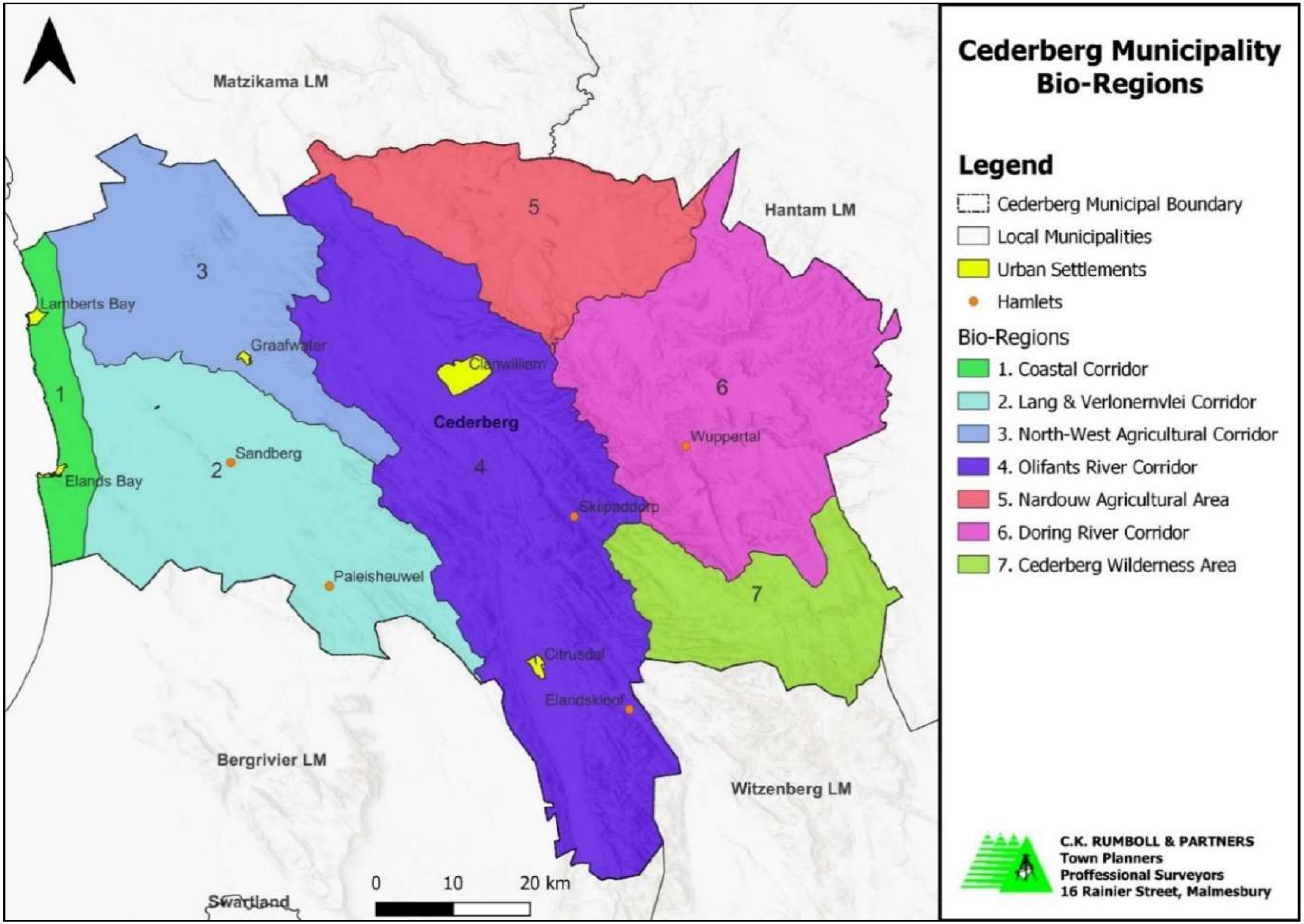
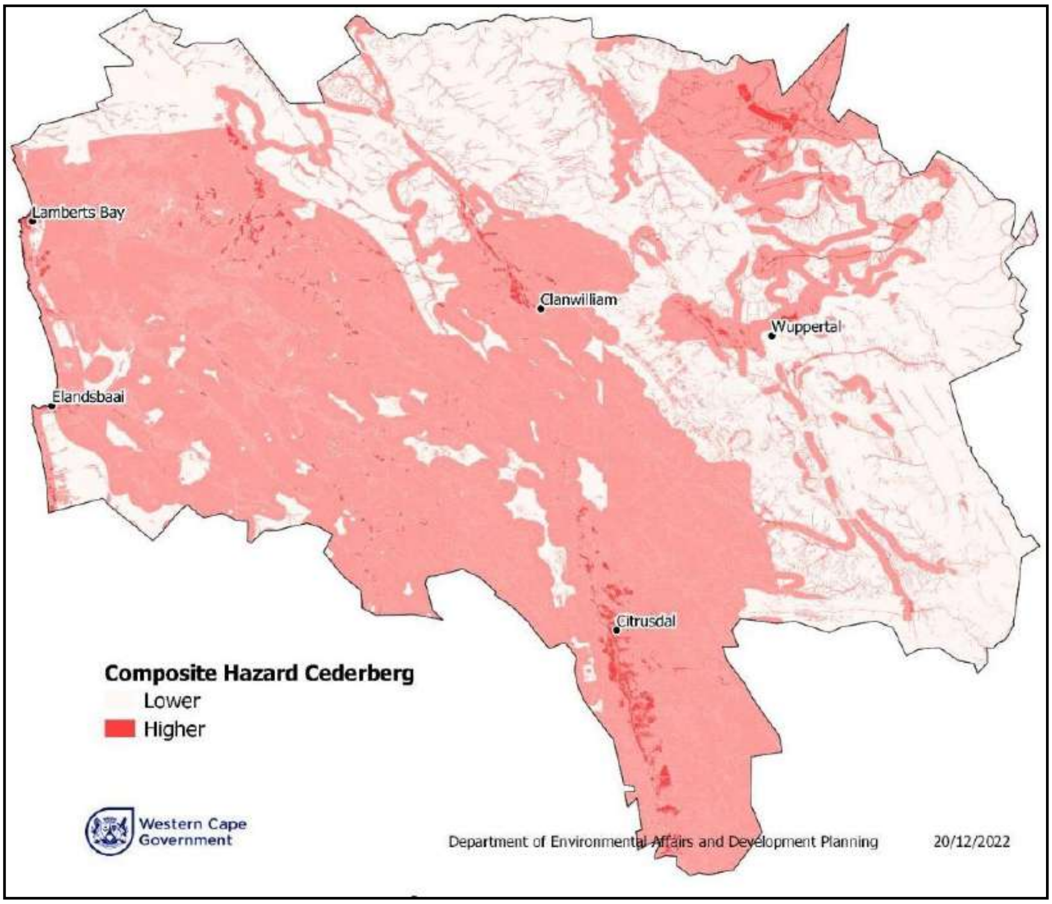


Table 1: Cederberg Bio-regional Overview

	COASTAL CORRIDOR	**LANG EN VERLORENVLEI CORRIDOR**	**NORTH-WEST AGRICULTURAL AREA**	**OLIFANTS RIVER CORRIDOR**	**NARDOUW AGRICULTURAL AREA**	**DORING RIVER CORRIDOR**	**CEDERBERG WILDERNESS AREA**
Altitude (m)	100 – 250	200 – 1 400	100 – 700	100 – 700	200 – 1 500	500 – 1 500	500 – 1 500
Population distribution	Elands Bay: 1 830, Lamberts Bay: 7 346 Total urban: 9 176	Leipoldtville: 358 (Urban).	Graafwater: 2 714 (Urban)	Citrusdal: 8 615 Clanwilliam: 9 211 Higher rural population. Total urban: 17 826	Sparse.	Wupperthal (Urban).	Sparse.
Agriculture / Commodities (Primary Economy)	Potatoes, vineyards and fishing.	Potatoes.	Rooibos and small stock.	Citrus, tropical fruit (mangoes), wheat, wine and table grapes, rooibos, tomatoes	Rooibos and Potatoes.	Rooibos and conservation.	Vineyards and conservation.
Mining (Primary Economy)	None.	None.	None.	Sand mines.	None.	None.	None.
Biodiversity	Coastal fynbos.	Aquatic biodiversity and fynbos.	Fynbos.	Cederberg fynbos.	Nardouw.	Cederberg and Succulent Karoo	Cederberg and Succulent Karoo
Secondary Economy	Agri-Processing and Wineries.			Agri-Processing.			Wineries.
Tertiary Economy	Eco-Tourism.	Eco-Tourism.	Agri-Tourism.	Agri-Tourism.	Eco-Tourism.	Eco-Tourism.	Eco-Tourism.
Renewable energy potential	Relatively medium wind speeds. Medium levels of solar radiation.	Relatively medium wind speeds. Medium levels of solar radiation.	Relatively medium wind speeds. Medium levels of solar radiation.	Relatively medium wind speeds. Medium levels of solar radiation.	Medium to high levels of solar radiation.	Medium to high levels of solar radiation.	Medium to high levels of solar radiation.
Hydrology/ Important Water Resources	The Verlorenvlei and Langrivier – moderately modified.	The Verlorenvlei and Langrivier – moderately modified.	Jakkalsrivier – moderately modified.	Olifants River – Largely Modified. Olifants River, dam, large storage capacity	Doringrivier – moderately modified.	Natural and moderately modified.	Natural. Rivers, a very low storage capacity
Climate change projections	Medium to high warning	Low to Medium warning	Low to Medium warning	Medium to High warming	Medium to High warming	Medium to High warming	Medium warming
Future potential	Decrease in productivity.	Remains viable if river flows and dams fill but limited by heat.	Decrease in productivity.	Remains viable if river flows and dams fill but limited by heat or occasional floods.	Decrease in productivity.	Decrease in productivity.	Decrease in productivity, especially in the north.

From an ecological risk perspective, the settlements within Citrusdal are the highly vulnerable due to the town's close proximity to the Olifants River.

Map 3: Vulnerability to environmental threats in Cederberg (combining socio-economic and governance indicators) (DEA&DP,2022)



3. Biophysical Environment

An initial analysis of the biophysical environment of the Cederberg Municipal area follows and is introduced by an overview of the regional climate and projected changes.

3.1 Climate

3.1.1 Status Quo

A typically Mediterranean climate, with warm, dry summers and mild, moist winters, prevails. Spring starts in August, summer in early November, autumn in April and Winter from Mid- May.

Rain: Although Cederberg is in a winter rainfall region, the Oliphant's River valley including the settlements of Clanwilliam and Citrusdal, gets an annual rainfall of 180mm and is classified semi-desert. The high Cederberg mountains get much more rain, i.e. over 1000mm in parts, and snow caps can be observed on the mountain peaks.

Wind: The wind direction is north-west in autumn and throughout winter, whilst in spring and summer winds blow in the south-eastern direction. The wind speed is mostly between 5-6m/second whilst along the coast with the area along the northern municipal boundary coast wards and the Nardouw mountains demonstrating increasing wind speed of 7-8m/second.

Sun and Temperature:
The annual mean temperature in the Cederberg range between 16°C – 20°C.

Horizontal Global Irradiance (GHI) is lower from the Olifants Valley to the coast and ranges from 1 901 to 2 100kWh/m^2/annum. From the Olifants Valley inland, the irradiance is 2 101 to 2 200kWh/m^2/annum. Solar irradiation measure 5 251W/m^2 to 5 500W/m^2 overall with 5 751Wm^2 to 6 000W/m^2 in the southeast.

3.1.2 Projected and Anticipated Changes to the Climate

According to an Overview of Climate Change and the Agricultural Sector in the Western Cape (WCG, 2015), the climate change projections for the Western Cape for 2040-2060 and the Cederberg in particular, are as follows:

Rain: The average annual rainfall in the Cederberg is likely to.

- Decrease by the mid-century;
- Decrease of ±10% seasonal rainfall along the West Coast;
- Possibly increase along the southern coast.

Table 2: Projected seasonal change in rainfall (mm)

Downscaled from the global circulation model	2080 – 2099 vs. 1961 – 1990	-30 mm
Dynamic regional climate model	2070 – 2100 vs. 1975 – 2005	-50 mm

The Projected dry-spell duration between Autumn and Spring in the Cederberg is increasing.

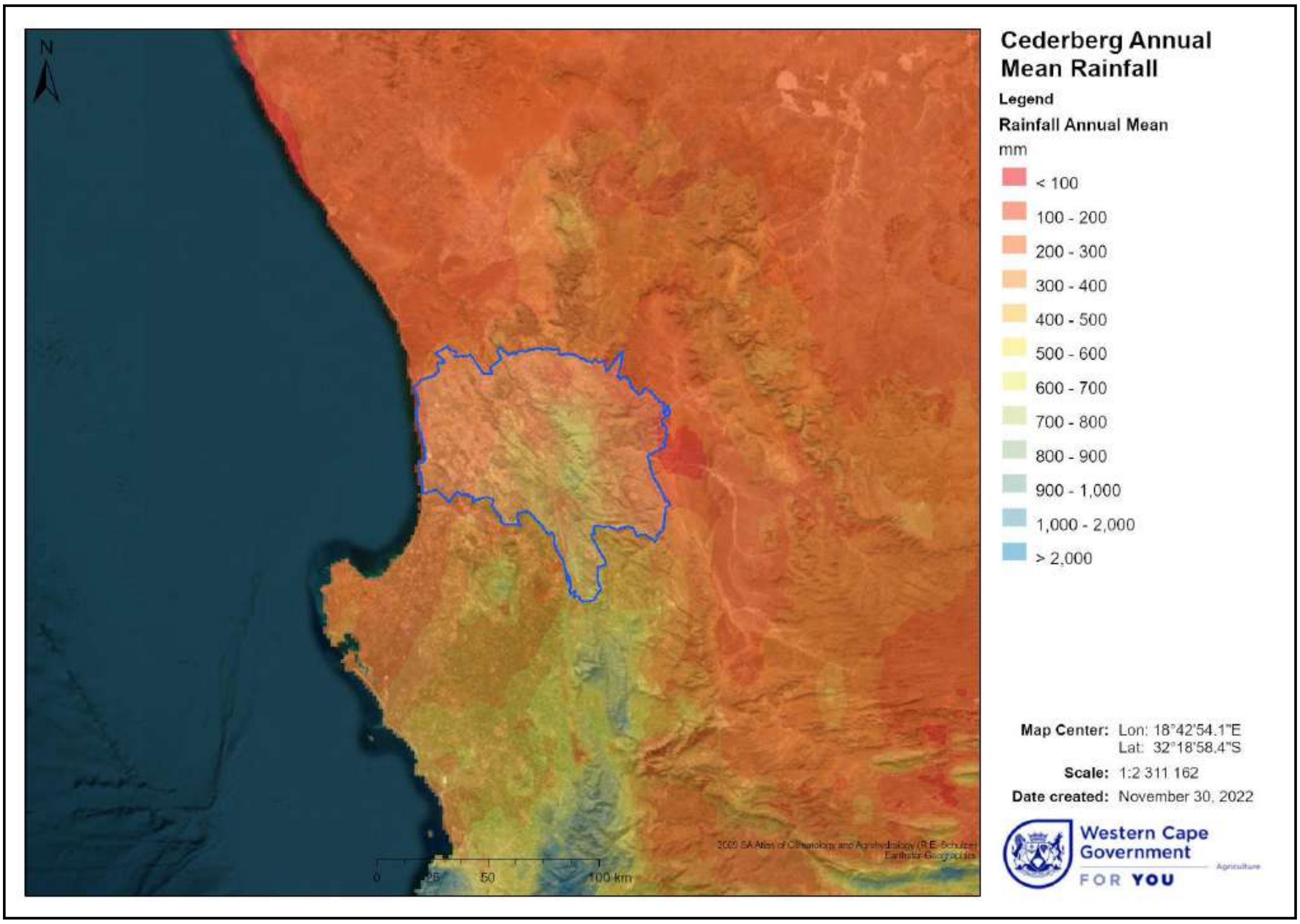
Table 3: Projected seasonal changes in dry-spell duration

Downscaled global circulation models	2046 – 2065 vs. 1961 – 1990	1.5 days
Downscaled global circulation models	2080 – 2099 vs. 1961 – 1990	2 days

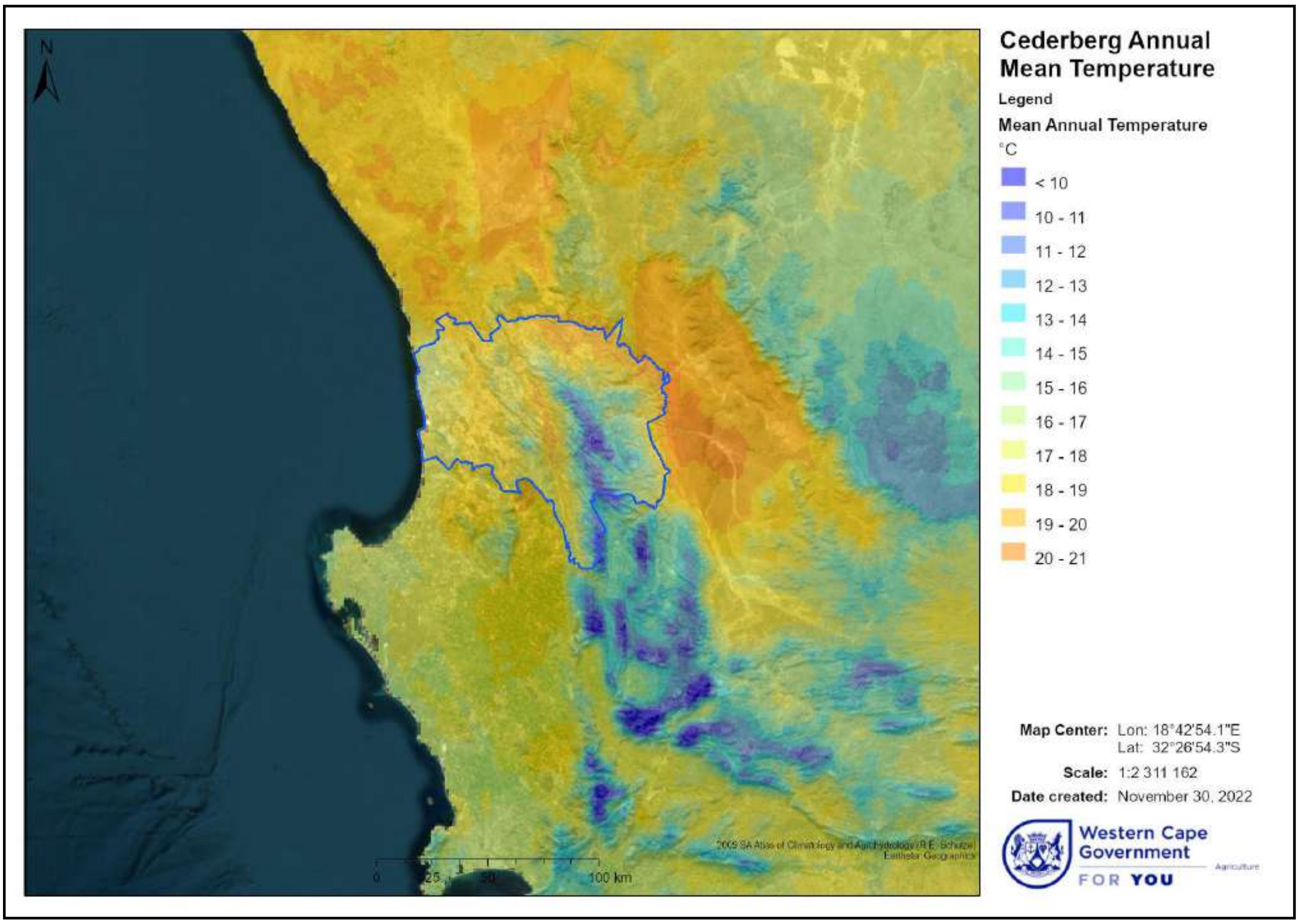
Sun and Temperature: Projections are that the average temperature is increasing.

- Higher minimum and maximum temperatures, as well as greater temperature differences for the interior areas;
- Increase in annual temperature of around 1.5°C to 3°C;
- Increasing number of warmer days and fewer colder days and frost;
- An increase of 2°C in the median temperature is projected over the coastal regions whilst an increase of 3°C is projected over the interior in South Africa.

Map 4: Average annual rainfall totals (mm) over South Africa



Map 5: Annual mean temperature (°C) over South Africa



3.2 Hydrology and Water Security

3.2.1 Status Quo

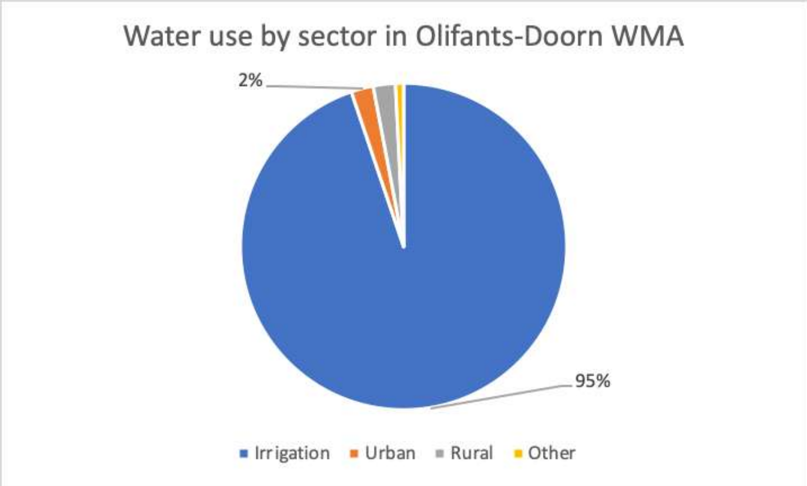
The Cederberg falls within the Olifants-Doorn water catchment areas of 46,220 km^2 in extent and is located around Ceres and the Cederberg mountains. The Olifants River rises in the Winterhoek Mountains north of Ceres. The mainstream is about 265 km long and flows into the Atlantic Ocean at Papendorp, 250 km north of Cape Town. These primary catchments are shared with neighbouring municipalities, making the Cederberg a significant contributor to water quality and security in the Western Cape. The Berg-Olifants Water Management Areas (WMAs) have a full total supply capacity of 43.95 million cubic meters (Mm^3) (DWS, 2020).

NFEPA (2007), classifies the Olifants River and its tributaries within the Olifants River Corridor bioregion, as largely modified. All the rivers in the southern half of Cederberg, i.e. Doring River and Cederberg Wilderness bioregions, are natural. All the rivers in the remaining bioregions are moderately modified.

Water bodies (e.g. rivers, wetlands etc.) are an important part of the agro-ecosystems.

The water sector must balance the allocation of limited water resources amongst major users (agriculture, domestic urban use and industry), whilst addressing the need to ensure fair access to water for all South Africa's people, as well as a sufficient ecological allocation to maintain the integrity of ecosystems and thereby the services they provide. Agriculture, which is an important sector in the Cederberg, uses 95% of the total water resource annually.

Figure 1: Use of water by sector in the Olifants/Doorn WMA (Midgley et.al., 2005)



River Management and Maintenance Plans (RMMPs) guide the process of rehabilitation through various objectives and expected outcomes to ensure that the area is transformed and maintained sustainably. A maintenance plan is a document that defines work done to maintain assets proactively without obtaining authorisation for doing so as the plan provides the authorization.

The National Environmental Management Act, 1998 (Act No. 107 of 1998) ("NEMA") defines a Maintenance Management Plan (MMP) in terms of the geographical scope being limited to watercourses as defined in the EIA Regulations, 2014 (as amended). The document does not relate to coastal activities or activities to be undertaken in an estuary.

A MMP for a watercourse **must** be undertaken through consultation with the Department of Water and Sanitation and/or the relevant Catchment Management Agency (responsible water authority). This is to ensure compliance in terms of a Permissible Water Use as set out in the National Water Act, 1998 (Act No. 36 of 1998). It is recommended that this process for authorisation in terms of the National Water Act be clarified prior to the drafting and submission of the MMP.

EIA Regulations, 2014 (as amended) dealing with the infilling or depositing of any material, clearance of indigenous vegetation and extraction of peat soils are no longer triggered as they are once the RMMP was adopted for a specific watercourse.

3.2.2 Projected and Anticipated Changes to the Climate

South Africa is a water-scarce country with a highly variable climate and has one of the lowest run-offs in the world – a situation that is likely to be significantly exacerbated by the effects of climate change. Based on current projections South Africa will exceed the limits of economically viable land-based water resources by 2050. Cederberg, similarly, will face the same challenge of exceeding economically viable land-based water resources.

Water security will be affected by water availability and water quality.

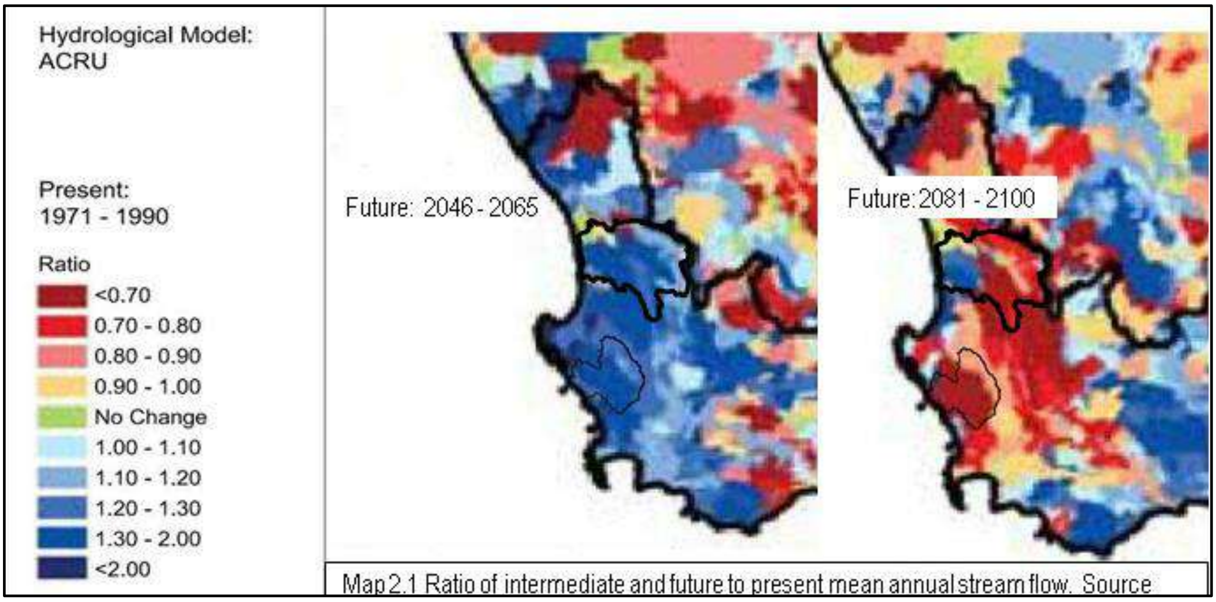
Water availability is a key climate change-related vulnerability. Rainfall is expected to become more variable, with an increase in extreme events such as flooding and droughts resulting in a much more variable runoff regime. This will affect freshwater resources i.e. groundwater. Groundwater is the primary but limited resource for domestic use in many rural areas.

With reduced rainfalls, there is less run-off, which refers to the water collected from surfaces like roofs, the sides of mountains, or shallow pools such as those forming in the Karoo when it rains. This run-off water, also called surface water, eventually collects in dams and rivers, and flows into the sea when rivers slope downward.

As rain falls, it seeps into the ground and gradually saturates the soil. Eventually, as observed in the last two years here in the Cape, the groundwater became so saturated that pools of water form on the surface. The augmentation of groundwater refers to the process of supplementing the available groundwater.

With the anticipated decrease in rainfall in the Cederberg region, both run-off and groundwater levels will decrease, leading to reduced surface water accumulation in water bodies. Additionally, the extraction of regional ground water, primarily for irrigation and drinking water, is further depleting these sources. As a result, water scarcity is expected to become more prevalent. Further research is needed to access the extent of the impact of decreased rainfall on mean run-off and groundwater availability.

Figure 2 (a) & (b): Ratio of Intermediate and future to present mean annual stream flow (Schulze, 2005).



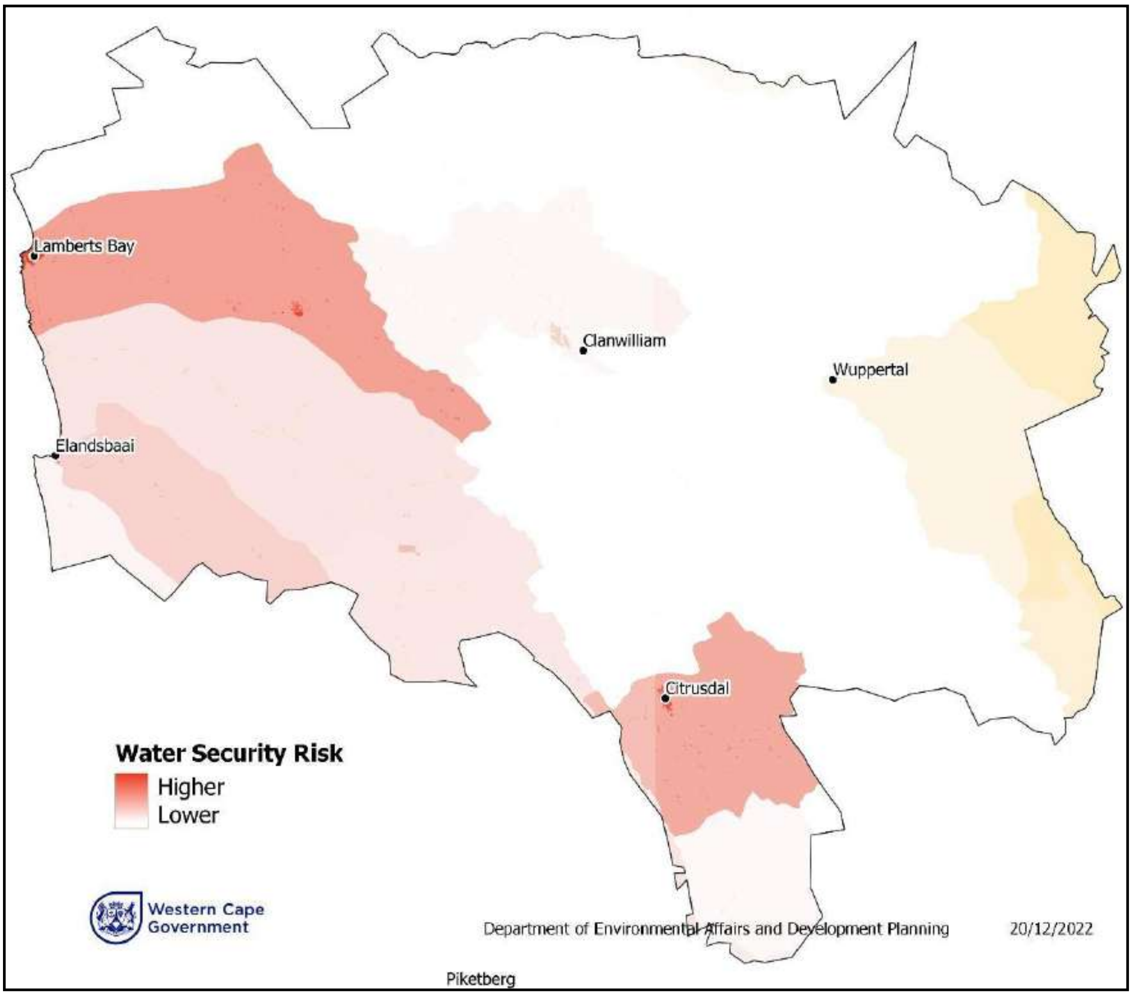
Stream- or channel flow in water streams and rivers will also experience changes in concentration and timing of high and low flows due to changes in rainfall patterns. A change of up to 10% in rainfall can affect stream flow up to levels of 30% (Schulze, 2005). Changes to the timing of high and low flows could disrupt water management decisions related to water demands for irrigation, and domestic and industrial use.

Figure 2 shows a prediction of how the mean annual stream flow will change in different time periods for a portion of southern Africa. In the Cederberg (indicated on map), an increase in mean annual stream flow is predicted from 1971-1990 to 2046-2065 (ratio of 1.10 – 2(0.9); shown in blue); followed by a decrease from 2046-2065 to 2081-2100 (ratio of 0.9 - <0.7; shown in red). The balance of mean annual groundwater use versus recharge in Cederberg is predicted to be 0 – 60% (Schulze, 2005).

Downscaled climate modelling suggests that the western and interior parts of the country are likely to become drier, and the eastern parts of the country wetter.

The map below shows the relative water security risk for different regions in the Cederberg. Areas around Lamberts Bay and Citrusdal are shown to have the higher risk relative to the other areas. Note that the map does not provide absolute risk values or predict the severity of water insecurity but rather highlights the areas with the highest risk. [1]

Map 6: Water Security Risk in Cederberg (DEA&DP, 2022)



Agriculture is a significant user of water. Higher temperatures in the Western Cape will cause increased rates of evapotranspiration. Less winter rainfall is expected on the West Coast and western South Africa. Groundwater stress indices are affected by a range of factors, including temperature and rainfall. Theoretically, higher temperatures would indicate higher irrigation needs, while lower rainfall indicates lower rates of groundwater recharge. Most results indicate lower rates of groundwater recharge in the farming area, particularly towards the southwest coast where intensive farming is taking place (Archer et al., 2009).

<u>Water quality:</u> A deteriorating water catchment system will consequently lead to lower inputs into the water supply systems and reduce overall water security due to lower natural retention and lower quality of water.

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[1] https://geosmart.space/solutions/reduced-flood-risk.html and https://s3-eu-west-1.amazonaws.com/csir-greenbook/resources/WS4_Flooding_Report_2019.pdf

Both food and energy security are affected by the lack of a steady supply of water at the appropriate level of quantity and quality. Whilst a successful economy relies on energy security and access to cheap energy, water quantity and quality underpin both food and energy security. Water is a key factor for socio-economic development, food security and healthy ecosystems, and is vital for reducing the burden of disease and improving the health, welfare and productivity of populations.

Extreme events, droughts and heavy precipitation (floods and heavy downpours) are expected to have a negative impact on the quantity and quality of groundwater reserves and surface water:

- Saltwater intrusion decreases water quality;
- Run-off, erosion and algal blooms decrease water quality;
- Consequently, droughts decrease agricultural development and profits.

3.2.3 Mitigation, Adaptation and Sector Response Plans

The following cross bioregional and municipal developments and interventions are proposed, as part of a further mitigation strategy.

<u>Water Bodies and Ecological Infrastructure:</u>

- Delineate flood lines in Citrusdal and Elands Bay and all other settlements (including Wupperthal) as coastal erosion and flooding is a risk;
- Invest in ecological infrastructure and:
    - Promote the restoration of moderately modified rivers across Cederberg and the Olifants River and its tributaries that are largely modified;
    - Delineate, during the wet season, and promote the implementation of buffers around wetlands estuaries, salt marshes, rivers and drainage water courses;
    - Promote the delineation of existing as well as historical connections between wetlands, drainage ports and rivers/streams spatially with groundwater information where applicable;
    - Promote the restoration of connections of wetlands wherever possible.
- Capitalise on the raised Clanwilliam Dam wall once completed: providing water to residents of Clanwilliam and the lower Olifants River region;
- Conduct sensitivity checks on existing wastewater, sewerage systems and treatment work against expected climate change impacts, and expedite outstanding upgrades of facilities;
- Coordinate with public and private sector stakeholders to develop strategies for identifying and managing sources of stormwater contaminants before final discharge points and coastal zones.

Adaptation measures at municipal level are:

Objective	Project
Monitoring of changes in weather patterns and annual rainfall levels	Increase the calibration frequency of local weather monitoring systems (e.g. in Matjiesrivier and Algeria stations) as climate conditions change. This will enhance rainfall prediction capabilities and improve community preparedness for droughts or floods.
Monitor changes in water course levels	Implement seasonal monitoring strategies for water levels in water bodies using satellite imaging.
Water governance at municipal level	Support the water governance at a municipal level for equitable sharing of resources and responsible use.
	Maintain bulk water infrastructure
	Prioritise outstanding dam maintenance and increase dam capacity in areas where patterns of increased rainfall have been observed in recent years.

3.3 Biodiversity and Ecosystems

3.3.1 Status Quo

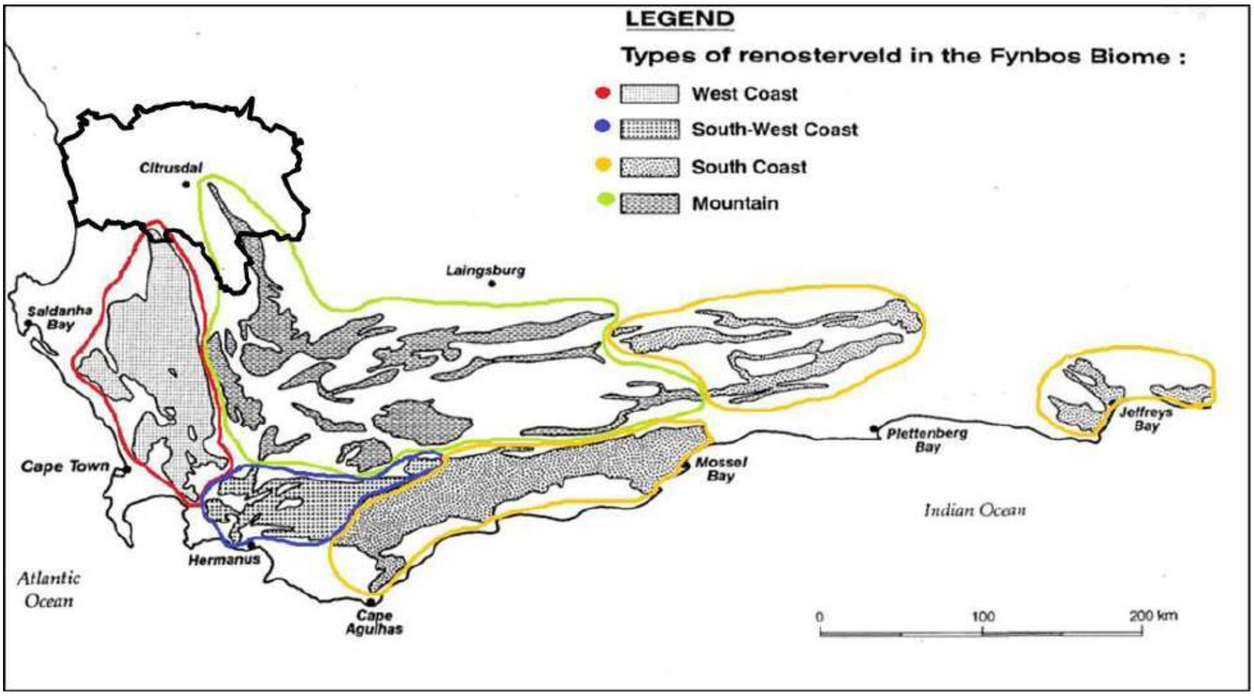
The biodiversity of the Cederberg Conservancy, enjoying World Heritage Site status, is under increasing threat from agriculture, settlement development and invasive alien species. Only 9% of the unique Renosterveld and Lowland Fynbos ecosystems remain, and much of the Succulent Karoo is also under threat. The transitional areas between these two biomes (generally occurring over linear distances that may span hundreds of kilometres) are home to a mix of species of both biomes.

Map 7: Cederberg Vegetation Types

The distribution of Vegetation Types in the Cederberg region includes *Macchia* (fynbos), Karroid Broken Veld, Succulent Karoo, Strandveld of the West Coast, and Western Mountain Karoo.

Four of the twenty-one (21) national threatened ecosystems are hosted in the Cederberg: Strandveld (along the coast), Kusfynbosveld (between Strandveld & inland), Renosterbosveld (inland), and Fynbosveld (mountains) and Succulent Karoo. The carrying capacity of these veldt types is low. The fynbos and Karoo vegetation mosaic supports a complex ecosystem of diverse fauna and flora species, and its interconnected nature promotes significant resilience.

Figure 3: Original extent & distribution of major Renosterveld Fynbos Biome types (Rebelo, 1995)



<ins>Protected Area Management Plans</ins>: In compliance with the National Environment Management: Protected Areas Act (NEM: PAA) (Act No. 57 of 2003), CapeNature is required to develop management plans for each of its nature reserves.

The objective of a management plan is to ensure the protection, conservation and management of the protected area concerned in a manner that is consistent with the objectives of the NEM: PAA and for the purpose it was declared.

Protected Area Management encompasses the strategies and practices implemented to preserve the natural, cultural, and scenic values of designated landscapes, ensuring biodiversity conservation, habitat protection, and sustainable use of natural resources.

There is only one protected area management plan in Cederberg and that is the Cederberg Complex Protected Area Management Plan (PAMP), 2019-2029. The PAMP identified 9 priority rivers in the Cederberg for fish conservation: Boskloof, Heks, Rondegat, Jan Dissels, Driehoeks, Matjies, Krom, Heks Tributary and Doring Rivers.

<ins>Topography</ins>: The Cederberg mountains extend about 50 km north-south by 20 km east-west and include in the north: Nardouw, Pakhuis, Krakadouw and Tra-tra Mountains, in the west: Olifantsberg and Swartberge and in the south: Witzenberg and Skurweberg. They are surrounded by the Sandveld on the west, the Pakhuis Mountains in the north, the Springbok Flats in the east the Kouebokkeveld Mountains and the Skurwe Mountains in the south.

The Cederberg mountainous geological formations are rich in palaeontological, and archaeological heritage, in addition to the historical heritage. The region is an astonishing representation of ongoing ecological and biological processes that accompany the evolution of terrestrial ecosystems and plant populations. The ecological map below indicates that the areas that are most vulnerable to climate change impacts are those closer to the coast, while the mountainous regions are of least concern[2].

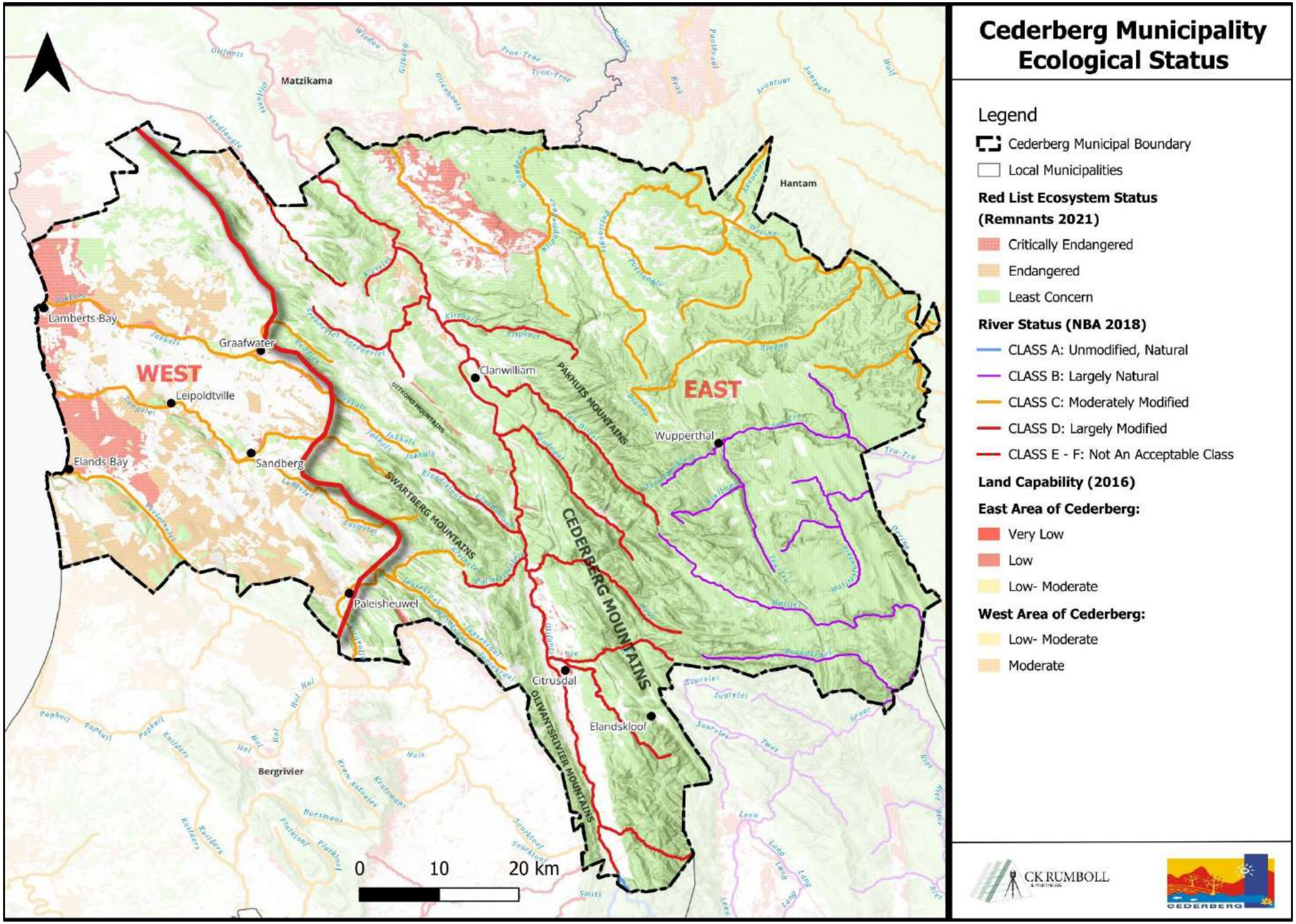
The ecological status map of Cederberg illustrates red listed ecosystems, river status and land capability. Cederberg. The combination of the layers result in dividing the Cederberg into an eastern and western area.

The western area has a high presence of threatened and red listed ecosystems as the land capability of the area is low to moderate. Agriculture is a competing use to conservation. All the rivers are moderately modified. Hence agriculture should become a key partner to mitigate and adopt to climate change in western area.

The eastern side has a lower presence of threatened and red listed ecosystems, its land capability is very low and rivers located in the middle of the region are largely modified whilst those rivers towards the eastern side is moderately modified and largely natural. Agriculture and Water Affairs should become key partners to adapt to climate change in the eastern area.

[2] https://www.capenature.co.za/uploads/files/protected-area-management-plans/Cederberg-Complex_PAMP_board-approved.pdf

Map 8: Ecological Status of Cederberg



3.3.2 Projected and Anticipated Changes to the Climate

Projected climate change impacts on biodiversity assets are likely to include although are not limited to:

- Roughly 30% of endemic terrestrial species in South Africa may be at an increasingly high risk of extinction by the latter half of this century;
- Changes in rainfall patterns and temperatures, and rising atmospheric carbon dioxide levels could shift the distribution of South African terrestrial biomes with serious implications for species diversity, ecosystem processes such as wildfires, and critical ecosystem services such as water yield and grazing biomass;
- The increasing frequency of extreme rainfall events will influence runoff quality and quantity in complex ways, significantly affecting the marine and estuarine environment. Fluctuations in water flow will alter the salinity of estuaries, affecting the breeding grounds and nursery areas of many marine species. Coastal estuaries will also be vulnerable to long-term sea-level rise;
- Increasing susceptibility of Fynbos to wildfires (due to increasing temperatures and consecutive dry days), combined with the prevalence of invasive alien species, and reduced and fragmented habitats will further increase the vulnerability of biodiversity to climate change.

Ecosystems Deterioration: The biodiversity and ecological infrastructure of the Western Cape is a valuable, but vulnerable asset. Loss of this resource also poses a threat to society, especially communities close to the most compromised ecological systems.

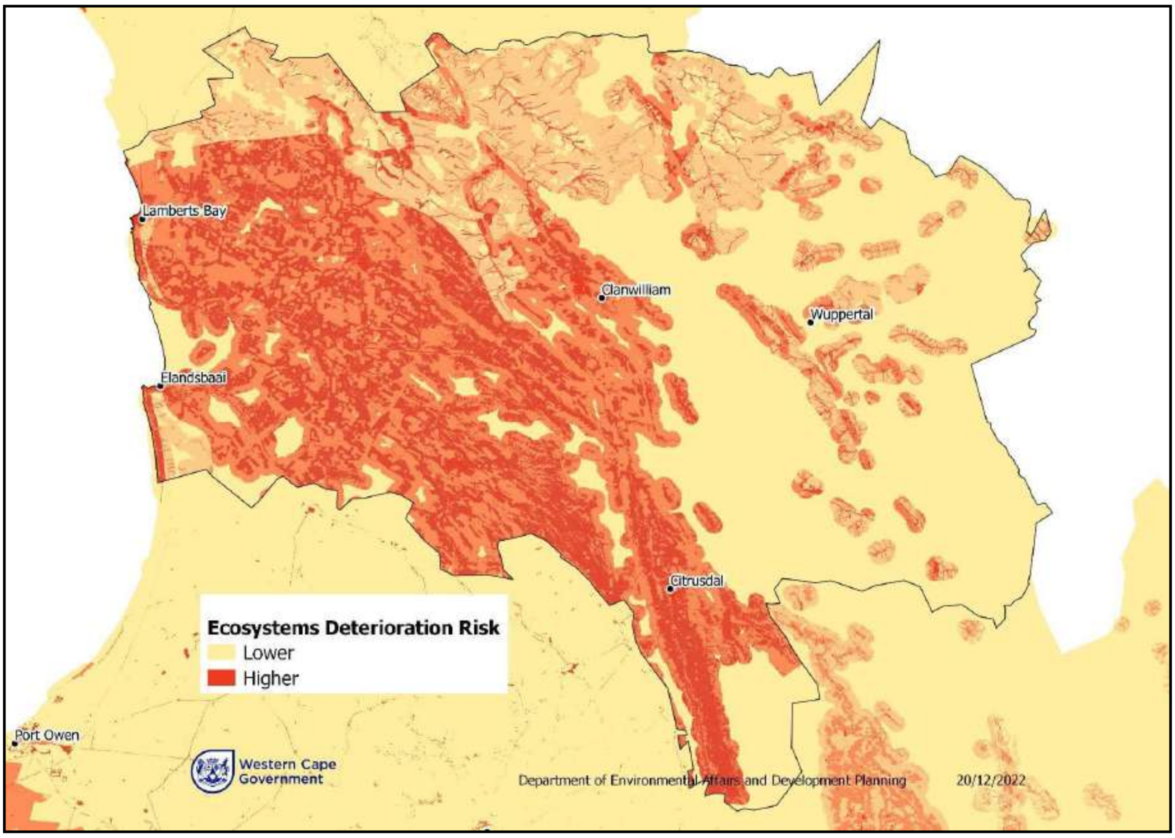
The map of Ecosystem Deterioration Risk in the Cederberg, combining the Hazard score with the Vulnerability score, is shown in the figure below.

This map uses an indicator of actual loss – satellite imagery that can identify whether any transformation has taken place in natural areas. The latest processed imagery available captures land cover in 2020 and is supported by a land cover change assessment that shows changes since 1990. This change detection product is used to identify areas that have previously or are currently being transformed. The overlap between these areas and sensitive areas mapped by the Western Cape Biodiversity Spatial Plan[3] (WCBSP) can be considered as the areas where the highest risk of non-functional ecosystem services is present.

The combination of the vulnerability dimensions with the ranking of biodiversity importance results in a map that indicates how different vegetation units compare in terms of the risk of ecosystem deterioration and loss of ecosystem services.

[3] https://www.capenature.co.za/uploads/files/protected-area-management-plans/SANBI_WCBSP-Handbook.pdf

Map 9: Ecosystems Deterioration Risk: Compromised natural area coincides with vulnerable populations (DEA&DP, 2022)



3.3.3 Mitigation, Adaptation and Sector Response Plans

A large aspect of the mitigation and adaptation within the Cederberg ecosystem needs to entail the protection of endangered (flora and fauna) species and preventing any further degradation of the natural habitat. It is reasoned that human activities within generally transformed areas and along a wildland interface would have the most to lose from a deteriorating ecosystem. As such, Cederberg Municipality's approach to adaptation and mitigation, similarly to that of South Africa's, must successfully manage development and significantly reduce poverty.

Objective	Project
Manage Loss of Priority Wetlands and River ecosystems	Rehabilitation of degraded wetlands and removal of alien species in the Velorenvlei Estuary by the Environmental Services and Technical Services Departments of Cederberg Local Municipality and Technical Services. This will include the development of an Alien Vegetation Management Plan.
Conserve vulnerable biodiversity	Promote the Sandveld Environmental Management Framework (EMF) addressing the cumulative impact on ecological degradation and biodiversity loss.
	Promote conservation plans for and protect sensitive habitats including Verlorenvlei, Bird Island, Elands Bay State Forest and Ramskop Nature Reserve.
Adapt urban spaces to improve the conservation of natural habitats	Promote the establishment of Cederberg Conservancy and West Coast Conservation Corridor to serve simultaneously as a climate change corridor and: o Provide ecological links to support connectivity between habitat areas and establishments from the Cederberg to the coastal landscape and buffer area. o Support the formalisation of Open Space Networks and Conservation Corridors in urban and rural areas to protect natural habitat areas. o Follow latest Western Cape Biodiversity Spatial Plan (Cape Nature, 2024).
	Integration of land use and transportation planning in urban areas to encourage the use of alternative (non-motorised) transportation in urban areas to reduce long-term use of non-renewable fuels.
	Promote the application of spatial planning categories, to facilitate decision-making in development applications. o Core Areas (Cederberg Wilderness Area, Matjies River Nature Reserve, Coastline, Public and Private Nature reserves).

	o Buffer Areas (Pakhuisberg, Kransvlei berg, Piekenierskloof, Smalberg, Maraisberg, Koerkasieberg). o Intensive Agricultural areas (Olifants River Valley, Traval South) areas.
	Protect and promote conservation of coastal ecosystems (estuaries, sandy beaches and dune systems, dune groves and fynbos). o Strandveld dune thicket and dune fynbos. o Lowland fynbos ecosystems (sand fynbos and limestone fynbos). o Mediterranean and mountain fynbos ecosystems (alluvial fynbos, granite, ferrous, conglomerate and silkretefynbos, grass fynbos and sandstone fynbos). o Renosterveld ecosystems (coastal renosterveld and interior renosterveld).

3.4 Air Quality

3.4.1 Status Quo

The largest contributors to South Africa's national greenhouse gas (GHG) emissions in 2022 was the energy sector, which accounts for around 78% of total emissions – primarily due to the coal-intensive electricity generation system. This was followed by the agricultural sector (11%), the industrial processes and product use sector (6%) and the waste sector (4%) (Department of Forestry, Fisheries and the Environment, 2025). Emissions from Land Use, Land-Use Change, and Forestry also form a part of the national total, but they represent smaller portions. In line with South Africa's Nationally Determined Contribution (NDC), there is an emphasis on reducing emissions from these sectors, with ongoing plans for transitioning to renewable energy and enhancing sustainable land-use practices (Department of Forestry, Fisheries and the Environment, 2021).

South Africa's GHG emissions are expected to peak between 2020 and 2025, plateau for approximately a decade and decline in absolute terms thereafter.

3.4.2 Projected and Anticipated Changes to the Climate

Poor air quality compromises people's health and livelihoods - specifically when exposure to atmospheric pollutants leads to respiratory diseases, which indirectly weakens immune systems and reduces optimal functioning. Poor health, in turn, increases vulnerability to the impacts and effects of other, unrelated threats brought about by disasters or economic hardship, such as extreme weather conditions or food shortages.

A map of potential risk, i.e. combining air pollution hazard with vulnerability, is generated by multiplying a vulnerability index with the values from potential emissions factors calculations. The map (below) shows how the potential hazard (count of potential emissions source types) and vulnerability interact to generate a picture of the relative risk of experiencing impacts from poor air quality. The most vulnerable areas are observed to include the densely populated urban areas, the major highways and the coastal regions of the Cederberg.

The potential emissions sources mapped from available data[4] include:

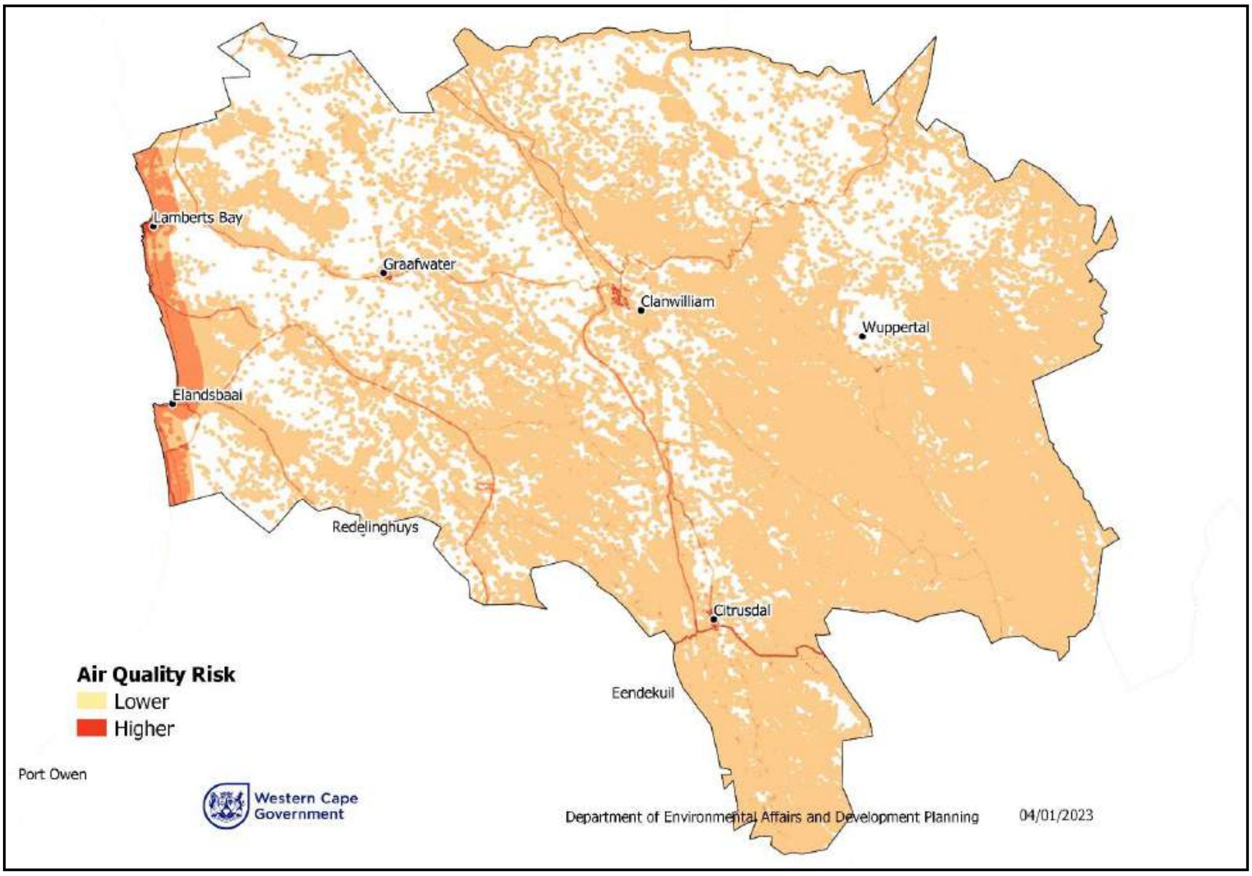
- Facilities with Atmospheric Emissions Licences (buffered by 250m);
- Residential areas with poor socio-economic status, as a proxy for likely poor indoor air quality due to the use of domestic fuels; [5]

[4] Not all municipal areas have complete emissions inventories. DEA&DP is currently working towards consolidating and standardising the provincial dataset. However, some data gaps remain, such as correct location data for most of the 'section 23' facilities in the City of Cape Town.

[5] Poor indoor air quality has long been neglected, but is now recognised for its severe impacts on vulnerable people (women, children, the elderly and those who are ill) who are more likely to spend time indoors, where they are exposed to smoke from fires and cook stoves - https://apps.who.int/iris/bitstream/handle/10665/204717/9789241565233_eng.pdf;jsessionid=EC3B8448EBD0A7543B1D3B89D6BA29CB?sequence=1

- Areas along major road and air transport infrastructure (roads, public transport routes and airports) (100m buffer);
- Bare ground indicated on land cover imagery (250m buffer);
- All areas along the coastline, where marine aerosols are present (3km inland of the water's edge).

Map 10: Relative index of air quality-related risk (DEA&DP, 2022)



Our vulnerability to poor air quality is determined by our socio-economic vulnerability (type of fuels used, quality of housing, access to health services), governance (policing and management of emissions, public health systems) and our state of health (susceptibility to respiratory infection).

3.4.3 Mitigation, Adaptation and Sector Response Plans

Although the cost of mitigation actions varies significantly, the main opportunities for mitigation consist of energy efficiency, demand management and moving to a less emissions-intensive energy mix, with consequent economic benefits of improved efficiency and competitiveness as well as incentivising economic growth in sectors with lower energy intensities.

Policy decisions on new infrastructure investments must consider climate change impacts to avoid the lock-in of emissions-intensive technologies into the future. However, in the short term, due to the stock and stage in the economic lifecycle of existing infrastructure and plant, the most promising mitigation options are primarily energy efficiency and demand-side management, coupled with increasing investment in a renewable energy programme in the electricity sector. In addition, in the short term, the emergence of biofuels and a suite of non-energy mitigation options, such as afforestation, are also important considerations.

Factors to be considered include not only the mitigation potential, the incremental and direct cost of measures but also the broader impact on socio-economic development indicators (such as employment and income distribution), our international competitiveness, the cost to poor households and any negative consequences for key economic sectors.

Objective	Project (mitigation)
Low-emissions energy alternatives	Shifting to lower-carbon electricity generation options, such as solar and hydro. These options should take into consideration the endowment of natural resources in the Cederberg region and how the availability of these resources may shift as a result of climate change.
	Significant upscaling of energy efficiency applications, especially industrial energy efficiency and energy efficiency in public, commercial and residential buildings and transport;
	Promoting transport-related interventions including transport modal shifts (road to rail, private to public transport) and switches to alternative vehicles (e.g. electric and hybrid vehicles) and lower-carbon fuels.
Sustainable/Adapted land and water management	Consider carbon capture and storage in applicable industrial processes and sectors.
	Transitioning the society and economy to more sustainable consumption and production patterns.

In Cederberg's long-term planning, information (alignment with provincial and national objectives) about the outcome of mitigation options, technology development, and other new information, may suggest additional mitigation actions.

In addition, a mix of economic instruments, including market-based instruments such as carbon taxes and emissions trading schemes, and incentives, complemented by appropriate regulatory policy measures are essential to driving and facilitating mitigation efforts and creating incentives for mitigation actions across a wide range of key economic sectors. Two such options for consideration in the Cederberg are discussed below.

Carbon Budget Approach:

Due to the current emissions-intense structure of the South African economy, many sectors require a flexible mitigation approach that permits the development and use of low-cost options, such as offset and other types of market-based mechanisms. Carbon budgets align with the National Climate Change Response Monitoring and Evaluation System, which includes an enhanced National Greenhouse Gas Inventory process. The carbon budget process aims to identify an optimal combination of mitigation actions at the least cost to and with the most sustainable development benefits for the relevant sector and national economy to enable and support the achievement of the desired emission reduction outcomes consistent with the benchmark National GHG Emissions Trajectory Range. Particularly at a municipal level.

For capital-intensive (and thus emissions-prone) sectors, a carbon budget approach that specifies desired emission reduction outcomes consistent with the benchmark national GHG emissions range trajectory is most viable. The economic sectors and sub-sectors in the Cederberg region to which carbon budget can potentially apply include those in the major energy supply (electricity and liquid fuels) and use (mining, industry and transport) sectors. Through a consultative process with the industries and other key stakeholders (communities etc.), the municipality can define carbon budget approaches, mechanisms and outcomes.

Sectoral Mitigation and Carbon Reduction Strategies (strategies to reduce carbon either during production or through mitigation):

Under the leadership of the relevant municipal sector government department, each significantly emitting economic sector or sub-sector must formulate mitigation and lower-carbon development strategies. These strategies should specify a suite of mitigation programmes and measures appropriate to that sector or sub-sector. They will also provide measurable and verifiable indicators for each programme and measures to monitor their implementation and outcome. These strategies will outline how to implement the proposed mitigation programmes via existing implementation mechanisms, such as the IRP 2010, or modified or new mechanisms. For example, with respect to industrial emissions, approved mitigation plans will conform to the Air Quality Management Act's requirements for Pollution Prevention Plans prepared by identified industries and sectors.

Short-term Climate Change Adaptation Measures:
While finding ways to reduce carbon emissions for climate change mitigation is vital in every municipality, it is also noted that the Cederberg's national contribution to climate change is very low. Therefore, the Cederberg should also focus on shorter-term adaptation measures, such as preventing the negative effects of deteriorating air quality. This involves measures that address specific vulnerabilities in the Cederberg.

Objective	Project (adaptation)
Reducing air pollution in high-risk areas	Encouraging use of public transport to reduce air pollution for those living near roadways.
	Green Infrastructure: Planting trees in industrial areas and along roadways; and encouraging residents to plant trees in their gardens.
	Supporting transition to clean energy for cooking within households, particularly in poor socio-economic areas.
	Green Infrastructure: Planting groundcover plants in areas to reduce dust pollution.

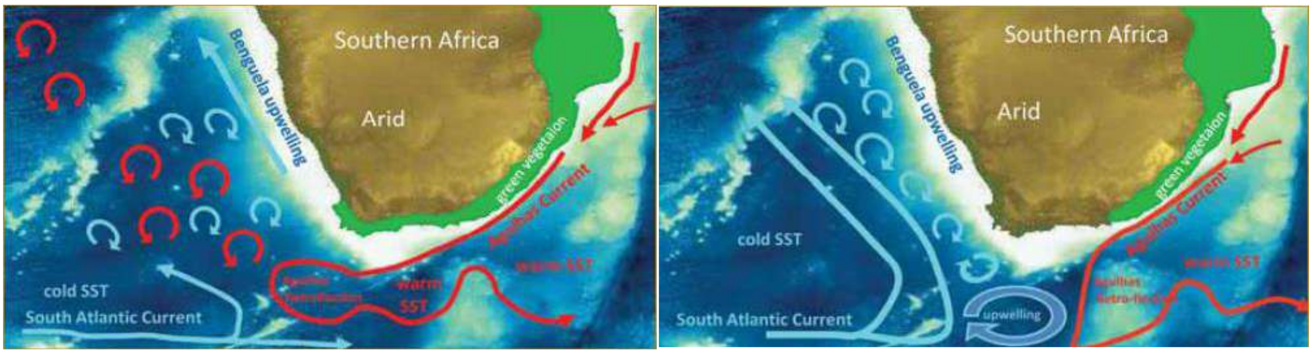
3.5 Coastal Ecosystems and Fisheries

3.5.1 Status Quo

Current regimes around South Africa consists of warm water currents and warm sea surface temperatures and of cold-water currents and cooler sea surface temperatures.

The exchange of large quantities of warm water from the Indian to the Atlantic Ocean (Agulhas Leakage) via the Agulhas Retroflection influences the entire coastal zone of South Africa (See Figure 4(a)). Agulhas Leakage occurs via the intermittent occlusion of the Agulhas Retroflection loop to form the world's largest anticlockwise vortices (gyres), Agulhas Rings (See Figure 4(b)). Each year, between four to eight Rings of varying sizes (200 to 400 km in diameter) are pinched off and adverted north-westward into the south-eastern Atlantic Ocean along the west coast of South Africa. The Agulhas Retroflection displays a downstream (normal) mode and an upstream mode.

Figure 4: Current regimes around South Africa (Lutheharms, 2006)



The above figure illustrates the current regimes around South Africa: Red illustrates warm sea surface temperatures and Blue cooler sea surface temperatures. Figure 4 (a) represents a normal downstream mode of the Agulhas Retroflection, leading to Agulhas Leakages via warm core Agulhas Rings. Figure 4 (b) represents the upstream Retroflection mode leading to a reduction in Agulhas Leakage and cooler SST along the south and west coast of South Africa.

During the upstream mode, the Agulhas Leakage is markedly reduced, which leads to cooler SST for the southern and western oceanic and coastal regimes, compared to during the normal Agulhas Retroflection mode. It has been shown that during Upstream Retroflection, when most of the warm saline Agulhas Current waters are diverted eastward at 25°S, negative SST anomalies are created south and west of South Africa.

Horse mackerel spawns on east and central Agulhas Bank during austral winter, overlapping onto the inshore west coast nursery during summer. Anchovies spawn on the whole Agulhas Bank peaking during mid-summer. Sardines spawn over similar areas as anchovy with two spawning peaks - early spring and autumn. Most of the eggs and larvae are then transported to the west coast nursery areas via narrow coastal jet currents. Hake, Snoek and Round Herring also spawn on the Agulhas Bank, after which larvae drift northwards and inshore to the west coast nursery. A considerable number of eggs and larvae is lost to the open ocean via Agulhas Current and Agulhas Rings entrainment and offshore Ekman drift.

These current regimes form an integral part of the Cederberg municipality coastal aquatic ecosystem.

3.5.2 Projected and Anticipated Changes to the Climate

Any change in the average positions of the Agulhas (east and south) or Benguela (west) current will impact not only the water mass[6] properties and circulation[7] of the coastal zone, but also on the coastal zone flora and fauna, and those communities that derive their livelihood from coastal zone goods and services.

Fisheries: Nurseries and spawning grounds of the commercially most important fish species (sardine, anchovy, horse mackerel, hake and squid) are found within the western coastal zone. The coastal zone fish species are all dependent on the various coastal currents and enclosed coastal ecosystems for the successful completion of their life cycles. Lutjeharms and de Ruijter (1996; cited in Lutjehams et al., 2001) showed that the Agulhas Current will exhibit increased meandering[8] due to Natal pulses[9], which will force the current further offshore, as far as 300km, from its contemporary mean position. In the present global climate regime, the Agulhas Current is located within 15 km from the shore along the east coast of South Africa 77% of the time. The meander modes of the Agulhas Current impact between four to six times a year, which will increase.

The western coastal zone, which consists mainly of the Benguela Upwelling System, will exhibit more intense upwelling due to a predicted increase in wind stress over the southern Atlantic on account of global climate change (Lutjeharms et al., 2001). This will induce much cooler sea surface temperatures (SST) along the west coast of South Africa than at present. However, an intensification of the South Atlantic Sub-tropical

[6] A water mass is a volume of oceanic water with similar physical properties such as water temperature and salt content, giving the volume of water a specific density, and thus a specific vertical location and behavior (depth)

[7] Circulation refers to the flow direction and dynamics of a certain water mass.

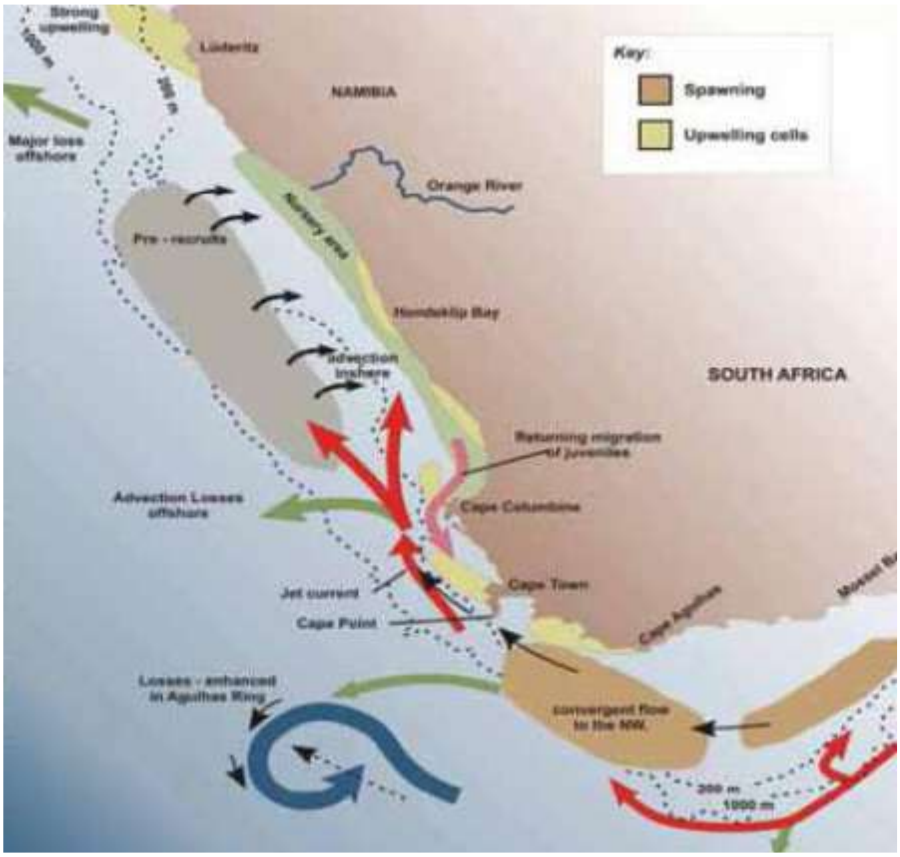
[8] Meanders refer to lateral deviations from the Agulhas Current's almost linear trajectory along the east coast of South Africa (also known as pulses)

[9] Pulses are intermittent, large solitary meanders in an otherwise steady trajectory of the Agulhas Current. These pulses generate the upwelling of cold nutrient rich water to the surface which induces the blooming of marine algae. These pulses translate southwestward along the eastern & southern coastal zone, impacting on coastal ecosystems.

gyre[10] may also lead to increased atmospheric subsidence[11], fewer clouds, increased insolation[12] and higher air temperature. The latter will result in the warming of the surface water, which may negate the increased upwelling and offshore transport of cooler waters.

A stronger Agulhas Current transport has been predicted due to global warming. The impact of a stronger Agulhas Current on the retroflection mode is still unclear. The model studies of Cai et al. (2007) and Rouault et al. (2009) indicate that the increase in Agulhas Current transport will lead to an associated stronger Agulhas Leakage with warmer Indian Ocean water passing the southern and western coasts of South Africa. The model study of Van Sebille et al. (2009) clearly shows the opposite – an increase in Agulhas Current transport will lead to a higher frequency of Upstream Retroflection, with a concomitant decrease in Agulhas Leakage.

Figure 5: West Coast nursery ground (Hutchings et al., 2002)



In either case, the impact of a stronger Agulhas Current will have definite and significant impacts on the coastal zone of South Africa.

Predicting the effects of climate change on local fisheries and fish stocks is particularly challenging, largely because the models used to predict the effects of global heating on marine life make global scale predictions, often with a high level of uncertainty and low geographic resolution (Monnier *et al.*, 2020). Incorporating local knowledge of small-scale fisheries industry is one way to gain a greater understanding of the changes happening in our oceans. According to a 2020 WWF publication, small scale fishers are already experiencing changes such as abnormally warm seawater temperatures and, in some areas, increased frequency and severity of extreme events like high tides and strong winds (Monnier *et al*., 2020). Furthermore, changes in ecology and biology of marine resources were observed such as a decrease in fish availability, either due to a decrease in fish abundance or the change in fish distribution (further offshore or deeper) (for example, species such as snoek were found in different places at the same time of the year, pushing fishers to travel further to catch the fish), changes in the health of ecosystems, and correlating socio-economic concerns (Monnier *et al*., 2020).

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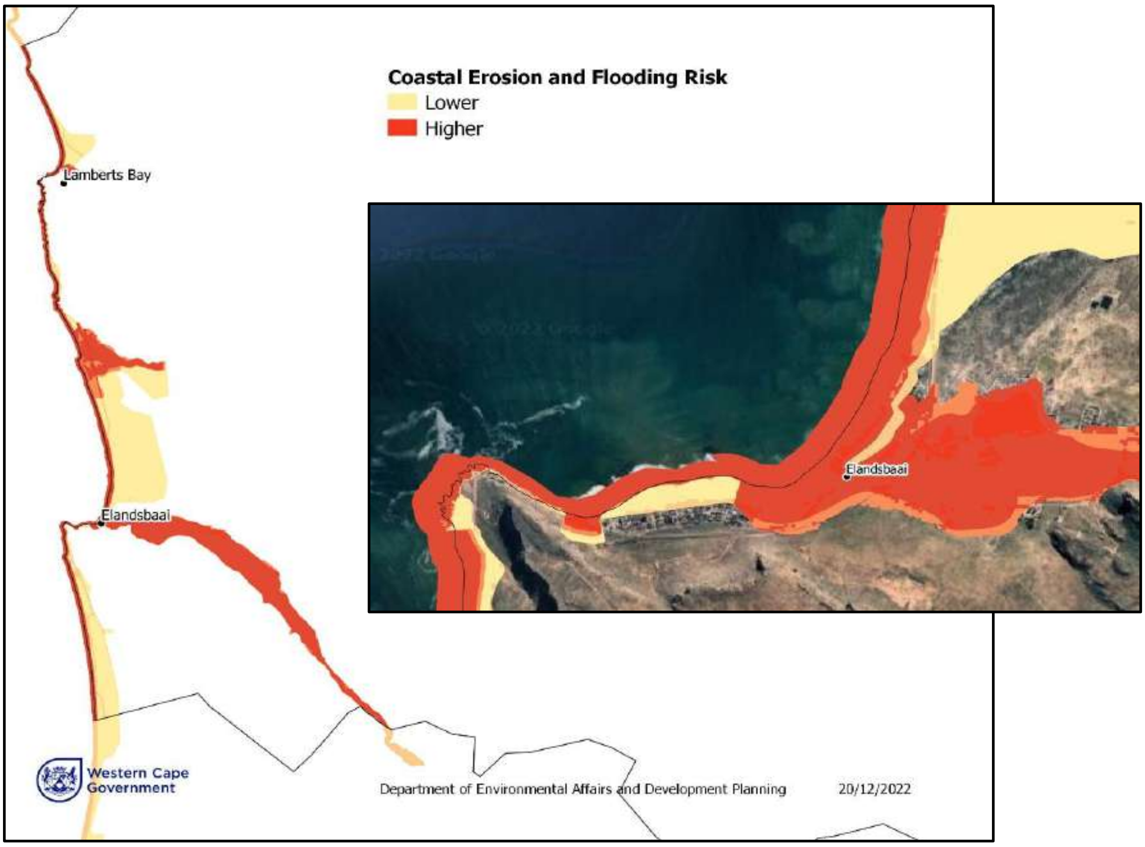
[10] Sub-tropical gyre systems are large gyres (circular water flows) that cover the major ocean basins, e.g. the South Atlantic Sub-tropical gyre is an anti-clockwise water flow in between South America and Southern Africa, creating the southward flowing Brazil Current along South America's eastern coast and the northward flowing Benguela Current along South Africa's West Coast.
[11] Atmospheric subsidence refers to large amounts of air descent.
[12] Insolation is a measure of solar radiation energy received on a given surface area in a given time.

Coastal ecosystems: Coastal ecosystems are at risk to coastal erosion, flooding and sea level rise. The map below shows areas at risk to coastal erosion and flooding[13]. Note that risk to estuaries generally ranks higher. Estuaries are ecologically important and biodiverse, but also very sensitive areas. While a study relating to Cederberg estuarine areas is not available, the general major climate change drivers regarding estuaries include changes in river flow, salinity, temperature, dissolved oxygen, sea-level rise, and lastly, connectivity between habitats and ecosystems (Whitfield *et al.*, 2023). The sensitivities of estuarine fish species to climate change are also largely understudied.

Map 11: Coastal Erosion and Flooding Risk in Cederberg (DEA&DP, 2022)



Coastal set back lines for each Cederberg coastal settlement are included in Appendix III – Adaptation Policy: Coastal Management Lines.

The effect of coastal erosion and sea level rise on settlements is discussed in more detail in socio-economic section 5.3 on Coastal Settlements.

3.5.3 Mitigation, adaptation and Sector Response Plans

Healthy marine ecosystems and populations are more resilient to the effects of climate change, such as rising temperatures and ocean acidification. They also sequester carbon and provide a barrier to storms and erosion. Safeguarding areas creates sanctuaries for fish stocks to be replenished and to reduce pressure on depleted species by procuring a broad range of sustainable seafood species (WWF, 2022).

[13] Map description: Coastal hazards are represented by consolidated hazard zones defined as part of the process of delineating a coastal management line for the Western Cape, undertaken between 2011 and 2017. This is supplemented with desktop mapping of littoral active zones visible on aerial photography in the Overberg and West Coast Districts, as well as updated estuarine flood line delineations and demarcation of the estuarine functional zones.

Objective	Project
Promote sustainable fishing practices	Promote sustainable fishing practices to increase ecosystem health, reduce fishing pressure on depleted species, avoid habitat degradation and incidental "bycatch".
Conserve important marine areas	Identify and protect ecologically important areas by expanding Marine Protected Areas.
Support small scale fisheries	Support small scale fishers to increase their resilience to climate change.
Manage increased damage to coastal ecosystems	Plant suitable vegetation (salt-tolerant plants with extensive root systems) along dunes and banks of the coastal areas as an alternative shoreline stabilising technique.
	Apply reinforcement structures such as breakwaters and dolosse to dissipate wave energy in coastal areas that are prone to impact by increased ocean storms.
	Maintain healthy ecological functioning of estuaries.
Preserve coastal biodiversity	Protect sensitive ecosystems, such as sensitive dunes, from development.
	Implement aquatic monitoring systems along the coastal areas to improve understanding of oceanic changes and anticipated impacts.
Investigate estuarine sensitivities to climate change	Conduct studies regarding the sensitivities of coastal habitats, estuaries (including estuarine fish species) to climate change.

3.6 Wildfires

3.6.1 Status Quo

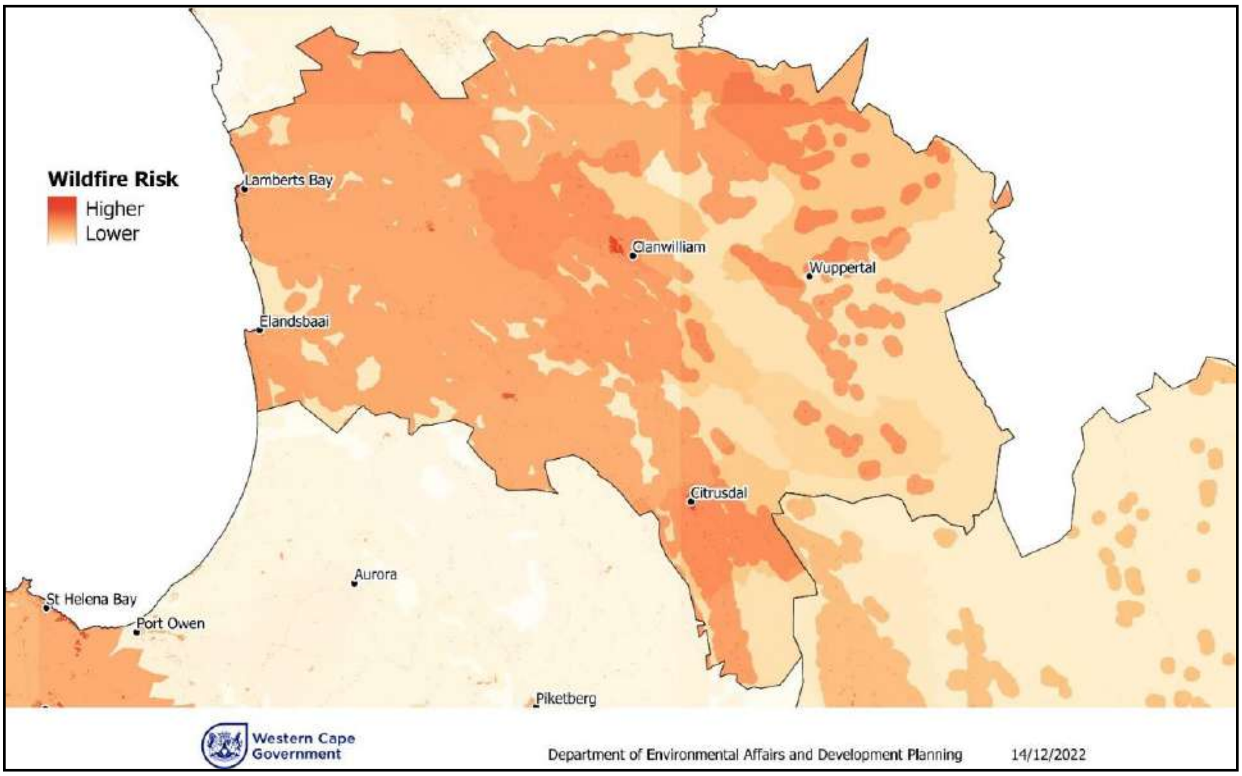
Fire-prone areas include veld zones with a high vegetation flammability index and areas where the atmospheric temperatures are high.

3.6.2 Projected and Anticipated Changes to the Climate

The Fynbos biome featured in the Cederberg region is a fire-driven ecosystem. The prevalent risk is the frequency of fires as a result of temperature increases due to climate change, and the potential for irreversible impacts to this ecosystem.

The risk map concerning wildfires in Cederberg, combining wildfire hazard with vulnerability to wildfire impacts, is shown below. Since the map represents risks posed to people, the highest risk tends to be allocated to populated places – i.e. settlements. As a result, settlements will always have a higher risk than the surrounding area despite being exposed to the same hazard level. The risk is also not proportional to population density – which means that rural settlements are treated as equal to more densely populated urban areas in terms of impact on people.

Map 12: Risk of increased wildfires in Cederberg (DEA&DP, 2022)



3.6.3 Prevention, Adaptation and Sector Response Plans

Objective	Project
Manage the potential increased risk of wildfires	Put preventative actions in place such as managing areas with high fuel load; and maintaining fire breaks in at risk areas.
	Installation of four early warning weather stations in identified areas by Fire Services to establish early warning systems in Winterhoek and Cederberg Mountains.
	Install early warning systems that blend into the natural across designated spots in fire-prone areas to improve fire response timing.
	Establish fire-wise communities in Elandskloof, Goedverwacht, Algeria, Esselbank, Heuningvlei, Clanwilliam and Citrusdal by Fire Services in collaboration with the Fire Protection Association.
	Put systems in place for recovery after fires.
	Conduct controlled burns in areas where plant material is old and dry during cooler temperatures. Teams to monitor and put out fires (i.e. active fire spotters).

4. Built Environment

As settlement-making concentrates people - 70% of the national population live on 1.5% of South African land – and are also regarded as the engine of the economy and fiscus, generating 65% of all economic activity. Hence severe pressure is brought about by ongoing urbanisation and population growth, increased poverty, higher dependency ratios and increased demands on services and resources. Bear in mind that in SA, the average growth rate for urban areas is consistently higher than the population growth rate.

Urban sprawl, fueled by informal settlement, reduces biodiversity and pollutes land, water and air. Informal settlements are vulnerable to environmental and health risks because dwellings are in areas prone to disasters and lack basic services.

Together with the bio-physical environment, the Built Environment of settlements renders services such as Water provision, Waste disposal, and Wastewater treatment. The efficacy (quality and efficiency) of these services is embedded in the bio-physical environment and ecological infrastructure. This interrelatedness is a critical link as a foundation for climate change.

The built environment will increasingly be subjected to several direct and indirect pressures because of the diverse climate change challenges faced by urban and rural human settlements. Some of these include:

- Poor urban management i.e. poor stormwater drainage systems and urban-induced soil erosion result in flash flooding;
- Larger settlements are slow to adapt to changes in the environment and they have entrenched dependencies on specific delivery mechanisms for critical services;
- Effective management of the interface between settlement residents and their surrounding environment producing sustainable social-ecological systems needs to the addressed;
- Our settlements are relatively spread out and the poorest communities tend to live far away from services and employment contributing to increased transport emissions;
- Water demand in settlements is growing rapidly, placing undue stress on water supply systems. Investment in wastewater treatment works has not remained in line with the growth in demand and use;
- Informal settlements are vulnerable to floods and fires, exacerbated by their location in flood- or ponding-prone areas and on dunes; inferior building materials; and inadequate road access for emergency vehicles;
- Dense settlements consume significant amounts of energy. While this can lead to increased energy efficiency, it also makes the energy systems more complex.

4.1 Water and Sewerage Services

4.1.1 Status Quo

Nearly ninety-seven percent (97.2%) have access to piped water within the dwelling or at most 200m from the dwelling. This domestic service is supported by the following bulk infrastructure[14]:

Settlement	Status	Village	Status
Citrusdal	3.3Ml reservoir upgrade. Additional borehole and water tanker required.	Algeria	200kl reservoir. Upgrade of borehole pipeline
Clanwilliam	5.3Ml reservoir, pressure management and replacement of pipe to purification works. DWS is raising dam wall by 13m to increase storage capacity (WSDP, 2023)	Elandskloof	Storage reservoir insufficient. Infrastructure required.
Elands Bay	1Ml reservoir.	Leipoldtville	0.5Ml reservoir.
Graafwater	1.5Ml reservoir upgrade.	Paleisheuwel	Upgrade reticulation.
Lamberts Bay	3Ml reservoir and upgrade reticulation. Desalination plant to become operational.	Wupperthal	200kl reservoir. Install borehole infrastructure.

The key sources of water for the settlements of the Cederberg Municipality are as follows (according to the Cederberg Water Master Plan, 2023):

- Citrusdal: Olifant River (for most of the 2021/2022 financial year the flow was too low for supply to the town) (WSDP, 2023) and Groundwater from three boreholes;
- Clanwilliam: Clanwilliam Dam and Jan Dissels River;
- Elands Bay: Historically six boreholes (not operational), Three boreholes east of Elands Bay;
- Graafwater: Raw water from three boreholes; management important as quality deteriorating (WSDP, 2023);
- Lamberts Bay: Groundwater from three boreholes (extraction exceeded safe yield volume in 2021/2022) (WSDP, 2023); due to be commissioned desalination plant;
- Leipoldtville: Groundwater from 1 borehole;
- Algeria & Paleisheuwel: Water from borehole and mountain streams for Algeria, groundwater from 1 borehole for Paleisheuwel. Sustainable yield for stream to be determined;
- Elandskloof & Wupperthal: raw water from mountain stream for Elandskloof, water from Tra-Tra river for Wupperthal. Sustainable yield and abstraction not currently metered, to be determined.

Over eighty percent (82.4%) of households have access to flush toilets (connected to sewerage systems or have installed septic tanks). The availability of the bulk sewerage infrastructure in each area of the Cederberg is summarised in the table below.

Settlement	Status	Village	Status
Citrusdal	Sufficient capacity	Algeria	Upgrade required.
Clanwilliam	New sewerage works required; upgrade in progress; near completion	Elandskloof	New sewerage works required.
Elands Bay	Upgrade or new sewerage works required given the overload during summer.	Leipoldtville	New sewerage works required.
Graafwater	New sewerage works required.	Paleisheuwel	Upgrade required.
Lamberts Bay	New sewerage works required.	Wupperthal	Sewerage upgrade by Moravian church required.

[14] http://www.cederbergmun.gov.za/download_document/2687

4.1.2 Projected and Anticipated Changes to the Climate

A local community's ability to cope with the future consequences of climate change is reflected in the status of their water, food and energy security.

To enhance the municipal level response to climate change impacts, Cederberg's Water Master Plan, 2023 emphasizes maintenance of the water networks as regular maintenance can prevent water leaks or bursting of water pipes, and flooding of sewage systems. Maintenance also includes the replacement of old and broken infrastructure.

All the water sources, stormwater and sewage within the Cederberg municipal area, will come under threat from rising temperatures and decreased rainfall due to climate change. Some of those identified risks are linked to changes in flow rates and quality of groundwater, and river and stream sources.

- Stormwater and sewage – overall flooding of stormwater into sewage systems during flood seasons; changes in biological activity in sewerage as a result of atmospheric temperature increases may lead to current sewerage disposal methods and purification processes being ineffective;
- Wastewater – there is a potential for blockages and overflows to occur; of particular concern is the intrusion of groundwater into wastewater networks;
- Water supply – changes or reduced quality of water may render current catchment systems and treatment methods ineffective.

4.1.3 Mitigation, Adaptation and Sector Response Plans

Unused resources and Intensification of resource protection:
The use of new and unused water resources i.e. reuse of effluent, desalination, and grey water should be explored whilst climate change corridors along rivers and around mountains should be encouraged.

Infrastructure upgrades:
Projects include the current raising of the Clanwilliam dam wall (Department of Water And Sanitation (DWS)), the proposed farmer production support units at Clanwilliam and Citrusdal, proposed upgrading of the harbour at Lamberts Bay (Department of Forestry, Fisheries and the Environment (DFFE)), social housing in Clanwilliam (Department of Human Settlements) and housing in Elandskloof (Department of Agriculture, Land reform and Rural development (DALRRD)) and the upgraded N7 completed and served as an informant for the proposals to follow.

The primary focus of adaptation and mitigation measures is on reinforcing and expanding the existing water infrastructure.

Objective	Project
Manage decreased water quality in the ecosystem.	Conduct a review of wastewater treatment works by local municipality (Engineering Departments) to determine more appropriate technology for improved quality and recycling of treated effluent for industrial and potable use.
	Implementation of new technology at the local municipality to improve the quality of treated effluent for industrial and potable use.
	Municipality to conduct a study in collaboration with the Department of Water and Sanitation on recharging aquifers with recycled, treated effluent.
Manage the quantity of water available for irrigation and drinking.	Review the entire surface water, groundwater, desalination water and treated effluent systems for catchment areas in the Cederberg by the Cederberg Municipality in collaboration with DWS and DEA&DP.
	Review rehabilitation of flood plains and catchments and stormwater management and treatment.

4.2 Energy Sector

4.2.1 Status Quo

Coal makes up 80% of South Africa's energy mix (CSIR, 2022), while renewable energy technologies (wind, solar PV and CSP) account for only 7.3%. As the generation of electricity from coal contributes significantly to the greenhouse effect, the use of alternative energy resources like hydroelectric power and nuclear energy is increasingly pursued. However, dwindling water resources and potential droughts in certain regions of the country due to climate change may limit its use as an alternative energy generation source.

Like the rest of South Africa, the Cederberg municipality's electricity is primarily generated from coal-fired stations. With 88% of households already connected to the grid, the municipality aims to achieve a 40% renewable energy generation by 2030. The short-term targets focus on areas of efficiency and low-capex renewable energy solutions targets and include:

- Increasing energy efficiency in commercial and industrial facilities by 10%;
- Use of energy-efficient lighting, alternative water heating and climate control with the latest energy-saving technology across all municipal-owned facilities;
- Install LED energy-efficient lighting to 30% of streetlights.

Long-term opportunities for generating alternative energy include the Clanwilliam dam as a potential source to generate energy, as was done historically. The Cederberg Integrated Resource Plan (CIRP) (2022) has identified additional renewable energy options to be implemented through the Cederberg Renewable Energy Independent Power Producer Procurement Programme (CEIPPPP). The aim is to tailor these solutions to the available natural (wind and solar) resources within the municipal region. The CIRP is discussed further in section 4.2.3 below.

4.2.2 Projected and Anticipated Changes to the Climate

The expected climate change impacts on the energy sector are direct and indirect. The direct impacts include energy resource availability, power production, transmission and distribution. The factors related to these direct factors depend on the vulnerability of the related infrastructure and available resources. The indirect impacts are primarily linked to changing supply and demand trends, of which the short-term targets (efficiency and low-capital renewable energy solutions) will have limited impact.

The Cederberg has energy infrastructure distributed along the coastal and mountainous regions and will be subjected to different region-specific climate change risks. The infrastructure dedicated to settlements along the coast is at risk of increased coastal erosion and flooding, while those in elevated areas may experience severe heat stress. The deployment of renewable energy alternatives to increase the resilience of the sector, both in improving reliance in the short term and for long-term mitigation.

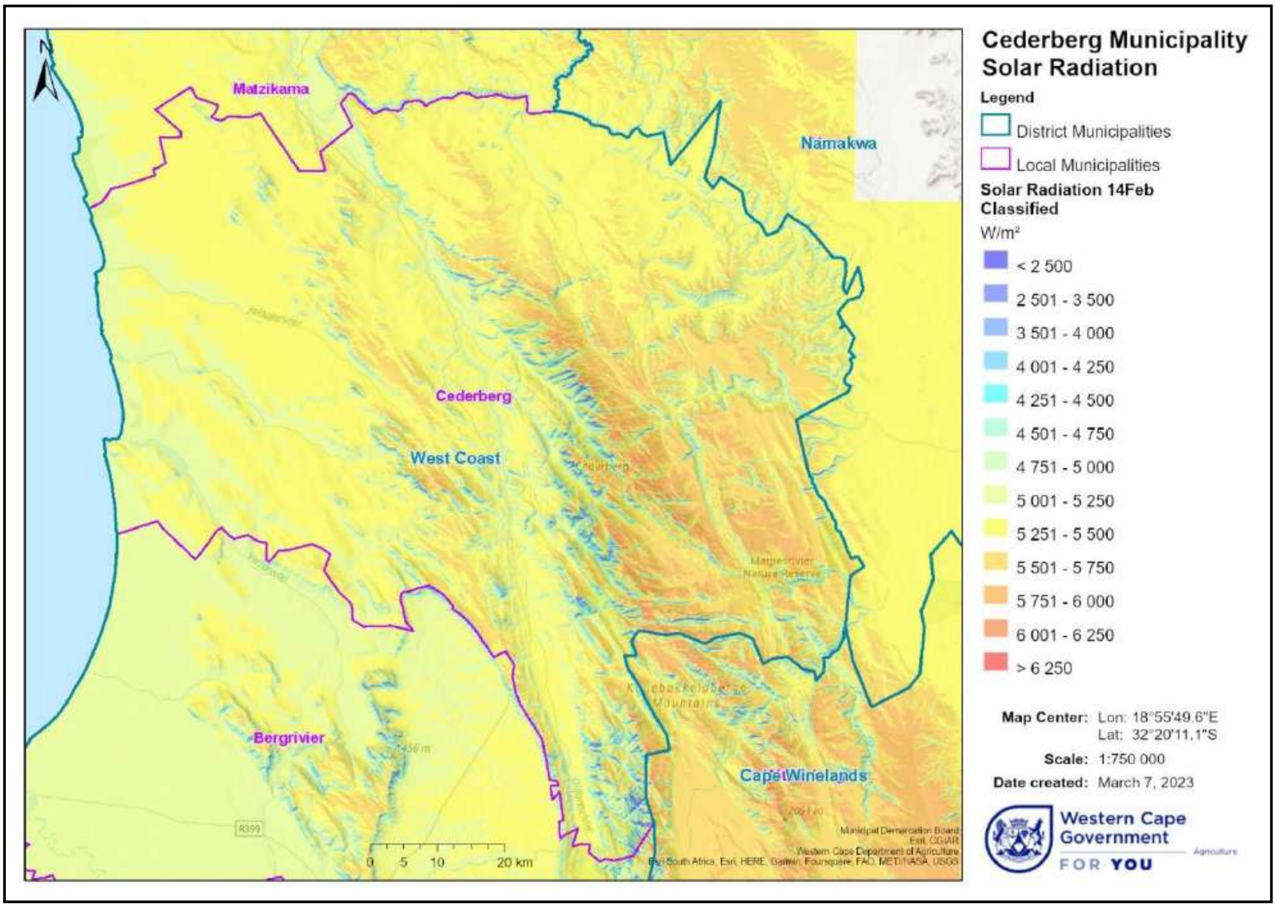
4.2.3 Mitigation, Adaptation and Sector Response Plans

The Cederberg energy generation strategy is guided by the Cederberg Municipality Integrated Resource Plan (CIRP) which prioritises providing the least-cost, reliant electricity to all citizens and businesses, stimulating economic diversification and job creation while reinforcing environmental sustainability.

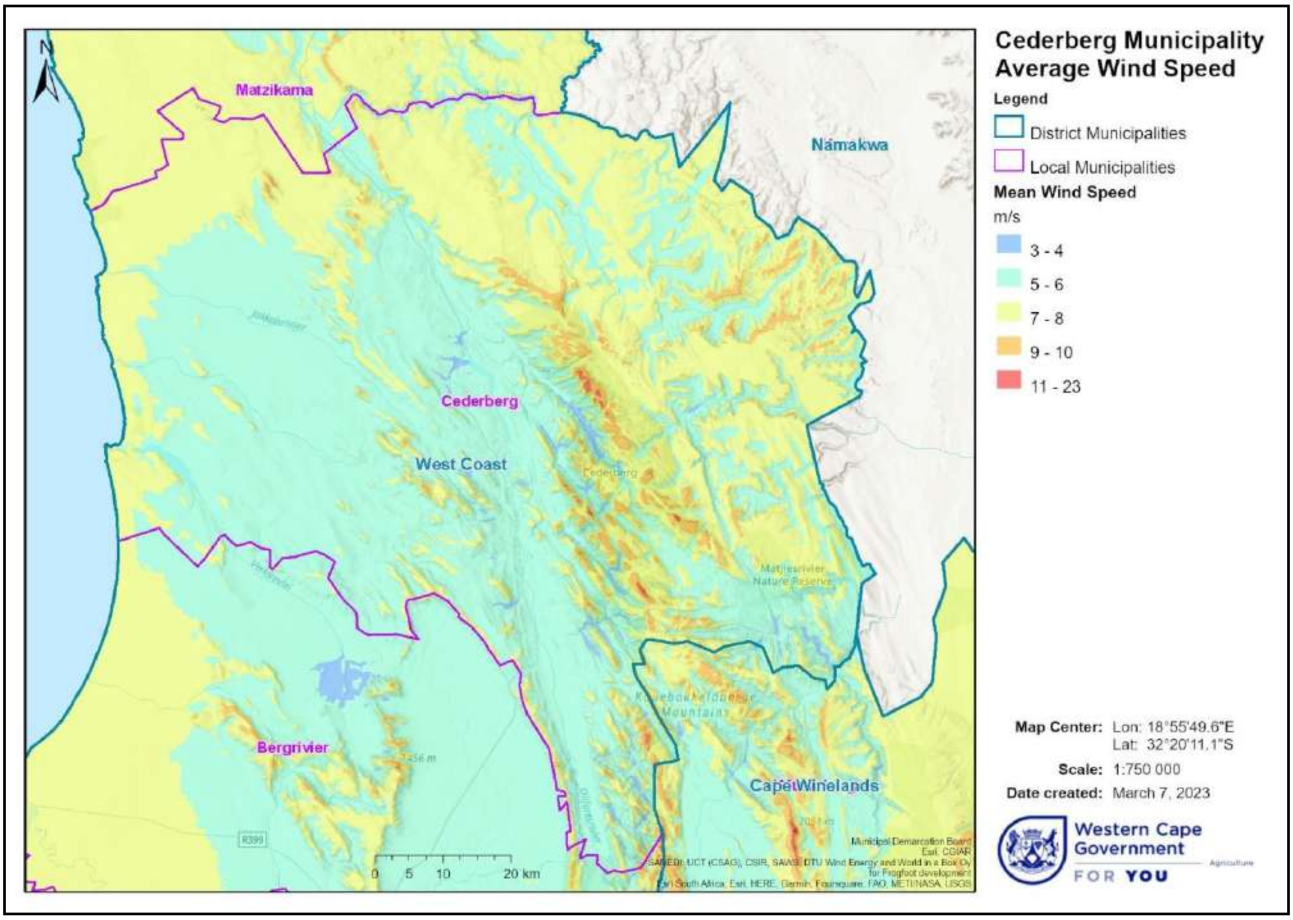
One of the initial strategies is to delineate alternative energy zones and promote energy generation facilities in viable zones only. While the overall viability of energy sources must be confirmed by specialist studies, several regions of the Cederberg have been identified as best environmentally suited for hosting various sustainable energy solutions:

- Solar Energy overall Cederberg, particularly regions 4, 5, 6 and 7 that have higher solar radiation, yet with great sensitivity around the visual impact in protected and conservation areas;
- Wind Energy particularly west of the N7, particularly regions 2 and 3 and partially in 4;
- Hydroelectricity at Clanwilliam and Hydrogen along the coast;
- Provide for solar facilities to cater for future urban expansion. Generate alternative energy for all settlements: Clanwilliam – hydroelectricity;
- Caution the establishment of commercial solar and wind farms in and around environmentally and visually sensitive areas, especially not in the Cederberg Wilderness Area. Especially do not support wind and solar farms on slopes as it has increased visibility and potentially a negative visual impact;
- Promote Wind Energy particularly west of the N7, hydroelectricity at Clanwilliam and Hydrogen along the coast;
- Promote energy-efficient (green) buildings and structures. The municipality can advocate that such initiatives be aligned with the energy policy through the implementation of incentives for municipal clients;
- Infrastructure durability: move/ improve durability of infrastructure that is at risk to coastal erosion and flooding and sun damage; and caution new infrastructure development in areas at-risk to coastal erosion or building with non-durable materials.

Map 13: Solar Radiation, Cederberg (Cederberg SDF, 2023-2027)



Map 14: Average Wind Speed, Cederberg (Cederberg SDF, 2023-2027)



4.3 Solid Waste Management

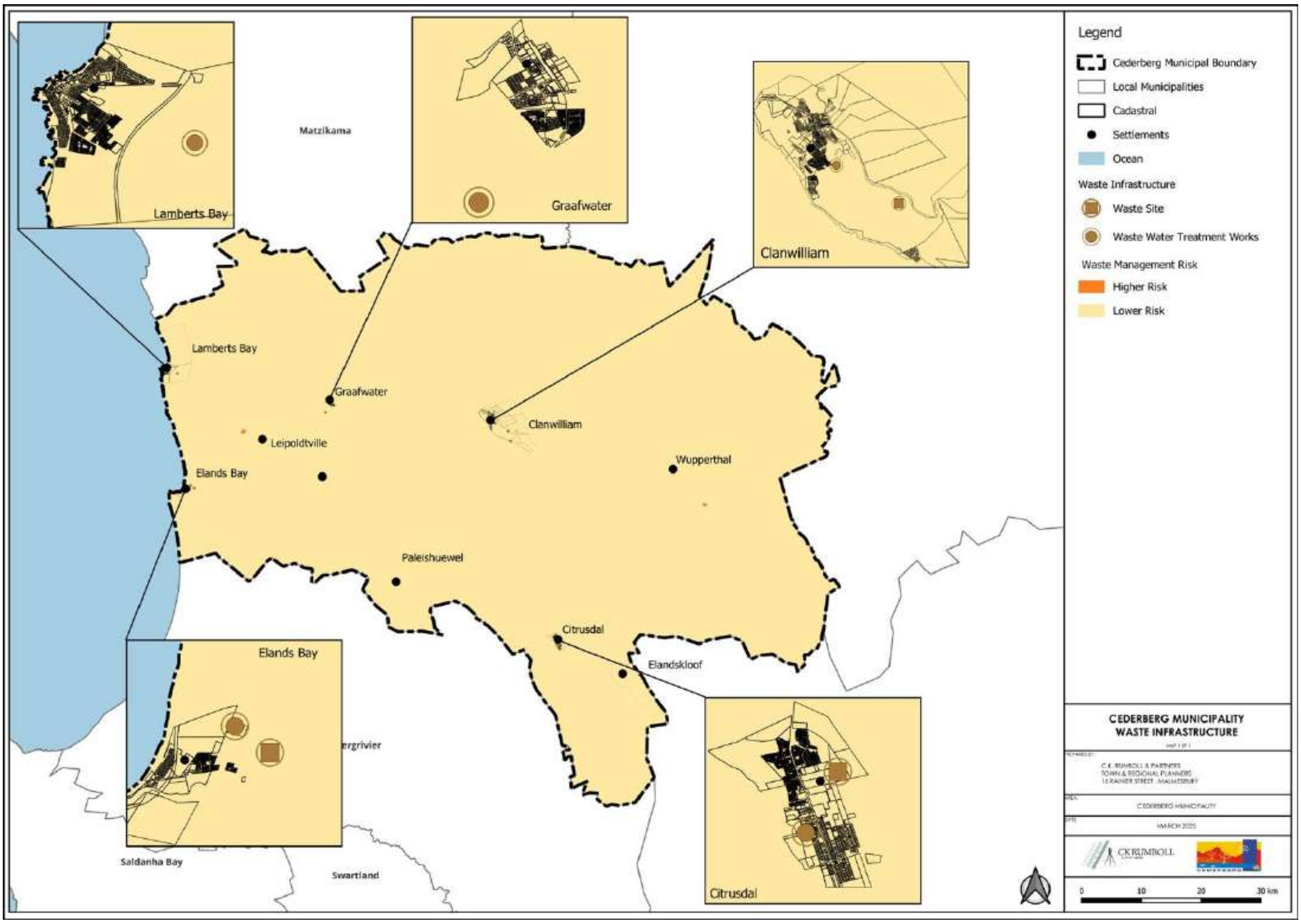
4.3.1 Status Quo

Within both rural and urban settlements, solid waste in the environment holds an inherent risk due to its potential to destabilise ecological balance or exceed natural waste processing capacities. In some situations, solid waste is a hazard by itself, but in other cases, it is transformed into or leads to the formation of, secondary pollutants that contaminate air and water.

Fifty-eight percent (58.1%) of Cederberg households have waste removed at least once a week. This service is supported by settlement-based waste sites that is in the case of Cederberg's larger settlements, mostly unlicensed and in the case of the smaller villages, unofficial.

Settlement	Status	Village	Status
Citrusdal	Licensed Waste Site	Algeria	Closed – to be rehabilitated
Clanwilliam	Licensed Waste Site	Elandskloof	Collection service only
Elands Bay	Licensed Waste Site	Leipoldtville	Closed – to be rehabilitated
Graafwater	Closed – to be rehabilitated	Paleisheuwel	Closed – to be rehabilitated
Lamberts Bay	License Waste Site	Wupperthal	Closed – to be rehabilitated

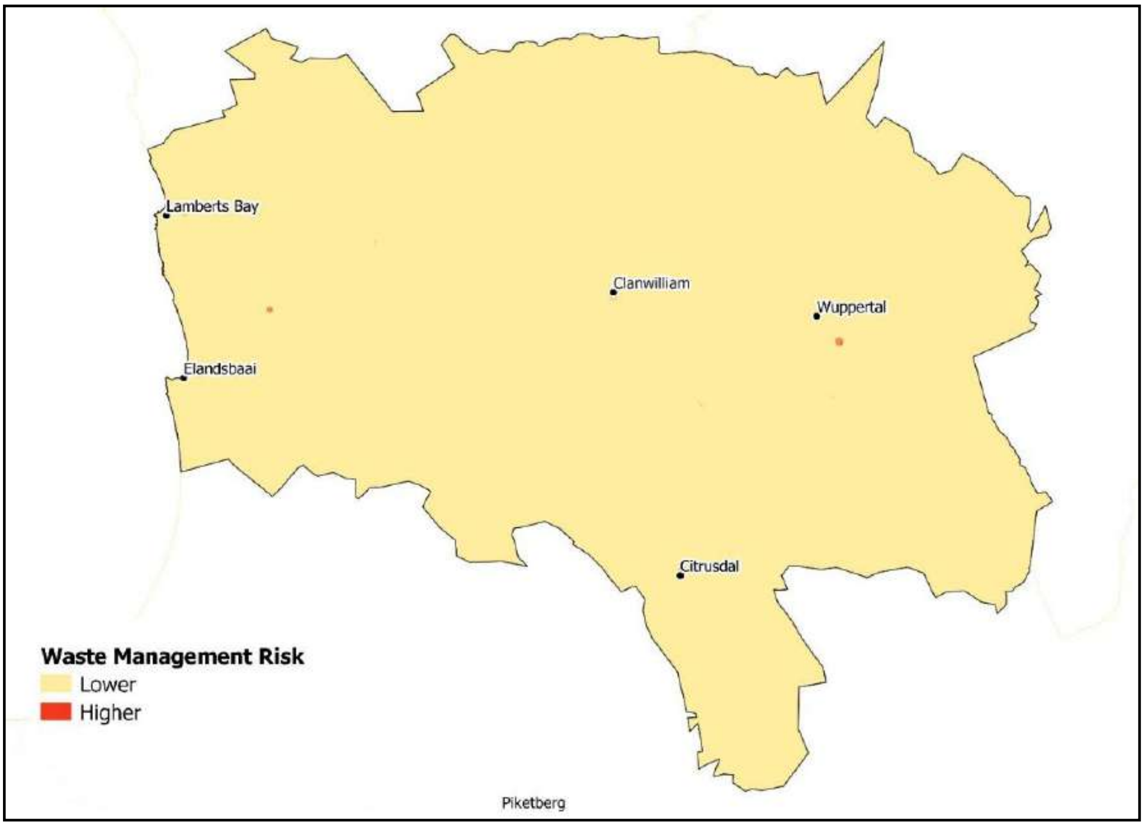
Map 15: The map provides the location of all waste facilities and waste water treatment works in relation to the settlement.



4.3.2 Projected and Anticipated Changes to the Climate

Using available data on municipal waste removal services and landfill sites, a map was generated that shows both the likelihood of solid waste accumulation in a municipality and the risk of environmental pollution stemming from formal disposal sites. Combining the hazard (potential presence of waste) with a generic vulnerability score (likelihood of being affected) results in a map that presents the risk of people being affected by waste 'spilling' out of formal waste management systems and degrading the environment. The resultant risk map is shown in the map below.

Map 16: Waste management risk in Cederberg (ranking relative to other municipalities)



4.3.3 Mitigation, Adaptation and Sector Response Plans

Reinforcing waste recycling practices into the current waste management processes is the impactful short-term response to ensuring that solid waste management facilities and dump sites are not overburdened as urbanisation trends increase in the Cederberg. Waste 'spillage' presents a notable challenge, considering that climate change-related temperature increases will alter chemical processes during waste degradation. Some ways to combat this in the short and long term include:

- Implementing sorting and catchment systems that exploit the physical properties of different materials to improve the efficiency of sorting processes;
- Provide relief from heat impacts for waste management workers;
- Deploy soil and water testing mechanisms to ensure early detection of spillages, before contaminants are leached into the soil;
- Put measures in place to prevent fires—and resultant air pollution—in storage facilities and dump sites;
- Expedite planned improvements, licencing and official adoption of waste management sites to ensure consistent handling of solid waste across areas of the Cederberg municipality.

5. Socio-Economic Environment

The analysis of the Socio-Economic environment outlines the municipal demographics, then focuses on the social risks posed by climate change and the municipality's capacity (as a governing entity and the receiving community) to deal with those challenges.

Cederberg contributed 1.3% to the GDP of the Western Cape and sixty percent (59.8% in 2011) or 35 723 people are of working age. The three biggest contributors to the Cederberg GDP – agriculture, manufacturing and trade – will also be subjected to direct and indirect climate change impacts. The direct impacts will be a result of the specific industry's infrastructure being damaged during extreme climate events and crop failures. Meanwhile shifts in resource (energy, people and municipal infrastructure) availability and utilisation regimes, particularly those stimulated by the municipality, will be responsible for the indirect impacts.

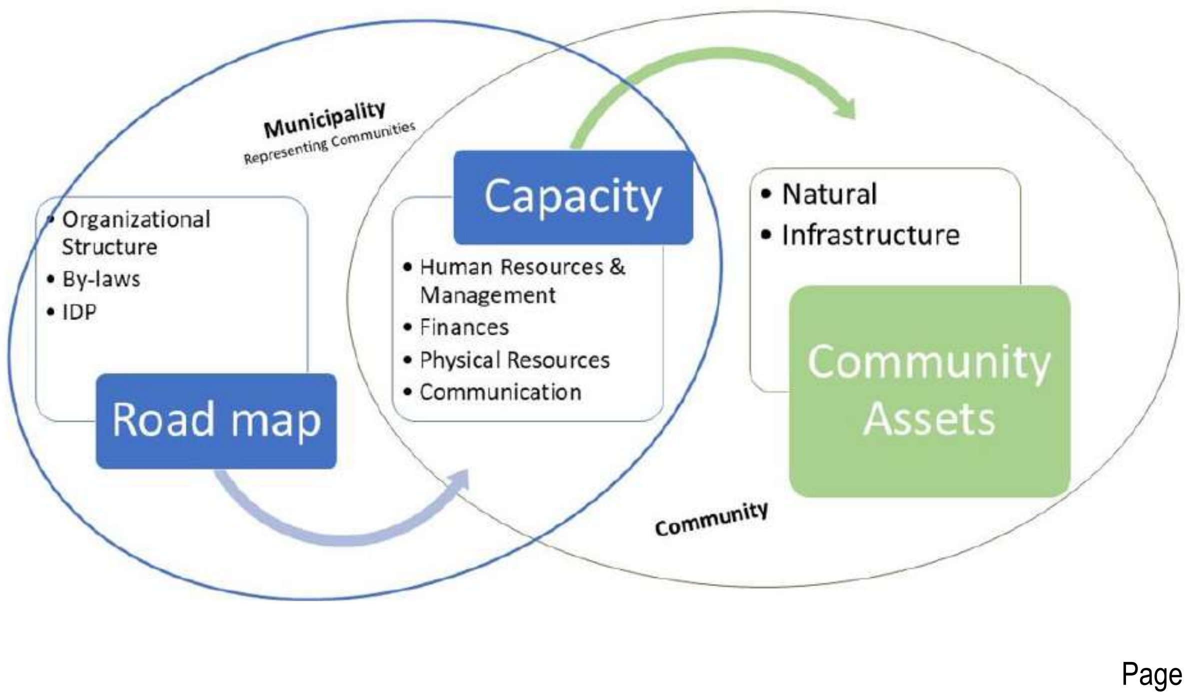
The agricultural sector plays a significant role to the Cederberg municipality's socio-economic well-being – it contributes 25% to local GDP and directly employs 14% of the population – and its activities heavily rely on the region's natural features and available resources. In addition, any notable shifts in this sector will also affect some secondary and tertiary industries such as agri-processing, tourism and trade. This warrants a special analysis of its vulnerability to climate change special attention in this section.

5.1 Municipal Capacity

5.1.1 Status Quo

How climate change is expected to unfold in different municipal spheres will vary but considering the expected risks, it is undeniable that municipalities will be placed at the forefront as they respond to evolving social demands. Climate change impacts will not only put the community resources and assets (natural and man-made) governed by the municipality under strain but also the municipal capacity (human, financial, physical and communication resources) and strategy (IDP, Organizational Structure and By-laws). As such, additional capacity in select divisions and/or strategic flexibility, may be required to cope with the changing needs and to secure the expertise necessary to effectively implement climate change mitigation and adaptation strategies.

Figure 6: Municipal and Community Assets relationship



The capacity required by the Cederberg Municipality to cope with and respond in a timely manner to climate change impacts on community resources and assets (natural and man-made assets) can thus be viewed from its capacity (human, financial, physical and communication resources) and/ or strategic (IDP, Organizational Structure and By-laws) perspective.

Table 4 below illustrates the organisational structure of the Cederberg Municipality as part of its strategy to govern community assets and resources effectively whilst the physical and human resources endowment available within each unit to execute specific responsibilities reflects its capacity. As a Class B municipality, Cederberg Municipality has the following strategic focus areas and respective responsibilities:

Table 4: Cederberg Municipality organisational structure[15]

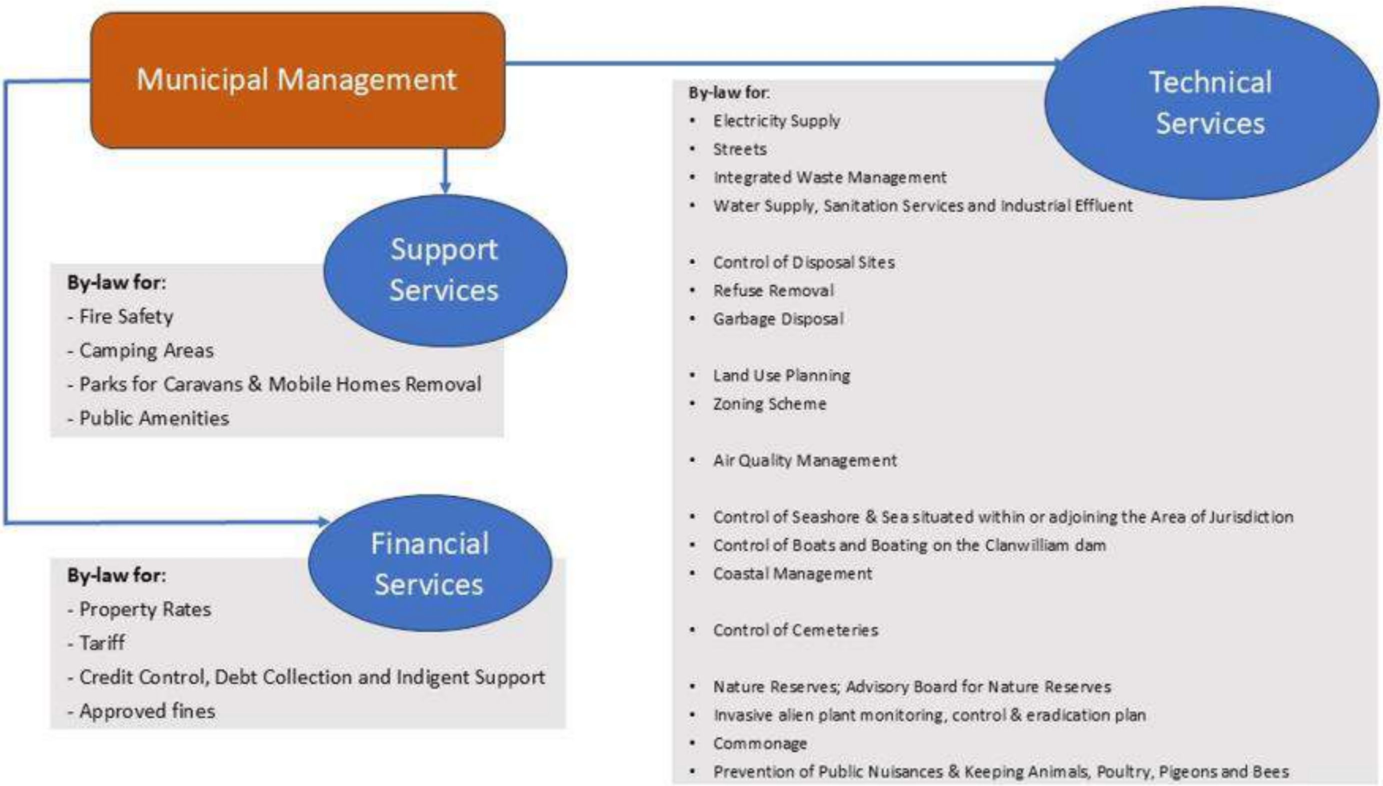
Structure	Strategic Focus	Responsibilities
Municipal Management	Strategic Services	IDP, Planning & Performance Management
		Organisational Risk Management
		Communication & IGR
	Legal Services	Legal & Support Services
	Internal Audit	Internal Audit
Financial Services	Financial Management Services	Financial Reporting & MSCOA Compliance
		Asset, Assurance & Liabilities Management
		Budget Management & Information System
		Expenditure Management
	Revenue Management	Revenue & Reconciliations, Valuations & Clearances
	Supply Chain Management	Demand, Stores and Acquisition Management
		Contract management
		Logistic & Disposal Management
Support Services (Community Development & Public Safety)	Socio-Economic & Rural Development	Rural, Socio-Economic and Sports Development
		Libraries
	Public Safety	Disaster Management
		Traffic Services
		Law Enforcement
	Resorts & Caravan Parks	Bookings & Accommodation
		Caravan Parks
		Chalets
	Human Resources	Labour Relations
		Skills Development & Organisational Development
		Job Evaluation coordination
		Recruitment & Selection
		Employment Equity
		Health & Safety, Employee Wellness
		Personnel Administration
	Administration	Administrative & Committee Services
		Archives
		Helpdesk
		Political Office Support
		Cleaning Services
	Information, Communication & Technology (ICT)	Systems / Network Administration
		Helpdesk & Compliance

[15] Cederberg Municipality Final IDP 2024/2024

Technical Services	Electro-technical Services	Electrical Services
		Pump Maintenance
	Water & Wastewater Services	Water Purification
		Wastewater Treatment
	Waste Management	Refuse Removal
	Town Planning	Town Planning
		Building Control
		Integrated Human Settlements
		GIS
	Project Management Unit	MIG
		Capital Projects
		EPWP
	Civil Services	Roads & Stormwater
		Building Maintenance
		Water & Wastewater Network
		Environmental Management
		Mechanical Services
		Parks, Gardens & Cemeteries

The municipal by-laws (and policies) are part of Cederberg Municipality's strategy and enhance its ability to effectively deploy its climate change initiatives, within relevant strategic focus areas (and directorates) and units with specific responsibilities.

Figure 7: By-laws relevant to Climate Change per Municipal Strategic Focus Area and units[16]



[16] Cederberg Municipality list of by-laws

5.1.2 Projected and Anticipated Challenges

Some of the previously identified gaps in the municipality's institutional capacity included the absence of a dedicated Environmental Officer and IDP-endorsed Climate Change Champion. From a strategic perspective, the lack of a Climate Change Response plan and policy was also previously identified[17]. These challenges were both addressed.

5.1.3 Mitigation, Adaptation and Response

To enhance the institutional preparedness of the Cederberg Municipal strategic focus areas or departments to effectively respond to climate change impacts, the existing gaps from an implementation perspective will have to be addressed across various levels and within units. As an initial step, some of the high-level responses to improve preparedness include:

- Creating key performance indicators to track the progress of municipal departments in implementing climate change adaptations;
- Streamlining structures for investment decisions for responding and adapting to climate change impact;
- Ensuring that climate change adaptation considerations feature as standard steps in development approval, planning, design and maintenance of municipal infrastructure or services.

5.2 Rural Settlements

5.2.1 Status Quo

In 2011, nearly half of the population (49.7%) and households (47.3%) in Cederberg lived in rural areas, and 15% of households were involved in agriculture, a large fraction of these are rural farms. Several of these function as agri-tourism destinations, amongst other tourist attractions in the region. The rural settlements within the municipality comprise both formal and informal tenure developments.

5.2.2 Projected and Anticipated Changes to the Climate

Due to limited access to municipal infrastructure and resources, such as disaster response teams due to remoteness, rural communities are especially vulnerable to adverse climate change impacts. Rural communities face the following climate change challenges:

- Small-scale and subsistence food production is particularly vulnerable to climate variability, relying mostly on dry land food production with limited capital to invest in soil fertilization, seed and weed, pest and disease control;
- Changes in production systems due to climate change and climate change-related damage and crop failures, is likely to negatively affect employment in rural areas;
- Spatial planning needs to address historical inequalities in land distribution without compromising the ability of the agricultural sector to contribute to food security;
- Rural communities are under-represented in the climate monitoring network even though they are less resilient, and likely to be the soonest and most greatly negatively affected by climate change.

[17] Climate Change Response Framework

5.2.3 Mitigation, Adaptation and Sector Response Plans

Some of the adaptation measures (suggested by Zhou *et al.*, 2022) that can be taken to improve the resilience of rural settlements while preserving the natural environment include:

- Set up early warning systems to help rural communities prepare for climate risks;
- Improve access to resources such as water, financial aid, and infrastructure development.
- Provide financial support and aid place-based policy development to allow adaptation that addresses specific vulnerabilities;
- Encourage cross-sectional and transboundary solutions to climate change challenges; and
- Promote just transition principles to ensure equity in climate adaptation policies.

Possible climate adaptation measures options in rural settlements include:

- Identify suitable renewable energy sources that blend in with the natural environment; and do not require clearing of portions of land or disturbance of natural habitats, such as solar PV installations in homes and commercial areas;
- Adopt structural design methods that take advantage of the natural environment and use readily available materials in the area. In this way, the carbon footprint of the area is also reduced;
- Create a circular economy and identify alternative applications for materials like plastics and textile materials, to promote sustainable practices and mitigate issues related to disposal such as eventual contamination of natural water systems.

5.3 Coastal Settlements

5.3.1 Status Quo

Cederberg has two coastline settlements i.e. Elands Bay and Lamberts Bay, along the 62km coastline. The coastal management line maps indicate the seaside that should be kept clear from structures and infrastructure. The coastline settlements are characterised by limited formal road infrastructure and sections are restricted for private use and development and as conservation areas. Most of the coastal access points are at and around these two settlements.

Coastal setback lines were generated for each settlement and were included in Chapter 4: Built Environment.

5.3.2 Projected and Anticipated Changes to the Climate

Evidence of rapid climate change, including more frequent and intense weather patterns and greater climate variability, has already been observed and is posing several risks to coastal infrastructure and settlements.

- Coastal human settlements are the most vulnerable to an increase in sea-level rise due to climate change. According to the Department of Forest, Fisheries and the Environment (2012), an estimated 30% of South Africa's population lives within 60km of the coast. Coastal towns and settlements host high volumes of local and international tourists annually whilst lifestyle and development opportunities in coastal areas are leading to significant migration to the coast. Hence safe setback distances, considering erosion resistance and local coastal topography, need to be determined;
- Flooding and coastal erosion result in the loss of coastal infrastructure (including breakwaters, roads and public amenities), habitat and ecosystem goods and services. Predicted rises in sea level may further exacerbate these impacts;

- A network of infrastructural installations and communication links along the coast are at risk. These are owned and overseen by public and private enterprises, and service the needs of the inhabitants, tourists and other entities in the coastal zone;
- Increased frequency and intensity of coastal storms, which includes seasonal cyclone activity on the east coast. Estuaries are particularly vulnerable;
- Increased coastal development and inappropriate land and catchment management will exacerbate these impacts.

5.3.3 Prevention, Adaptation and Sector Response Plans

- A continual assessment of coastal defences, particularly at harbours, estuaries and lagoons, and along low-lying coastal land, will be needed to reduce damage in high-risk areas;
- To protect natural landscapes, delineate development lines around mountains and koppies and in marshes or a water sponge or in a floodplain;
- Prepare for coastal erosion, particularly at Elands Bay.

The mitigation strategies for Coastal Settlements must be coordinated with those for Coastal Zones and Fisheries to ensure that both the social and environmental aspects are considered when planning and responding to climate change impacts.

Objective	Project
Manage loss of land due to sea level rise	Apply lessons learnt from the West Coast District Municipality and Saldanha Local Municipality's Environment and Technical Services Departments research project on sea level rise at Langebaan Beach.
	Prepare to move infrastructure such as railway lines inland out of risk zone.
Manage increased damage to property from sea level rise	Apply lessons learnt from installation of gabions at Strandfontein Beach in Vredendal by the Matzikama Local Municipality Environmental Services and Technical Services Departments to manage the damage to property.
	Apply reinforcement structures such as breakwaters and dolosse to dissipate wave energy in coastal areas that are prone to impact by increased ocean storms.
Preserve coastal biodiversity	Preserve existing coastal vegetation (particularly ecosystems with flood retention properties such as wetlands) and plant suitable vegetation (salt-tolerant plants with extensive root systems) along dunes and banks of the coastal areas to stabilise the shoreline.

5.4 Terrestrial flooding

5.4.1 Status Quo

Although flooding is to be expected during rain seasons in areas where main water river sources and natural catchments run, of particular concern is the significant threat this poses to settlements located along rivers and flood plains. The settlements located along such landscapes in the Cederberg include:

- Citrusdal along Olifants River;
- Clanwillliam and Bulshoek along Olifants River;
- Elands Bay's Edge, the Verlorenvlei River;
- Lambert Bay's Edge the Jakkals River;
- Leipoldtville's Edge the Langvlei River.

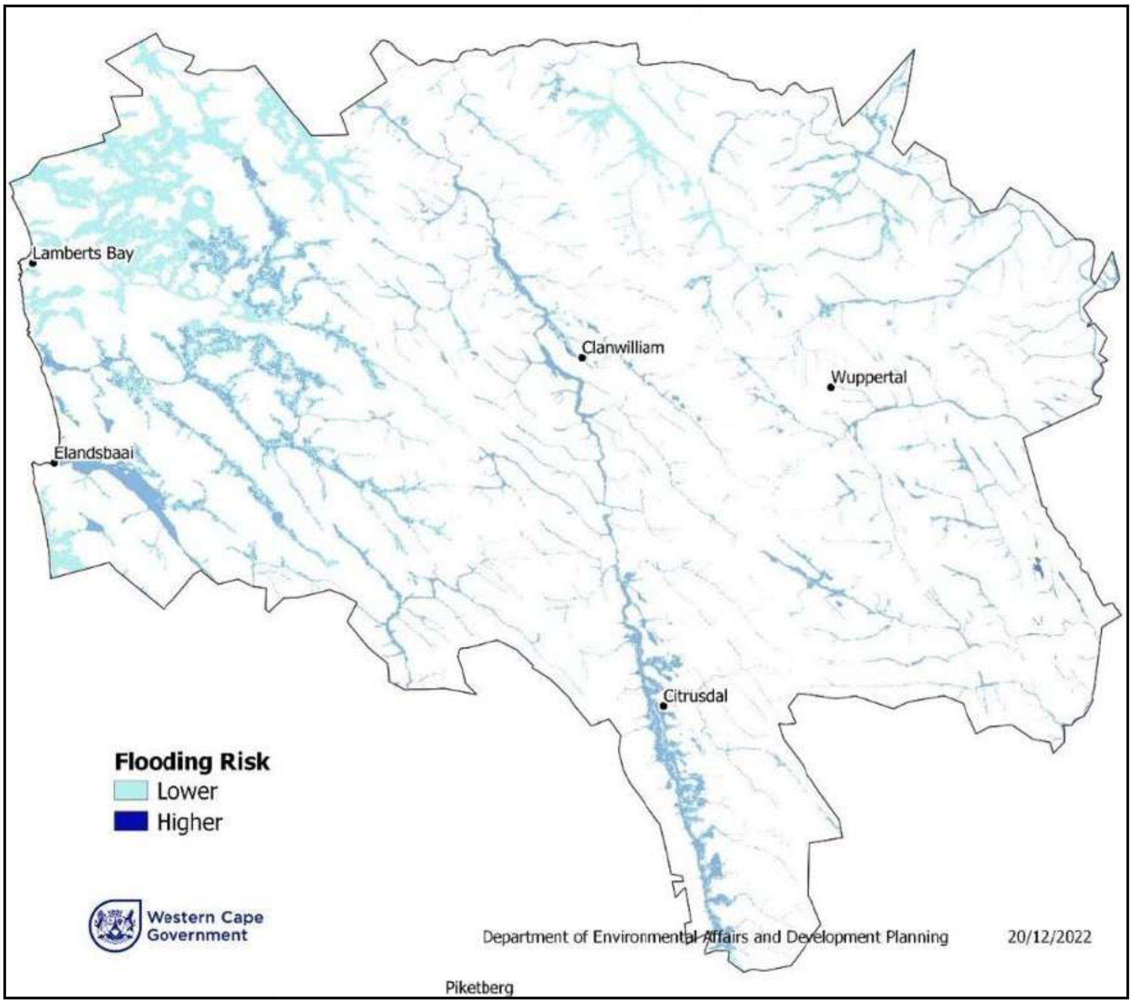
Two settlements that are regularly flooded are Citrusdal and Bulshoek.

5.4.2 Projected and Anticipated Changes to the Climate

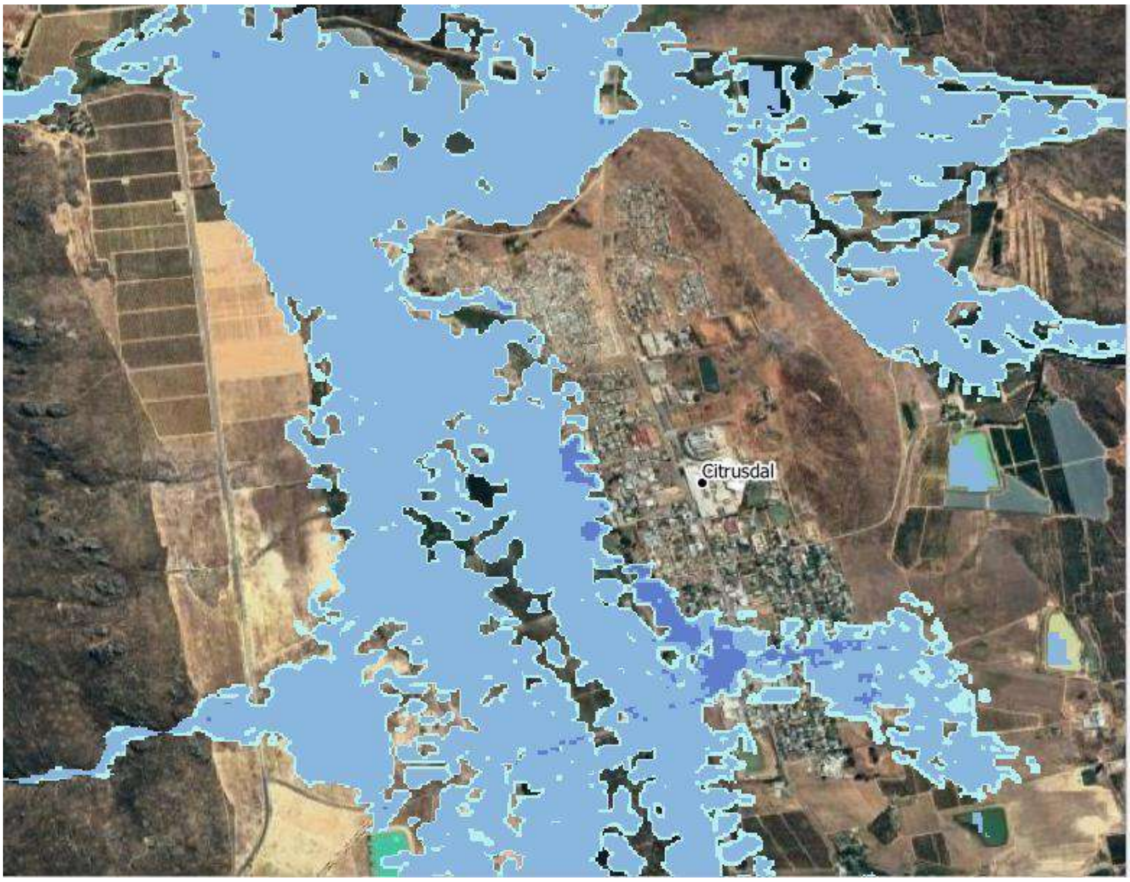
Flood prediction and forecasting are limited to flagging areas where terrestrial flooding and flood risk are generally higher due to inherent local characteristics. It is not local-scale flood forecasting or calculation that incorporates meteorological data and employs hydrological modelling. Rather the risk of flooding impacts and socio-economic vulnerability and governance is considered.

The soil disruptions due to mining activities could introduce additional risk as these may progressively develop into flood plains. Sand mining is the only form of mining practised and there are three operating sand mines around Citrusdal and Clanwilliam. Mining in the Cederberg is already limited as the most important sand deposits in the Cederberg are Hillwash and Colluvial Sand. These sands have been moved downslope under the influence of gravity and by surface wash during major storms which cause saturation of the soil (followed by surface runoff). These areas therefore also increase the risk of erosion and diversion of rivers and streams towards settlements.

Map 17: Flood Risk in Cederberg, as a composite of likely flood area, flood likelihood and vulnerability (DEA&DP, 2022)



Map 18: Flood risk in and around Citrusdal (DEA&DP, 2022)



5.4.3 Prevention, Adaptation and Sector Response Plans

An initial step towards improving the resilience of settlements situated along flood plains is the close coordination across municipal departments to upgrade at-risk infrastructure such as roads, (electricity and water) distribution networks. This includes critically looking at infrastructure design and placement in areas at risk to flooding. The municipality should review their monitoring processes and enforcement protocols related to the Cederberg SDF guidelines regarding developments along riverbanks and flood plains. The municipality should also review watercourse and catchment management processes in general.

Improving the preparedness of the community by deploying early warning systems for the community and disaster response teams will help minimise life-threatening incidents during flood seasons. Preparedness may include conducting evacuation drills within communities that are most susceptible to flooding as the climate changes, either due to their proximity to rivers or the landscape.

Like coastal settlements, the following structural modifications can be implemented in areas along riverbanks to minimise flood-related impact on local settlements:

- Apply reinforcement structures such as breakwaters and dolosse to dissipate the kinetic energy of rivers;
- Apply alternative riverbank stabilising technique, such as planting suitable vegetation (salt-tolerant plants with extensive root systems) along the banks to reinforce the soil;
- To minimise soil erosion and landslides due to local mining activities, ensure that land use guidelines in the Cederberg SDF governing mining activities significantly align with climate change objectives and initiatives;
- Conduct thorough assessment of previously mines areas and rehabilitate to prevent further erosion and land shifts, as well as the formation of flood plains.

5.5 Disaster Risk Reduction & Management

5.5.1 Status Quo

Disaster risk reduction and management are important for climate change adaptation as they both address vulnerability to climate change-related impacts. Disaster risk reduction aims to prevent or minimize the impact of disasters before they happen, whereas disaster management focuses on responding to and recovering from disasters. Resilience to climate change-related extreme events should be region-wide and across municipal boundaries.

South Africa's Disaster Management Act sets out a comprehensive approach to disaster management and it identifies the roles and responsibilities of key institutions and disaster management agencies. In addition, the Act establishes a National Disaster Management Centre whose role is to address disaster prevention, coordinate disaster management agencies and capacity across government and ensure that critical information is disseminated speedily.

5.5.2 Projected and Anticipated Changes to the Climate

Climate change will increase the number of extreme weather events in the Cederberg such as:

- Extreme drought;
- Flooding of rivers;
- Flash flooding of riverbeds in mountainous areas;

- Increase risk of veldfires due to increase in dryness of vegetation;
- More extreme storms that can lead to more rainfall in a short period of time;
- Rise of sea levels;
- More persistent heatwaves.

5.5.3 Adaptation and Sector Response Plans

Prevention and adaptation responses include:

- Early warning systems:
    - Continue to develop and improve its early warning systems for weather and climate (especially severe weather events) and pest infestation events and to ensure that these warnings reach potentially affected populations timeously. To this end, we will investigate and implement plans to use the mass media and appropriate information and communication technologies to alert vulnerable populations;
    - Seek to collaborate with our neighbouring municipalities to share early warning systems with regional applications and benefits;
    - Promote the development of Risk and Vulnerability Service Centres at universities, which will, in turn, support resource-constrained municipalities;
    - Facilitate increased use of seasonal climate forecasts among key stakeholders such as those in the water and agricultural sectors;
    - Maintain, update and enhance the SARVA as a tool that provinces and municipalities may use to inform their climate change adaptation planning.
- Community preparedness:
    - Implement clear preparedness and response planning, including drills for worst-case scenarios with emergency response teams;
    - Conduct priority testing and replacement of weak or damaged infrastructure located in areas most susceptible to extreme climate conditions and in vulnerable communities;
    - Identify and ensure the availability of alternatives (essential supplies, water, energy, food and access roads) during extreme weather conditions;
    - Collaborate with social networks such as community organisations, non-governmental organisations (NGOs), women and farmers organisations, and the Adaptation Network to help raise awareness to transfer technology and build capacity;
    - Develop mechanisms for poor communities to recover after disasters, including micro-insurance.
- Infrastructure design and master planning:
    - Municipal departments overseeing infrastructure construction, operation and maintenance must conduct master planning based on expected climate change impact;
    - Municipal departments responsible for infrastructure construction testing should conduct sensitivity assessments of current and planned infrastructure and review operating and design standards, and safety factors;
    - Apply “build back better” strategies in disaster recovery. In other words, rebuild communities and infrastructure in a way that enhances resilience and sustainability after disasters.

5.6 Health

5.6.1 Status Quo

The South African health sector is one of the five key priorities of government. A significant proportion of South Africans, and particularly the poor, already have serious and complex health challenges compounded by poor living conditions. These include among the world's highest rates of tuberculosis and HIV infection. The links between the environment, food security and the infectious profiles of communities and regions have been well established.

5.6.2 Projected and Anticipated Changes to the Climate

The effects of climate change on human health are mostly indirect, and not easily quantified as their manifestation is complex. Physical health impacts and risks by Bunyavanich *et al.* 2003, and mental health risks by Barnwell (2021) are tabulated below:

Table 5: Major health effects of climate change

Phenomenon	Human Health Impact	Additional Child-specific risks
Fewer cold days & nights.	Fewer cold-related deaths.	Children will benefit.
Increased frequency of warm spells & heat waves.	Increased heat-related deaths & illness.	Very young at higher risk of death, older children will have more heat stress due to time spent outside during exercise.
Increased heavy precipitation events.	Increased risk of injury, death, as well as infectious respiratory and skin diseases.	Very young vulnerable to hospitalisation and complications from infection.
Increased drought, and wildfires.	Increased risk of food & water shortage, malnutrition & infection, concentration of toxic water pollutants, injury and death.	Growth retardation, developmental delays.
Increased air pollution: burned fossil fuels & stagnant air episodes.	Exacerbation of respiratory illness, premature mortality.	Children's small airways are more susceptible to asthma and infection.
Changes in distribution & potency of allergens & mycotoxins.	Ore severe and more prevalent allergies.	Allergies, cancer, birth defects.
Increased sea level, saltwater intrusion into freshwater.	Abrupt coastline change, forced migration, injury, drowning.	Disruption of family & school infrastructure, other social disruption.
Lack of food security.	Decline in nutritional status & lower resistance to HIV/ AIDs & tuberculosis.	More orphans. Malnourished children (Kwashiorkor & Marasmus).
Sick and elderly household members increase.	Women, primary caregivers take more strain: less time to earn a livelihood. Neglect own health in prioritising the health of others.	
More tropical weather.	Increased vector-borne diseases like malaria, rift valley fever and schistosomiasis may spread, requiring a concomitant expansion of public health initiatives to combat these diseases.	
One or more of these phenomena	Profound negative psychological and mental health consequences, including ecological grief, climate trauma, depression, anxiety, and so on.	

5.6.3 Prevention, Adaptation and Sector Response Plans

Considering that the health-related impacts are indirect, a multi-dimensional approach is necessary to ensure the long-term resilience of the population.

- One apparent approach for mitigating adverse effects on human health is to put sufficient response mechanisms in place for different crisis scenarios (e.g. floods, droughts); specifically tailored for the unique needs of each Cederberg district type, and place emphasis on empowering the local community to respond when taking into consideration their relative distance from central municipal districts;
- Increasing the preparedness of disaster management and health personnel and facilities to respond to outbreaks will also minimise the long-term impacts of climate change phenomenon on human health;
- Deploying extensive research initiatives aimed at a) early risk identification to enable early response or long-term trend spotting; and b) finding novel solutions to combat health pandemics and thus increase the resilience of the population;
- Timely implementation of the measures identified for minimising impact on the biological and physical environment ensure long-term prevention of some of the risks to human health discussed above.

5.7 Agriculture

5.7.1 Status Quo

Geology & Soils are characterized by sandy loam to clay soils generally derived from shales and mudstones of the Cederberg Formation. Cederberg soils are highly leached acid sands, low in nutrients with a low moisture retaining capacity.

Agricultural cultivation: is mostly intensive; it comprises irrigated citrus and mango orchards, potato and rooibos tea fields, small grain, limited vineyards and some commercial pine plantations around Algeria forest station. In the Cederberg, 65% of the total arable land area (as per Cederberg SDF, 2017 – 2022) is under cultivation. In 2018, 27% of the cultivated land, or 54 892ha, was cultivated:

- 3 424ha vegetables (irrigated);
- 11 345h orchards (irrigated);
- 33 972ha tea, tobacco and hops (dryland / partially irrigated);
- 6 152ha was planted with grains, oils seeds and Lupines (dry land).

Income from vegetable production and deciduous fruit constituted the largest contribution to South Africa's gross income from horticultural products in 2008, whereas citrus fruit was South Africa's top exported agricultural product in 2020/2021. Cederberg's vegetable crop coverage contributes 21.3% to that of the West Coast 45% coverage of the total hectares of vegetables cultivated in the Western Cape. Cederberg's orchard coverage contributes 13.9% to that of the West Coast's 23% cover of the total hectares of orchard cultivated in the Western Cape.

Horticulture is a key sector in the Western Cape, contributing 43% to the region's gross farming income and 18% to South Africa's total gross farming income (Western Cape, 2021).

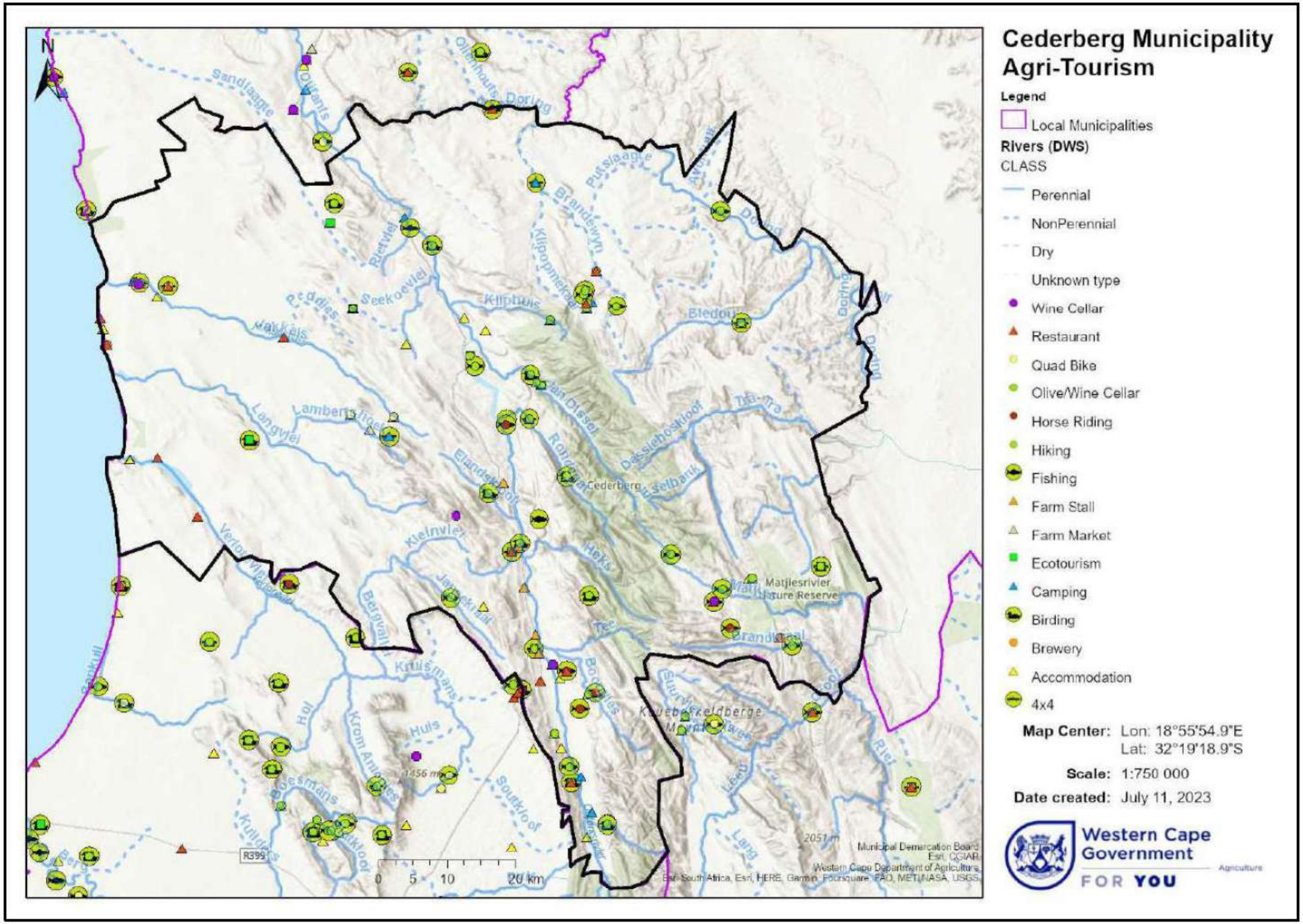
Small-scale farming or subsistence farming is limited.

Agri-processing is largely represented by, but not limited to, Rooibos tea and wineries.

In the Cederberg, agriculture contributes 18.7% of GDP and 42% to employment. Crop failures will therefore have a significant economic impact.

Agri-Tourism: As a wilderness area, the primary activity is eco-tourism, including camping, rock climbing and hiking. The Cederberg hosts numerous day and overnight hikes including the popular and spectacular Wolfberg Arch, Wolfberg Cracks and the Maltese Cross. The area is also home to an amateur astronomical observatory, which regularly hosts open evenings for the public. The agricultural productive landscape together with the magnificent scenery including the mountains, coast and wilderness area, forms the basis of its tourism industry. Several farms predominantly function as tourism farms catering to the local and international tourist market.

Map 19: Cederberg Agri-tourism (Cederberg SDF, 2023-2027)



5.7.2 Projected and Anticipated Changes to the Climate

Agriculture, being the largest consumer of water (through irrigation), is highly vulnerable to changes in water availability, increased water pollution (particularly from toxic algal or bacterial blooms) and soil erosion from more intense rainfall events and increased evapotranspiration.

Climate change will affect agriculture in the context of multiple interacting drivers and pressure points. Agriculture is highly dependent on effective risk management that covers all three sustainable components: economic, environmental and social components. The Western Cape is likely to remain a strong agricultural region, at least in the short to medium term, if planning takes the future climate into account and appropriate support is provided.

The agricultural sector can broadly be divided into three main clusters: animal production, field crops and horticulture.

Field Crops: The profitability of wheat production is highly climate dependent. According to Schulze (2007, as cited in Lötter, 2010), the predicted 2°C increase in temperature and a 10% reduction in rainfall could reduce profits of wheat by around R500/ha, which is equivalent to a yield reduction of 0.5 t/ha. Jack et. al (2022, p. 32-33) also predicted temperatures increases of more than 2˚C and a 20% decrease in rainfall along the Cederberg to Sandveld region between 2000 and 2060. Depending on the extent of warming and drying, the Cederberg—and other wheat-producing regions in marginal areas of the winter rainfall region—can expect losses of 15 to 60% by 2030-2050 (Midgley et al., 2007, as cited in Lötter, 2010).

Tea cultivation in the Cederberg contributes to 57% and 58% of the provincial and West Coast tea and Tabaco cultivation respectively. According to Lötter and le Maitre (2014), the range of both wild and cultivated tea (from Nieuwoudtville in the Northern Cape, south toward Piketberg) is likely to contract substantially, with some range shifts upslope and in a southeasterly direction.

Another significant threat of climate change for field crops will be changes in the distribution and intensity of pest species, the spread of diseases and the growth of weeds.

Horticulture: The sector includes deciduous fruit, citrus fruit, vegetables, viticulture and subtropical fruit.

The expected increase of 2°C in temperature will cause many agriculturally significant areas of the country to experience a 15 to 35% increase in heat units, especially in the higher-lying mountainous areas in the southern and eastern parts of the country (Schulze, 2007, as cited in Lötter, 2010) i.e. Olifants River Mountains and Cederberg.

Similarly, a significant decrease is predicted in the accumulation of chill units, which are highly sensitive to climate change-induced warming. This will have extensive implications for the deciduous fruit industry of the Western Cape, including the Cederberg.

Citrus is completely dependent on water that may be less readily available. The anticipated change in chill and heat unit accumulation may bring about shifts in traditional fruit-producing areas, gradually giving way to other varieties or crops.

Viticulture is expected to be more resilient to warming and drying trends. However, non-irrigated grapevines are expected to suffer slight to severe losses depending on the extent of warming and changes in rainfall amounts and distribution patterns.

The notable threats to overall horticulture include inadequate quantity of water for irrigation and changing patterns of pests and diseases. Dry ground horticultural crops (ex. Rooibos) will experience terrain shifts in suitable production areas, with warmer and drier areas decreasing and new areas that are currently too cold or wet becoming suitable.

Livestock and pastures: Further decline in water availability in these water-stressed areas is likely to impact carrying capacity and may lead to severe livestock loss and a decline in overall productivity.

Heat stress is another important factor in livestock production and can cause decreased milk production and poor reproductive performance in dairy cows, with significant economic implications. Conversely, the projected general increase of minimum temperatures might alleviate cold weather stress on livestock as warm nights increase and cold nights decrease. Extensive livestock production (cattle, sheep, goats and ostriches) will be mainly affected by changes in pasture crops and fodder production.

Emerging, small-scale and resource-poor farmers are particularly vulnerable to climate change and variability because they have fewer capital resources and management technologies at their disposal.

Agri-businesses in areas where agricultural systems are already under stress economically or biophysically, where crops are nearing climate tolerance thresholds, or where multiple stresses exist, are at the highest risk (DEADP, 2008).

Agritourism is likely to be indirectly affected given the West Coast's popularity for camping and birding and the Cederberg's popularity for hiking, rock face climbing, mountain biking and water skiing.

Global warming is projected to alter agricultural productivity, and have important implications for pest and disease management, farming systems, day-to-day management and food security, and livestock selection for a specific locality, as well as cultivar choices and cropping calendars.

Predicted changes in climate are expected to:

- Modify agricultural productivity across different farming regions;
- Alter the spatial distribution of climatically suitable growing areas, with certain areas benefiting, while others may find themselves at a disadvantage;
- Impose new management practices or adjustments to existing operations;
- Result in a shift in agricultural trade patterns; and
- Identify new crop opportunities with certain crops having competitive advantages/ disadvantages over others (Schulze, 2007, as cited in Lötter, 2010).

5.7.3 Mitigation, Adaptation and Sector Response Plans

Adaptation and mitigation strategies should therefore take into consideration the crop types that are predominantly cultivated within the Cederberg region. The potential damage to agricultural infrastructure due to the generic risks of floods, droughts, hail, frost and fires should also be accounted for in the planning process.

Objective	Project
Planning for climate change and variability	Improve risk management, disaster and insurance planning, and integrate agricultural monitoring with climate monitoring systems.
	Implement evidence-based monitoring initiatives that feed into management systems for crop production.
	Promote knowledge generation, knowledge sharing, stakeholder participation and awareness-raising in crop (grain, viticulture, fruit) production.
	Commission research to improve understanding of climate change impacts on crop (grain, viticulture, fruit) production.
	Partner with the private sector to research and implement advanced (technology-driven) crop monitoring tools and techniques
	Work with research institutions to research and identify drought-resistant crops that can be implemented.
Sustainable/Adapted land and water management	Implement irrigation and scheduling technology and identify new (sustainable) water sources for irrigation.
	Coordinate with national departments to encourage the co-use of low-yield agricultural land for renewable energy installations to diversify of municipal income stream and broaden the tax base.
	Promote knowledge generation, knowledge sharing, stakeholder participation and awareness-raising regarding the alternative crop cultivation areas and production techniques in the western cape.
	Generate and share scientific, social and indigenous knowledge that will minimise the loss of areas suitable for specific crop (fruit, grain etc.) growth.
	Identify climate-resilient uses that will support the agricultural industry's efforts to exploit new agricultural opportunities, new areas and new crops thus reducing climate change impacts on current agricultural potential.
	Promote organic production to minimise adverse effects of pesticides and fertilisers on soil and water sources.
	Apply mixed farming and diversification to improve soil conditions for optimal crop yields.
Manage increasing risks to livestock	Commission research and improve understanding of climate change impacts on livestock and land availability.
	Continually adapt livestock breeding and breed selection techniques, and vulnerability to pests and disease to reflect ecological changes over time.
	Develop a framework that will assist and educate farmers with adjusting to reduced rainfall.
	Generate and share scientific, social and indigenous knowledge that will assist with adapting to the reduction in herbage yields.
	Improve collaboration and partnership on existing programs (e.g. LandCare Programme, EPWP and River Health Programmes)
	Strengthen livestock management plans, to enable continuous monitoring of water and herbage availability for livestock.

6. Policy Context

The following table summarises the primary policy and planning instruments as well as legislative mechanisms with which the Cederberg Climate Change Plan is to be aligned.

The comprehensive summary of the relevant legislation in shaping the Cederberg municipality's Climate Change Plan on International, National, Provincial, District and Local levels are presented in the table below.

Table 6: Climate Change Legislation, Policies and Frameworks

	Climate	Hydrology and Water Security	Biodiversity and Ecosystems	Air Quality	Coastal Zone and Fisheries	Wildfires	Water and Sewerage Services	Energy Sector	Solid Waste Management	Municipal Capacity	Rural Settlements	Coastal Settlements	Terrestrial flooding	Disaster Risk Reduction and Management	Health	Agriculture
UNFCCC	X															
Third National Communication	X															
COP26	X															
International Carbon Action Partnership	X															
Sendai Framework for Disaster Risk Reduction (2015-2030)														X		
The Paris Agreement (2016)	X															
Nationally Determined Contribution (NDC)	X															
Convention of Biological Diversity			X													
Climate Change Act (2022)	X															
National Development Plan Chapter 5: "Transition to a Low-Carbon Economy";	X							X	X							
National Climate Change Adaptation Strategy (2020)	X															
National Climate Change Response Policy (2011);	X															
National Environmental Management Act (NEMA);	X	X	X											X		
Medium-Term Strategic Framework: Programme Environmental Management and Climate Change;	X															
National Water Resources Strategy;		X														
National Disaster Management Act;														X		
National Disaster Management Framework;														X		
National Drought Management Plan;		X														
National Disaster Management Framework under the Disaster Management Act of 2002;														X		
National Agriculture Strategic Framework (2018);																X
National Water Act;		X														
Conservation of Agricultural Resources Act (CARA);																X
Land Reform Act;																
Just Transition Framework;																

	Climate	Hydrology and Water Security	Biodiversity and Ecosystems	Air Quality	Coastal Zone and Fisheries	Wildfires	Water and Sewerage Services	Energy Sector	Solid Waste Management	Municipal Capacity	Rural Settlements	Coastal Settlements	Terrestrial flooding	Disaster Risk Reduction and Management	Health	Agriculture
National Climate Risk and Vulnerability (CRV) Assessment Framework;	X													X		
National Biodiversity Strategy and Action Plan (2015);			X													
Strategic Framework & Overarching Implementation Plan for Ecosystem-based Adaptation (EbA) in SA (2016-2021);			X													
Ecosystem-based Adaptation Strategy 2016-2021;			X													
Water and Sanitation Climate Change Policy (2017);	X	X					X									
Climate Change Adaptation and Mitigation Plan for the South African Agriculture and Forestry Sectors;	X															X
Biodiversity Sector Climate Change Response Strategy (2014);	X		X													
Climate Change Adaptation Plan for South African Biomes (2015).	X		X													
Western Cape Climate Change Response Strategy: Vision 2050, 2022;	X	X	X													
Western Cape Municipal Energy Resilience Initiative;								X		X						
Sustainable Water Management Plan;		X					X									
Electric Vehicle Fleet Transition;								X		X						
2050 Greenhouse Gas Emissions Mitigation Pathway;	X			X												
Provincial Air Quality Management Plan;				X												
Provincial Waste Management Plan;									X							
Provincial Biodiversity Strategy and Action Plan;			X													
Biodiversity Spatial Plan;			X													
Protected Area Expansion Strategy;	X		X													
Sustainable Public Procurement Programme;							X		X	X						
Western Cape Climate Change Response Strategy Implementation Plan, 2022;	X	X	X		X	X		X	X					X	X	X
SmartAgri Plan (2016);	X															X
SmartAgri: Updated Climate Trends and Projections for the Western Cape, 2022 (SmartAgri Plan);	X															
Western Cape Government Strategic Plan: PSG4		X														

	Climate	Hydrology and Water Security	Biodiversity and Ecosystems	Air Quality	Coastal Zone and Fisheries	Wildfires	Water and Sewerage Services	Energy Sector	Solid Waste Management	Municipal Capacity	Rural Settlements	Coastal Settlements	Terrestrial flooding	Disaster Risk Reduction and Management	Health	Agriculture
Western Cape Government: Agriculture Strategic Plan;			X													X
Western Cape Government: Environmental Affairs and Development Planning Strategic Plan	X	X	X		X				X	X						
Western Cape Climate Change Strategy & Implementation Framework;	X	X	X		X	X		X	X					X	X	X
Provincial Strategic Plan;										X						
Western Cape Provincial Disaster Management Framework														X		
Western Cape Green Economy Strategy Framework;								X								
Ecological Infrastructure Investment Framework.		X	X	X		X							X	X		
West Coast District Spatial Development Framework;	X	X			X		X	X	X	X	X	X	X	X	X	X
West Coast IDP;							X		X	X						X
West Coast Climate Change Plan, 2019;	X													X		
West Coast District Disaster Management Plan;						X								X		
Infrastructure Master Plans;							X	X	X							
West Coast District Environmental Management Plan;	X	X	X	X												
West Coast District Disaster Risk Assessment;	X					X							X	X		
West Coast District Municipality Regional Economic Development Strategy;										X	X					
West Coast District Municipality Air Quality Management Plan.				X											X	
Cederberg Spatial Development Framework (SDF);	X	X			X		X	X	X	X	X	X	X	X	X	X
Cederberg Waste Management Strategy;									X	X						
Cederberg Municipality Local Economic Development Strategy;										X	X					
Second Generation Coastal Management Program, 2024;			X		X							X				
Estuary Management Plans;			X		X									X		
Cederberg Disaster Management Plan, 2019.						X								X		

Ongoing projects to implement climate change policy:

Various projects are being commissioned by the relevant government departments to develop tools aimed at enhancing South Africa's ability to respond to current and future climate change impacts. One of these initiatives is the Environmental Risk and Vulnerability Mapping Project, as facilitated by the Department of Environmental Affairs and Development Planning, Directorate: Climate Change (DEA&DP, 2022). The main objective of the project is to generate a composite environmental risk map that highlights areas in the Western Cape where compound risks threaten people, their livelihoods and/ or infrastructure.

The data modelling conducted to create the composite environmental risk maps for seven different themes is discussed in Appendix 7.1.

7. Appendices

7.1 Appendix I – Risk Map Data Models

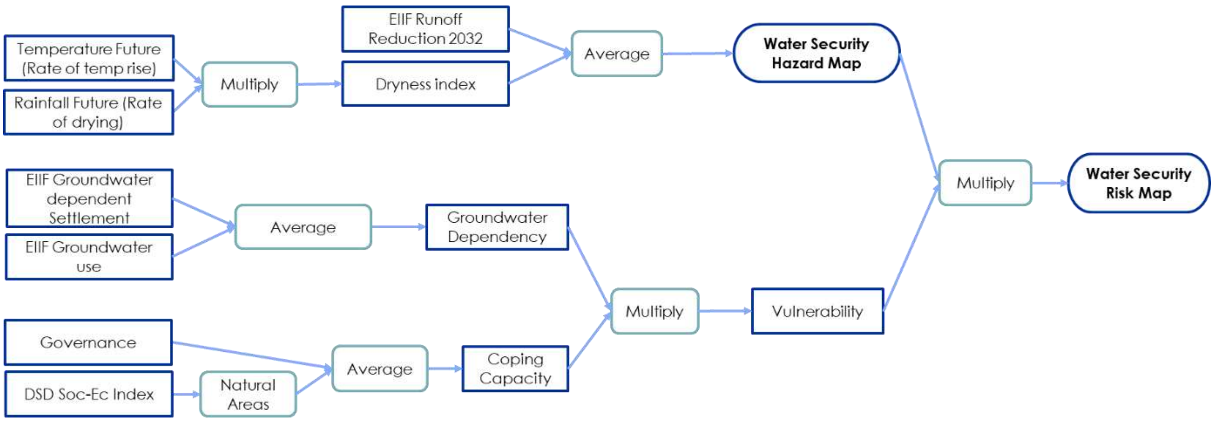
The following data models were utilised to map the environmental risk and vulnerability across the West Coast. Consideration is given to the following seven themes:

- Water Security (insufficient data currently prevents modelling of the desired risk);
- Air Quality and Health;
- Ecosystem Deterioration;
- Solid Waste Management;
- Coastal Erosion and Flooding;
- Wildfires;
- Terrestrial Flooding.

a) Water security risk index

The score is achieved by combining the 'hazard' of deteriorating catchments with the threat posed by a drying climate (a 'Dryness Index'), as well as a water security vulnerability score as per the figure below:

Figure 8: Revised water security threat data model



The vulnerability score is derived by combining the default socio-economic/ governance score with a groundwater dependency score obtained from the Ecological Infrastructure Investment Framework (EIIF) project of DEA&DP.

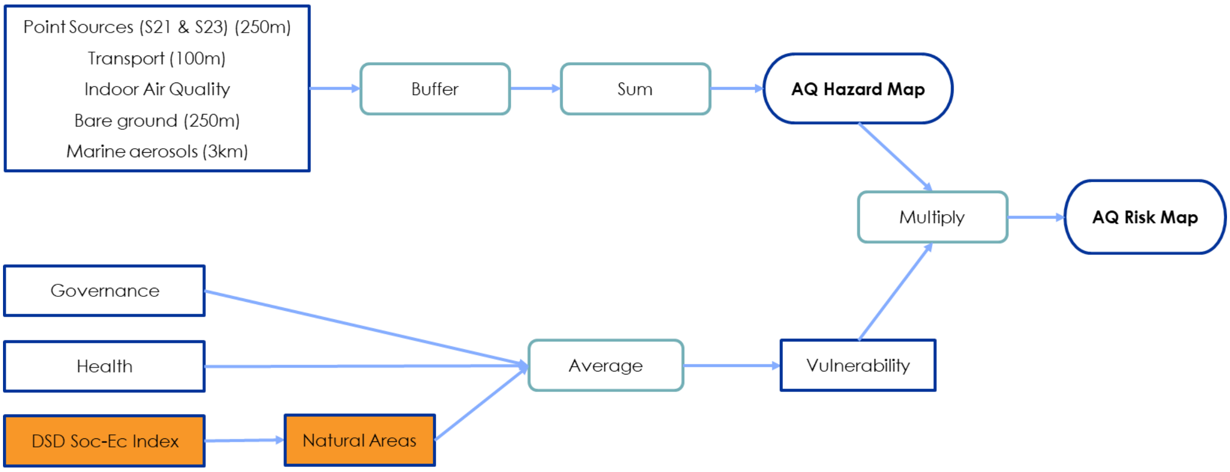
b) Air quality risk index

The index covers dimensions of vulnerability, socio-economic vulnerability and governance. Susceptibility to respiratory infection, on the other hand, is not mapped directly by authorities but is based on a health index compiled by the CSIR. This index was compiled at the census enumerator area scale to map COVID-19-related risks based on a combination of values for:

- Poverty;
- Age;
- Child mortality;
- HIV;
- Life expectancy.

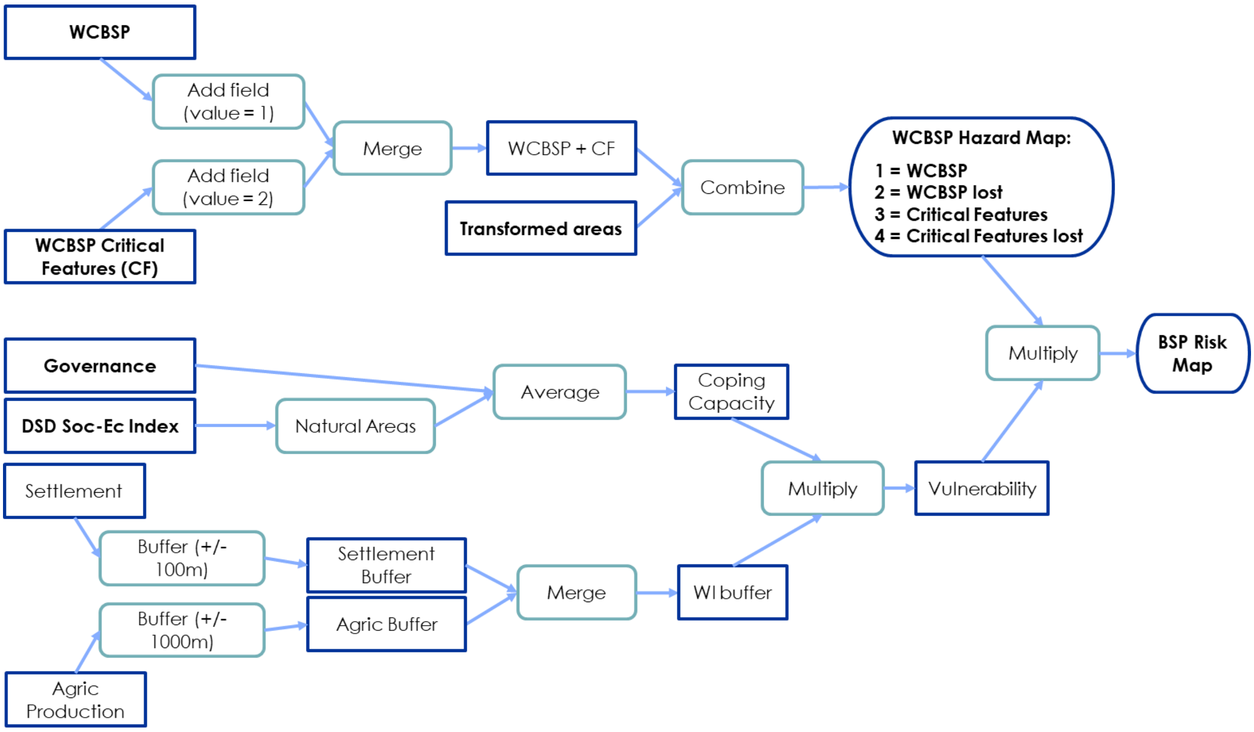
This index is used to highlight where communities are most likely to have high sensitivity to poor air quality from a health risk perspective. The GIS model used to generate the risk map is given below:

Figure 9: Data model for calculating and mapping air quality risk



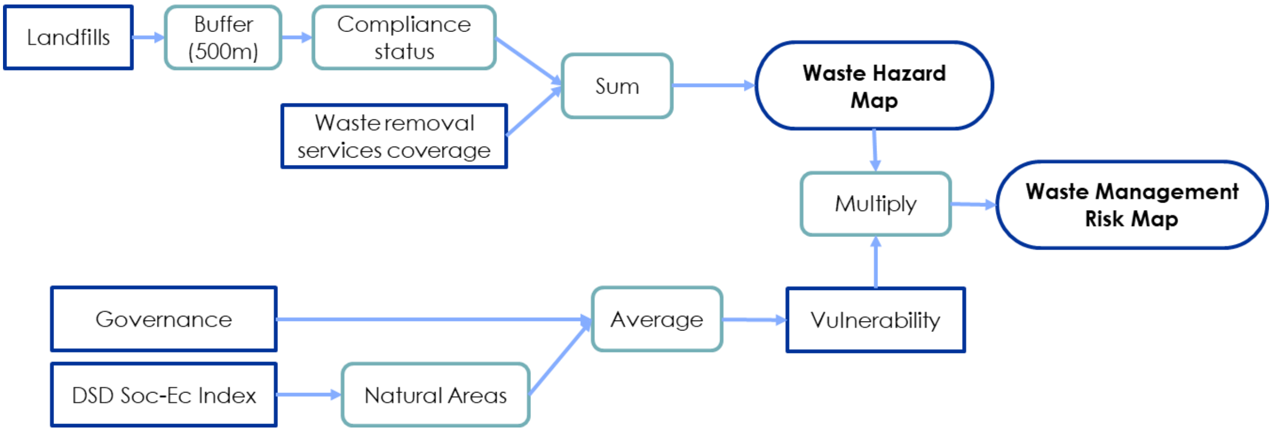
c) Ecosystem deterioration risk index

Figure 10: Data model for mapping ecosystem deterioration risk



d) Waste Management Risk Index

Figure 11: GIS model for mapping the risk emanating from solid waste

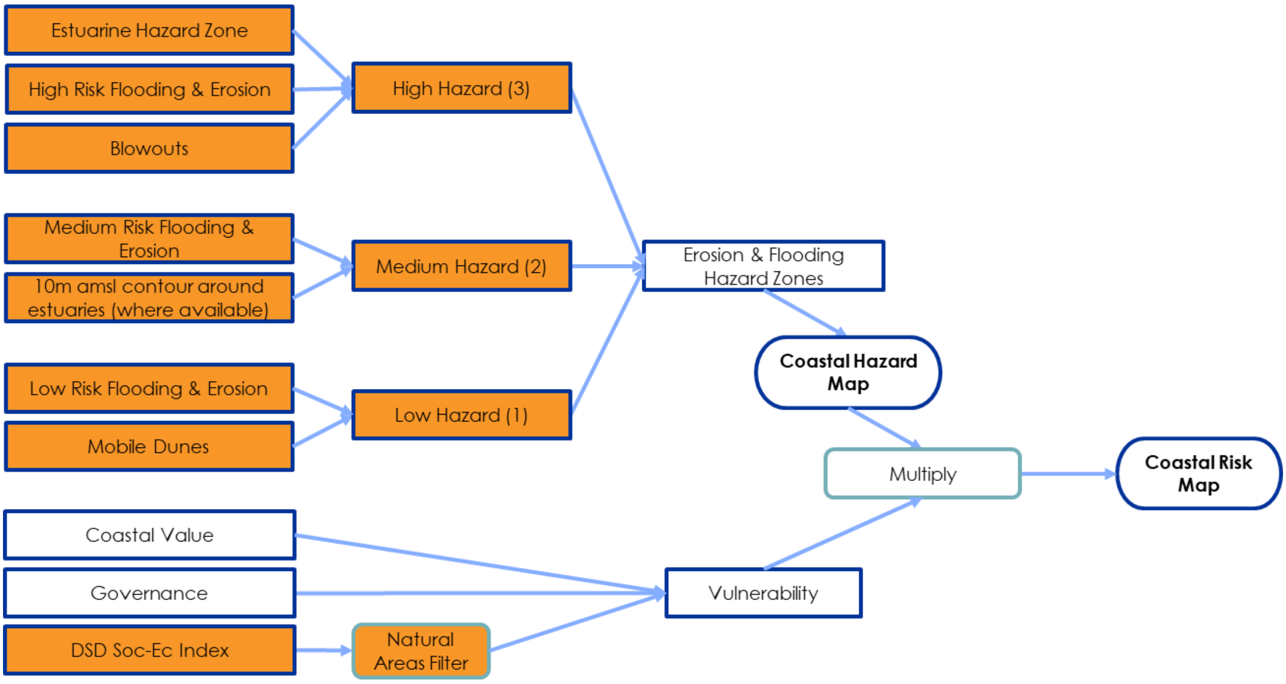


e) Coastal risk index

Vulnerability is expressed as a combination of two generic factors – socio-economic vulnerability and governance – along with an indicator related to the relative importance of coastal resource value to the local municipal context. This third variable is based on a score allocated to each coastal municipality based on the presence and importance of valuable coastal resources (beaches, industrial activity, harbours and rocky shores). This subjective score provides a relative comparison of the different municipalities.

The coastal risk is calculated by multiplying the hazard classes/scores (1-3) with vulnerability scores (0-10). The result is classified as low, medium and high risk using equal intervals. A schematic of the data model is provided in the figure below.

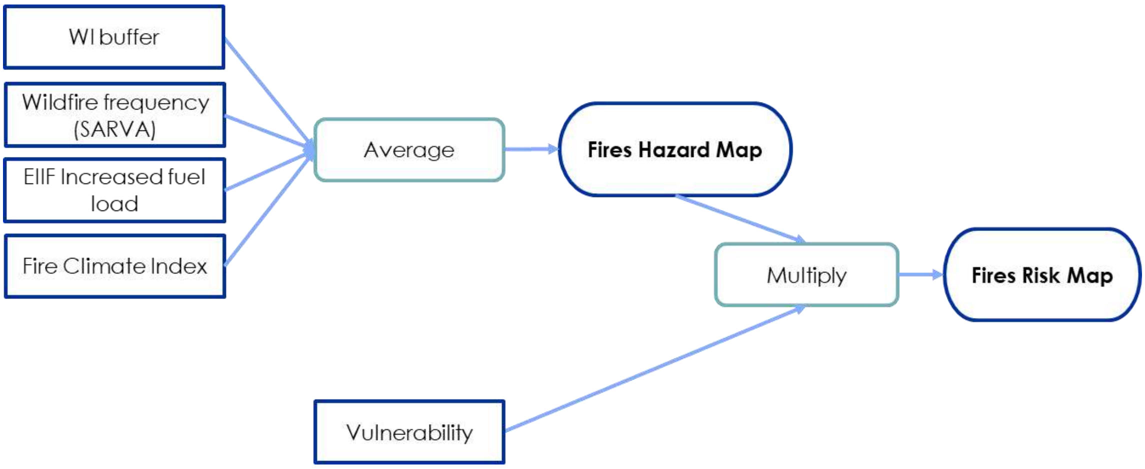
Figure 12: GIS data model for mapping coastal erosion risk



f) Fire risk index

The data model used to depict fire risk in the province is shown below.

Figure 13: Revised GIS data model for mapping wildfire risk

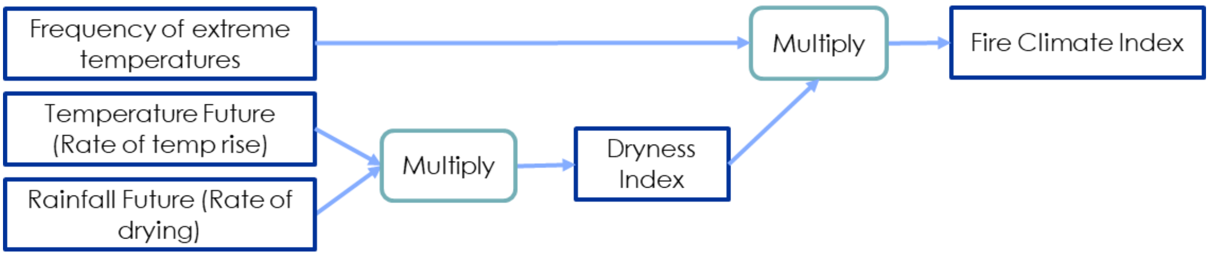


The Wildfire Hazard index is informed by:
Fire frequency in the period 2000 to 2016 - the South African Environmental Observation Network (SAEON) curated a dataset of fire occurrence for the period 2000-2016 as part of the South African Risk and Vulnerability Atlas (SARVA) data repository.

Fuel loads in catchments due to alien invasive plant infestation - infestation by invasive alien plants as calculated for the Ecological Infrastructure Investment Framework project of the Department of Environmental Affairs and Development Planning (dated 2020, and available from the Chief Directorate: Environmental Sustainability).

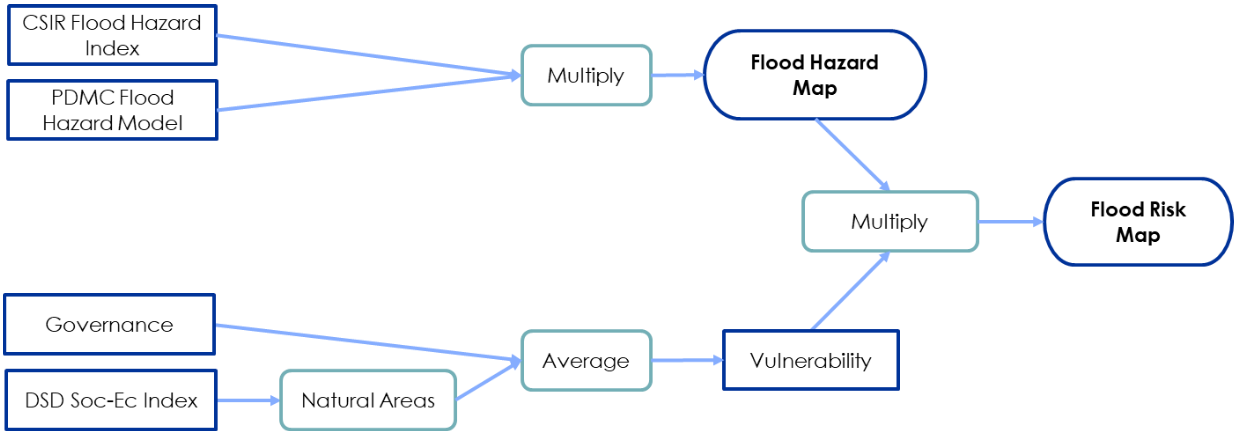
Wildland-urban and wildland-agriculture boundary:
A 'Fire Climate Index' is indicative of future climate conditions conducive to wildfire occurrence. The Fire Climate Index is generated as a composite of general rainfall decrease, general temperature increase as well as the frequency of extreme temperatures as per the figure below.

Figure 14: Climate change indicators informing wildfire risk



g) Flooding index

Figure 15: GIS model for the mapping of flooding risk



7.2 Appendix II - Adaptation Policies: Spatial Development Planning Categories

Policies that provide mitigation measures, are the Spatial Bioregional Planning Categories resulting from the Critical Biodiversity Framework and Coastal Management:

Sustainable development is generally defined as development that satisfies the needs of the current generation without jeopardising the ability of future generations to provide for their needs. The National Environmental Act, Act 107 of 1998, defines sustainable development as the integration of social, economic and environmental factors through planning, implementation and decision-making to ensure that development can support future generations. The following frameworks and policies promote sustainable development:

- *Critical Biodiversity Framework and Biodiversity Spatial Plan*
  The Western Cape Critical Biodiversity Framework (WCBF) (2010) integrates key biodiversity information relevant to land use such as Protected Areas, Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) into a single layer map. Data from the provincial Biodiversity Spatial Plan, 2017, was added to the map and municipal maps were generated and used to inform the development of the Bioregional Spatial Planning Categories maps for the Cederberg. These maps form the basis of the SDF maps (WCBA, 2021). This framework was updated in 2023 and adopted in 2024. The 2023 Western Cape Biodiversity Spatial Plan (WC BSP) is a provincial plan that is developed to inform the Provincial Protected Area Expansion Strategy, the Provincial Biodiversity Strategy and Action Plan (PBSAP) and policy and guideline development in terms of environmental legislation (Western Cape Biodiversity Spatial Plan, 2024).

- *Bioregional Spatial Planning Categories*
  The Bioregional Spatial Planning Categories (SPCs), consistent with the principles of bioregional planning and UNESCO's MaB (Man and the Biosphere) Programme have their origins in the Bioregional Planning Framework for the Western Cape. Bioregions can occur across municipal boundaries to provide meaningful geographical areas with common interests. The implementation of the categories is to support the conservation and integration of natural areas, e.g., nature reserves and biospheres (WCBA, 2021).

The Bioregional SPCs were translated by the Department of Environmental Affairs and Development Planning to SPCs as per the matrix below. An SPC map constitutes the basis of the Cederberg SDF and the Climate Change Plan at the local level.

Table 7: CBA and ESA Maps Categories, recommended corresponding Spatial Planning Category

Biodiversity information critical to ***land use*** vs. ***Spatial Planning*** Categories	**Protected Areas**	**CBA* 1**	**CBA 2**	**ESA* 1**	**ESA 2**	**ONA***	**NNR***
Core 1	■	■					
Core 2			■	■			
Buffer 1						■	
Buffer 2					■	■	
Intensive Agriculture							■
Settlement							■
Industry and Existing Mining							■

*(CBA – Critical Biodiversity Areas, ESA – Ecological Support Areas, ONA – Other Natural Areas, NNR – No Natural Remaining)

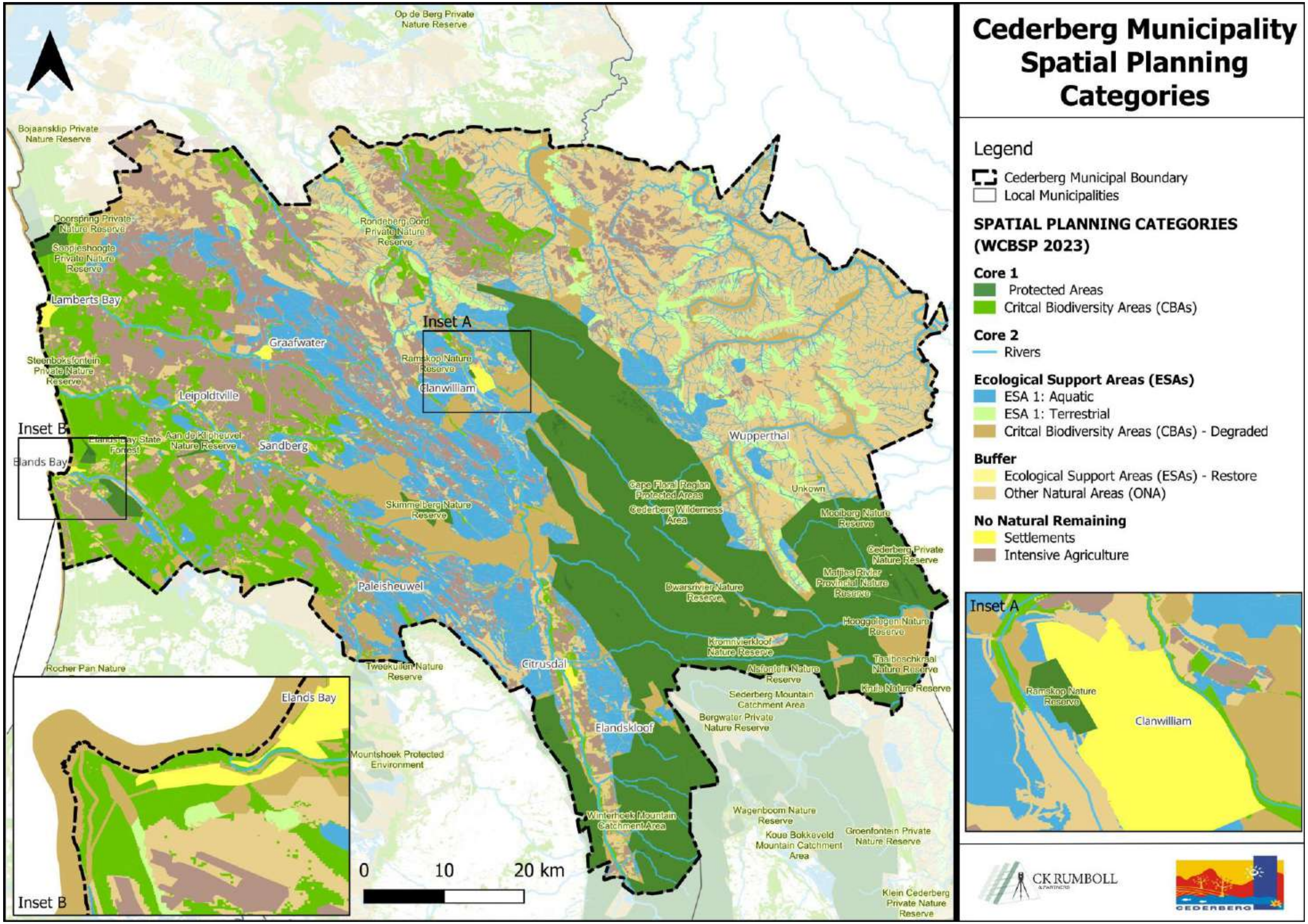
Table 8: Description of Spatial Planning Categories and recommended land use activities

Spatial Planning Categories	***Formal Conservation Status:***
Core 1: Wilderness Areas, & Critical Biodiversity Areas 1 - regardless of whether the area is in a rural, urban area or a formal conservation area.	No go area, only non-consumptive activities are permitted, e.g. passive recreation and tourism (hiking trails, bird watching) religious ceremonies, research and environmental education and associated buildings, no agriculture. Wilderness areas: Statutory and de facto wilderness areas serve as a 'benchmark' for environmental health and provide primitive, non-consumptive, non-mechanised outdoor recreation.
Core 2: Statutory Conservation areas, degraded critically endangered habitat areas & ecologically support areas 1, private conservation areas.	Biodiversity compatible and low impact conservation land uses as per Core 1 areas but allowing for a limited increase in the scale of development in less sensitive areas. Acceptable land uses are those that are least harmful to biodiversity and include compatible and low-impact conservation land uses as per Core 1. Areas, whilst allowing for a limited increase in the scale of development in less sensitive areas (provided ecological processes are not disrupted). To be informed by detailed site-level mapping of habitat conditions, transformation thresholds and cumulative impacts.
Buffer 1: Other Natural areas, public conservation, private conservation.	Biodiversity-compatible uses as informed by transformation thresholds, including low-density rural residential development, resort and holiday accommodation, tourist and recreation facilities, additional dwelling units, and renewable energy projects. Extensive agriculture: game and livestock farming: Public conservation areas: Public conservation areas with statutory conservation status - not qualifying for A-status, surrounding, or within Core Areas, e.g. contractual national parks, national monuments, local authority nature reserves. Private conservation areas: De facto conservation areas in private ownership, no statutory conservation status, but ideally within registered conservancies – protecting the integrity of core areas.
Buffer 2: Other Natural areas, ecological corridors, and rehabilitation areas.	Activities and uses directly related to primary agricultural enterprise, including a homestead, agricultural buildings and worker accommodation, additional dwelling units to limited 5 units. Additional land uses include small-scale holiday accommodation (farm stay, B&B, guesthouse, boutique hotel); restaurant, lifestyle retail, venue facility; farm stall &

	farm store; home occupation; local product processing (e.g. cheese making), and Tourist and recreational facilities (e.g. hiking trail, mountain biking, 4x4 routes). Ecological Core Areas or corridors: Natural linkages between ecosystems that contribute to the maintenance of natural processes, e.g. rivers, and continuous tracts of natural vegetation. Rehabilitation areas: designated for rehabilitation (i.e. conservation-worthy areas previously degraded by agriculture, mining, and forestry).
Intensive Agriculture Settlement	Activities and uses directly related to the primary agricultural enterprise, Farm buildings and associated infrastructure (e.g. homestead barns, farm worker accommodation, etc.). 5 Additional dwelling units. Ancillary rural activities of appropriate scale, avoid detracting from farming production but diversify farm income, and add value to locally produced products. Agricultural activities of an excessive scale (regional product processing) and non-agricultural activities not suited for location in the Intensive Agricultural and Buffer 1 and Buffer 2 areas to be located within settlements or their "fringe areas".

A SPC map has been developed for the Cederberg municipal area. Map 20, on the next page, shows the location of each of the SPCs within the Cederberg Municipal area.

Map 20: Cederberg Spatial Planning Categories



7.3 Appendix III – Adaptation Policy: Coastal Management Lines

Policies that provide mitigation measures, are the Spatial Bioregional Planning Categories resulting from the Critical Biodiversity Framework and Coastal Management:

Coastal management lines, commissioned by the Western Cape Department of Environmental Affairs and Development Planning in 2014, comprise the area below the coastal management line inclusive of all sensitive areas along the coast, both in terms of biophysical sensitivity and socio-economic value. The coastal management/setback line differentiates between areas along the coastline with existing development rights and future development options (within settlements) and those areas that should be left undeveloped due to high risk from dynamic coastal processes or as coastal public property. The following considerations determined the coastal management/setback line:

- *Environmental buffers* required inland to form the highwater mark to maintain a functional coastal ecosystem under future sea level rise scenarios;
- *Social buffers* are required along the coast which include public beach access through and along the coastal frontage areas which have cultural significance or heritage resources at historically sensitive locations that require specific management, for example, Mussel and Baboon Point and Doorspring/ Soopjeshoogte;
- Economic development requirements for the coast, for example, allowance for new beach facilities that will need to be placed closer than standard development to serve the public.

Table 9: Coastal Buffer Lines

Social Buffers			
Heritage resource	**Description**	**Location**	**Action/comment**
Mussel Point Midden and Baboon Point	Archaeological and rock art sites.	Baboon Point, Elands Bay.	CML to run landwards of the proclaimed heritage area. Further heritage assessments are required before CML is amended to include Mussel Point sites.
Doorspring / Soopjeshoogte	Shell middens x3 Soopjeshoogte.	Private Nature Reserve, north of Lamberts Bay.	Not a concern. A heritage impact assessment dated 1994, recommended northern part of the development proceed.

**CML - Coastal Management Line*

In ***rural areas,*** the coastal management/setback line follows the landward boundary of the long-term risk projections. Where necessary, a separate line can be drawn around existing development and development rights within the risk zone to protect the development rights. As it is not the intention to use the coastal management/setback line to impact existing development rights, the line is drawn seaward of properties abutting the shoreline with existing development or development rights in ***urban or developed areas*** as illustrated by the Coastal Management Setback Line and Zone in Elands and Lamberts Bay below:

Figure 16: Coastal Management Setback line and zone in Elands Bay and Lamberts Bay (Cederberg SDF, 2023-2027)

This Concept Coastal management/setback line for the Cederberg is included as an Annexure enabling the municipality to make informed decisions when considering development proposals along the coastline.

Coastal Management Overlay Zones:

Coastal management overlay zones refer to areas designated by risk modelling as subject to short-term (1:20 year), medium-term (1:50 year) or long-term (1:100 year) risk emanating from coastal processes such as coastal erosion, storm surges, sea level rise and storm wave run-up. Development in these zones is possible under certain circumstances and after appropriate environmental and risk assessments have been undertaken. Restrictions in this area can be applied strictly and consistently since it is informed by scientifically modelled coastal processes or hazard zones. Three Coastal Management Overlay Zones are proposed for WCD **urban areas**:

- High-risk zone – 20-year horizon – 0 metres above mean sea level;
- Medium risk zone – 50-year horizon – high-risk line to medium risk line;
- Low-risk zone – 100 years – medium risk line to low-risk line.

Figure 17: Application of LUMs Risk Zones Overlay Example (WCG, 2014)

In **rural areas**, the entire area between the 0m above mean sea level and the landward boundary of the low-risk (long-term risk) zone represents the coastal management overlay zone. This risk zone is expanded in places where littoral active zones are present, as these contribute to the risk of exposure to possible future coastal erosion.

Coastal Protection Zone:

The National Environmental Management: Integrated Coastal Management Act (ICM, 2008) makes provision for the demarcation of a zone adjacent to coastal public property that "plays a significant role in a coastal ecosystem". The ICM Act defines a default CPZ which, consists of a continuous strip of land, starting from the highwater mark and extending 100 meters inland in developed urban areas zoned as residential, commercial, or public open space, or 1000 meters inland in areas that remain undeveloped or that are commonly referred to as rural areas. These default boundaries may only be changed through a formal process of adjustment by the relevant Provincial MEC or National Minister.

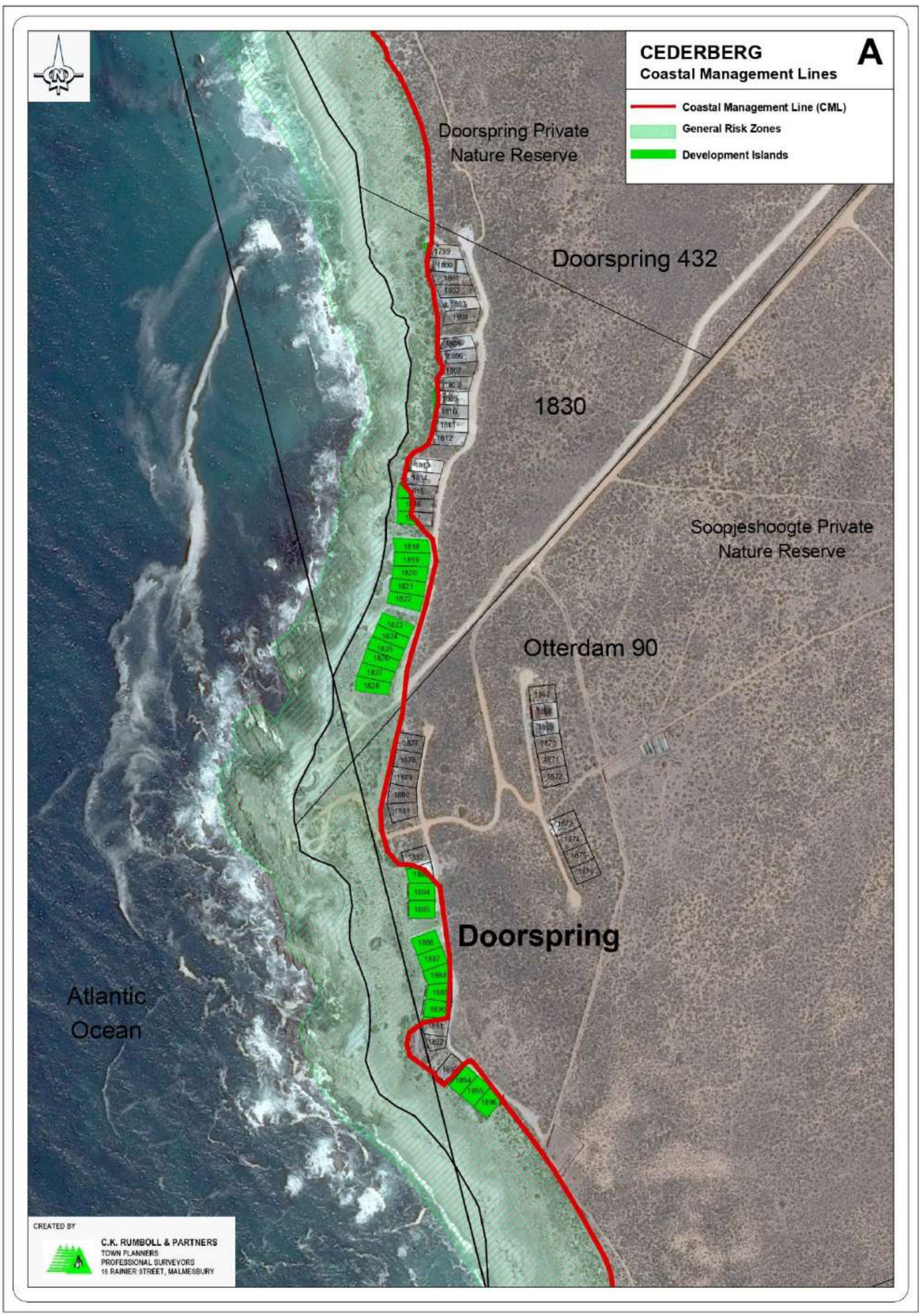
The coastal management lines and overlay zones should be included in the Cederberg Integrated Zoning Scheme after the identification and adoption of a Coastal Overlay Zone. The Coastal Overlay Zone will also form part of the Municipality's Climate Change Plan.

The SPLUMA principles and structural and spatial tools will be applied at regional (rural) and settlement levels to generate SDF proposals, which will include environmental-related proposals.

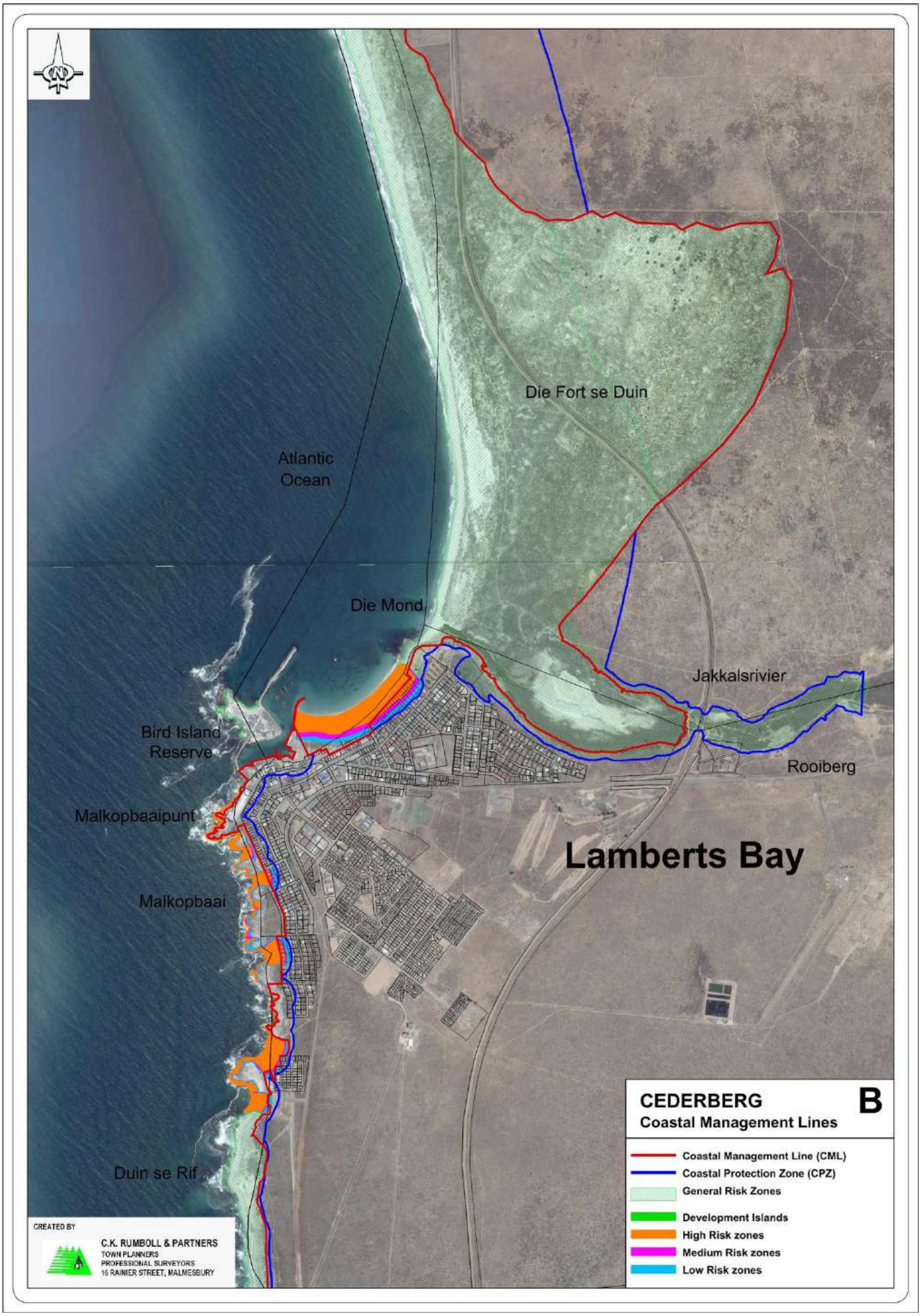
7.3.1 Coastal Setback Lines

Map 21: Cederberg Coastal Management Lines (Cederberg SDF, 2023-2027)

Map 22: Cederberg Coastal Management Lines: Area A (Cederberg SDF, 2023-2027)

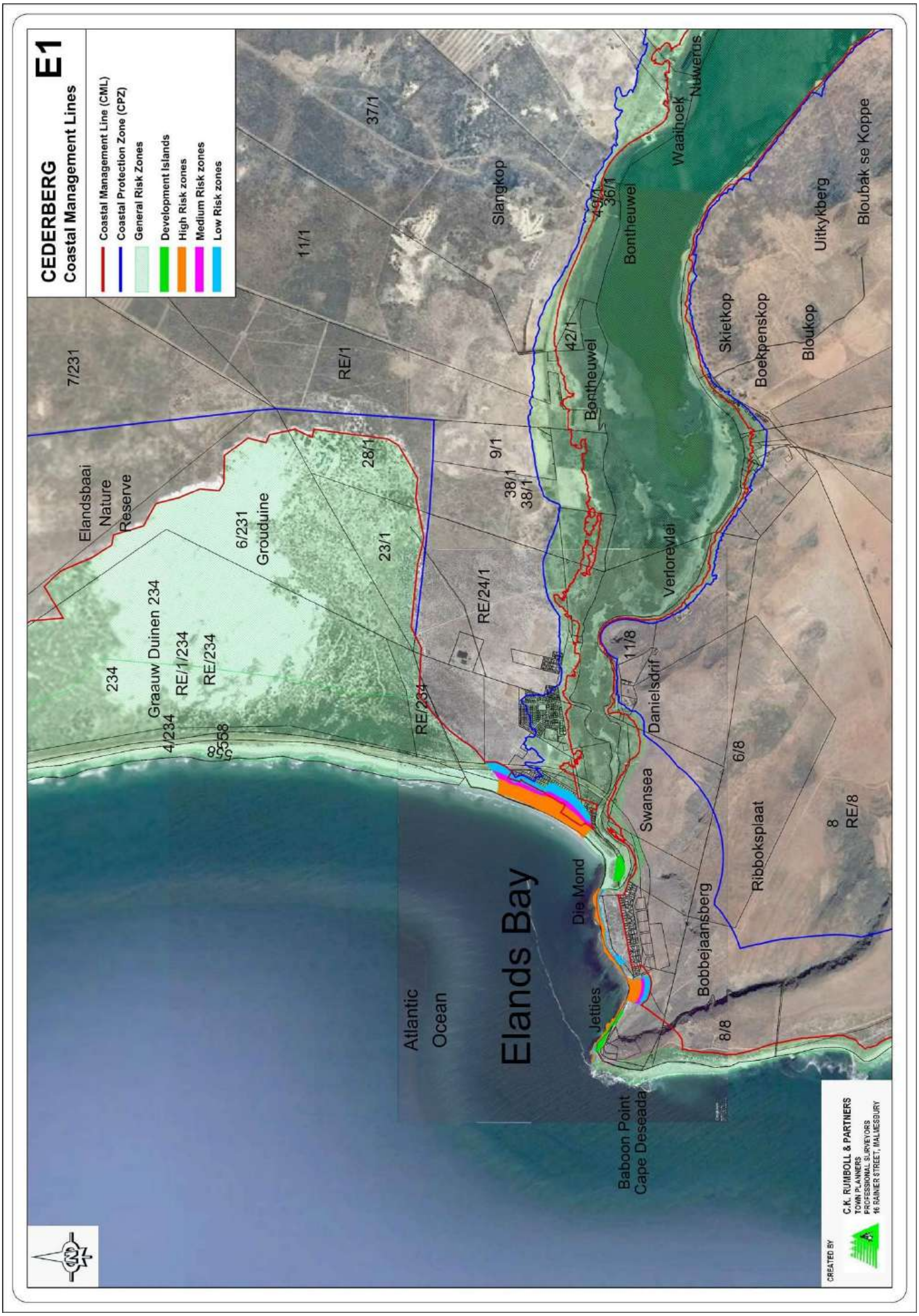


Map 23: Cederberg Coastal Management Lines: Area B, Lamberts Bay (Cederberg SDF, 2023-2027)

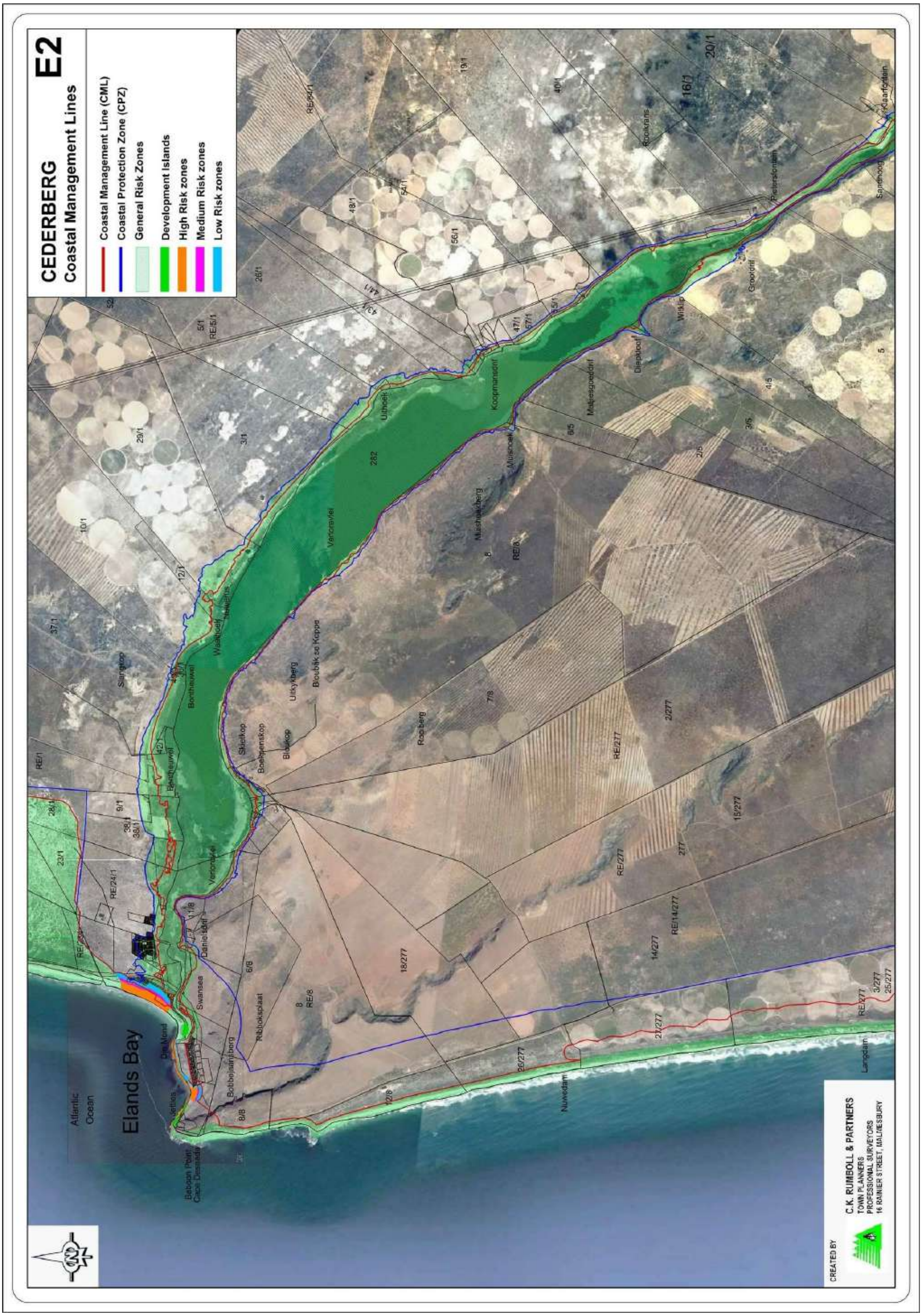


Map 24: Cederberg Coastal Management Lines: Area C (Cederberg SDF, 2023-2027)

Map 25: Cederberg Coastal Management Lines: Area E1, Elands Bay (Cederberg SDF, 2023-2027)



Map 26: Cederberg Coastal Management Lines: Area E2, Elands Bay (Cederberg SDF, 2023-2027)



7.4 Appendix IV – Mitigation Policies: South African Air Quality Response Plan

South Africa has relatively high emissions for a developing country, measured either per capita or by GHG intensity (emissions per unit of GDP). By any measure, South Africa is a significant emitter of GHGs.

The energy intensity of the South African economy, largely due to the significance of mining and minerals processing in the economy and our coal-intensive energy system, has resulted in an emissions profile that differs substantially from that of other developing countries at a similar stage of development as measured by the Human Development Index. Since coal is the most emissions-intensive energy carrier, South Africa's economy is very emissions-intensive.

In 2000, average energy-use emissions for developing countries constituted 49% of total emissions, whereas South Africa's energy-use emissions constituted just fewer than 80% of total emissions. This far exceeds the emissions of other fast-developing countries with a similar reliance on coal for energy.

Emissions from land-use change (primarily deforestation) contribute a significantly smaller share to our emission profile compared to other developing countries. Transportation and energy used in industry contributed just fewer than 10% each of total emissions and industrial process emissions constituted around 14% of total emissions. Emissions from agriculture and land-use change in South Africa constitute only around 5% of emissions, compared to an average of 44% in developing countries as a whole.

7.4.1 Benchmarks National GHG Emissions Trajectory Range

In 2008, in the context of South Africa's moral and legal obligation to make a fair contribution to the global mitigation effort under the UNFCCC and its Kyoto Protocol, the Cabinet fully considered the Long-Term Mitigation Scenario study of the country's mitigation potential. This led to the announcement that South Africa's emissions should peak in the period from 2020 to 2025, remain stable for around a decade, and decline thereafter in absolute terms. The President confirmed this strategic policy direction at the 2009 National Climate Summit and further detailed this as a South African undertaking in the context of all legal obligations under the UNFCCC and its Kyoto Protocol before the international UNFCCC Climate Change Conference in 2009.

This strategic policy direction and international undertaking has informed a National GHG Emissions Trajectory Range, projected to 2050, to be used as the benchmark against which the efficacy of mitigation action will be measured.

The benchmark National GHG Emissions Trajectory Range:

- Reflects South Africa's fair contribution to the global effort to limit anthropogenic climate change to well below a maximum of 2oC above pre-industrial levels;
- Details the "peak, plateau and decline trajectory" used as the initial benchmark against which the efficacy of mitigation actions will be measured (see the document published by the Department of Environmental Affairs (DEA) in 2011 entitled "Defining South Africa's Peak, Plateau and Decline Greenhouse Gas Emission Trajectory"). In summary:
    - South Africa's GHG emissions peak in the period 2020 to 2025 in a range with a lower limit of 398 Megatons (109 kg) (Mt) CO2-eq and upper limits of 583 Mt CO2-eq and 614 Mt CO2-eq for 2020 and 2025 respectively;

- South Africa's GHG emissions will plateau for up to ten years after the peak within the range with a lower limit of 398 Mt CO2-eq and an upper limit of 614 Mt CO2-eq;
- From 2036 onwards, emissions will decline in absolute terms to a range with a lower limit of 212 Mt CO2-eq and an upper limit of 428 Mt CO2-eq by 2050.

- Defines an initial National GHG Emissions Trajectory Range, which may be reviewed in the light of monitoring and evaluation results, technological advances or new science, evidence, and information.

7.4.2 GHG Emissions Inventory

Accurate, complete, and up-to-date data is the foundation of an effective response to GHG emissions. Two essential elements for the definition of desired emission reduction outcomes and the development of CBs are emissions data and data to monitor the outcome of specific mitigation actions.

The DEA in partnership with the South African Weather Service, the host of the SAAQIS, will prepare a GHG Emissions Inventory annually. The inventory will conform to the IPCC's 2006 or later guidelines and will be periodically reviewed by an international team of experts. The inventory will also undertake and report analyses of emissions trends, including detailed reporting on changes in emissions intensity in the economy and a comparison of actual GHG emissions against the benchmark national GHG emission trajectory range.

As is currently contemplated by the DEA, reporting of emissions data will be made mandatory for entities (companies and installations) that emit more than 0.1 Mt of GHGs annually or that consume electricity which results in more than 0.1 Mt of emissions from the electricity sector. Qualifying entities will also be obliged to report energy use by energy carriers and other data as may be prescribed. The emissions inventory will be a web-based GHG Emission Reporting System and will form part of the National Atmospheric Emission Inventory component of the SAAQIS.

7.4.3 Integrated Approach

Considering that climate change effects will cut across industries and sectors, a collaborative approach is also vital to ensure that the collective efforts of the various stakeholders within the municipality don't cancel each other. This approach will also ensure efficient allocation and utilisation of resources for the various climate change adaptations and mitigations. To this end, the key elements in the collective approach include:

- ***Monitoring the performance benchmark*** - based on the National GHG Emissions Trajectory Range. Cascade desired emission reduction outcomes for each sector and subsector, to individual company or entity level;
- ***Identify desired sectoral mitigation contributions*** – an in-depth assessment of the mitigation potential, best available mitigation options, science, evidence and a full assessment of the costs and benefits;
- ***Define Carbon Budgets for significant GHG emitting sectors and/or sub-sectors*** – Adopting a carbon budget approach to provide for flexibility and least-cost mechanisms for companies in relevant sectors and/or sub-sectors;
- ***Develop Mitigation Plans*** – Request companies and economic sectors or sub-sectors wherein the desired emission reduction outcomes have been established to prepare and submit mitigation plans that set out how they intend to achieve the desired emission reduction outcomes;

- ***The use of different types of mitigation approaches, policies, measures and actions*** – Developing and implementing a wide range and mix of different types of mitigation approaches, policies, measures and actions that optimise the mitigation outcomes (including job creation and other sustainable developmental benefits). This optimal mix of mitigation actions will be developed to achieve the defined desired emission reduction outcomes for each sector and sub-sector of the economy by ensuring that actions are specifically tailored to the best available solutions and other relevant conditions related to the specific sector, sub-sector or organisation concerned;
- ***Collaboration with the private sector*** – Deploy a range of economic instruments and systems that interlink with the municipal emissions reduction targets. Including the appropriate pricing of carbon and economic incentives, as well as the possible use of emissions offset or emission reduction trading mechanisms for those relevant sectors, sub-sectors, companies or entities where a carbon budget approach has been selected;
- ***Monitoring and evaluation*** – Establishing a national system of data collection to provide detailed, complete, accurate and up-to-date emissions data in the form of a Greenhouse Gas Inventory and a Monitoring and Evaluation System to support the analysis of the impact of mitigation measures.

7.5 Appendix V – Climate Change Perspectives and Governance

The Cederberg Climate Change Plan is developed in full consideration of the multi-level climate change legislative objectives to ensure its alignment with these.

7.5.1 International Perspective

The international climate change space is steered by the United Nations Framework Convention on Climate Change (UNFCCC), which was formed in 1992 because of a global commitment by countries to respond cooperatively to climate change. The latest assessment of climate change risks and exposure at a global level is contained in the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (IPCC, 2022). Encompassed in the UNFCCC is the Conference of the Parties (COP). This is the supreme decision-making body of the Convention, and all states that are Parties to the Convention are represented at the COP. Their main objective is to review the national communications and emission inventories submitted by Parties, and based on this information, COP assesses the effects of the measures taken by Parties and the progress made in achieving the ultimate objective of the Convention. Notably, the previously held COPs have been criticised for lacking in the implementation component, which is an area aimed to be addressed in the upcoming COP27, to be held in November 2022.

As a party to the Paris Agreement, South Africa is obligated to uphold the international commitment to maintaining the global temperature below 2˚C. The Paris Agreement requests each Country to outline and communicate their post-2020 climate actions, known as their Nationally Determined Contributions (NDCs). NDCs embody efforts by each Country to reduce national emissions and adapt to the impacts of climate change. South Africa's position on climate change is further presented in its Third National Communication (TNC) (2018) to the UNFCCC, which describes the local understanding of climate change impacts, the progress made in responding to these impacts and commitments to reducing national GHG emissions. Furthermore, the Sustainable Development Goals (SDGs) are a global agenda adopted by all United Nations Member states in 2015, including South Africa, which provides a call to action to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity. Goal 17 of the SDGs encompasses a call for climate action. The Cederberg Climate Change Plan aligns with these international agreements and provides a local framework to contribute to the global effort to respond to climate change.

7.5.2 National Perspective: South Africa

South Africa has a robust climate change policy space. Since the advent of democracy in 1994, South Africa has become a strong player in global climate change and sustainable development. This agenda is enshrined in Section 24 of the Constitution of the Republic of South Africa, 1996, which states that everyone has the right to (a) an environment that is not harmful to their health or well-being; and to (b) have the environment protected, for the benefit of present and future generations. Furthermore, the Climate Change Bill (B9-2022) has been introduced more recently. It provides the legal basis for the Country's governance and management of climate change (B9- 2022). It is envisaged that the bill once finalised (the Climate Change Act), will prescribe enabling institutional arrangements for climate action. As outlined in the Climate Change Bill, all municipalities must develop a municipal climate change response implementation plan to achieve the goal of a just transition to a low-carbon and climate-resilience economy and society for South Africa.

The National Development Plan (NDP) 2030 sets out the Country's commitment to becoming an environmentally sustainable, climate change resilient, low-carbon economy and just society by 2030. It aims to eliminate poverty and reduce inequality and notes that South Africa can realise these goals by 'drawing on the synergies of its people, growing an inclusive economy, building capabilities, enhancing the state, and promoting leadership and partnerships throughout society.' Chapter 5 of the National Development Plan encompasses 'ensuring environmental sustainability and an equitable transition to a low-carbon economy'. One of its key aims is to facilitate a transition to a low-carbon future and a more diverse and inclusive economy. In 2020, South Africa established the Presidential Climate Change Coordinating Commission (P4C), a statutory body formed to coordinate and oversee the just transition towards a low-carbon, inclusive, climate-resilient economy and society.

South Africa's position on climate change is further presented in its Third National Communication (TNC) (2018) to the UNFCCC, which describes the local understanding of climate change impacts, the progress made in responding to these impacts and commitments to reducing national greenhouse gases (GHG) emissions. In 2019, South Africa developed its National Climate Change Adaptation Strategy (NCCAS) to serve as a common reference point for climate change adaptation efforts in the Country and provides guidance for national climate change adaptation objectives for the Country as a whole, all sectors of the economy.

Relating to mitigation, the Integrated Energy Plan (IEP: 2015 to 2050) and the Integrated Resource Plan (IRP: 2030) set out the Country's energy and electricity plans and pathways, which include a transition to clean and renewable energy. Furthermore, to ensure a reduction in emissions, the Carbon Tax Act (2019) provides for the imposition of a tax on GHG emissions, giving effect to the polluter-pays principle for large emitters and ensuring that companies and consumers take GHG emissions into account when deciding on production, consumption and investments. In addition, South Africa's Nationally Determined Contribution (NDC) outlines its planned contribution to global GHG emission reductions, and the Low Emission Development Strategy published in 2020 provides actions to ensure that South Africa follows a low carbon growth trajectory while making a fair contribution to the global effort to limit the average temperature increase.

7.5.3 Provincial Perspective: Western Cape Province

The Western Cape Climate Change Response Strategy (2014) was revised in 2020–2021 under the direction of the Climate Change Directorate of the Western Cape Government's Department of Environmental Affairs and Development Planning to update its key messages and bring it in line with the severity of the global climate emergency and the socio-economic context of South Africa. The revision, branded as "Vision 2050", is about responding to the slowly unfolding disaster and making the most of the opportunities for rapid developmental gains possible through climate change responses. Whilst recognising the progress made since the release of its predecessor in 2014, the updated strategy aims to address critical timelines to 2030, ultimately planning a trajectory for strategic outcomes in 2050.

It is recognised that a strategy on its own does not represent a step forward – it must be translated into meaningful action. Action that leads to change and impacts the lives of people. As an accompaniment to the Western Cape Climate Change Response Strategy: Vision 2050 (WCCCRS), an Implementation Plan was developed and intended to accelerate the Provincial Government's climate response actions to mitigate the greenhouse gas emissions footprint and increase resilience to climate change. This acceleration will require coordination of existing initiatives and institutional structures at the provincial and local levels to align with the objectives and targets of the WCCCRS as guided by our 2050 Vision.

The Implementation Plan adds detail to the response actions outlined in the strategy and identifies the role players required to drive the actions. It also specifies timeframes for the actions and a framework within which they can be evaluated to measure progress and overall impact. Effective coordination of climate change responses greatly depends on aligning the strategies, plans, programmes and projects of stakeholders, especially government departments and their operational units. Central to the coordination effort is the WCCCRS, which outlines the objectives of the overall climate change response effort in the Western Cape.

The WCCCRS informs sector responses and certain provincial-scale strategic positions, such as energy, transportation and land use management. All the while ensuring the integration of the latest scientific knowledge throughout the network of connected plans. The strategy also identifies specific gaps in knowledge or strategic positions, which need to be filled to complete the knowledge base and economic positioning of the Western Cape.

The SmartAgri Plan in the SmartAgri Status Quo Report (2016) aims to promote a climate-resilient agricultural future for the Western Cape with a coordinated sector plan and is focused on providing action and implementation in the agricultural sector. The Plan proposes the following four Strategic Focus Areas (SFA):

- Promote a climate-resilient, low-carbon emitting production system that is competitive, equitable and ecologically sustainable across the value chain;
- Strengthen effective climate disaster risk reduction and management for agriculture;
- Strengthen monitoring, data and knowledge management and sharing, and lead strategic research for climate change and agriculture;
- Ensure good cooperative governance and institutional planning for effective climate change response implementation for agriculture.

The SmartAgri Status Quo Report (2016) has recently been revised and updated to the SmartAgri Plan (Jack, et al., 2022) to present the climate change trends and projections for the Western Cape.

7.5.4 District Perspective: West Coast District - Policy Framework for Climate Change Response

Climate change has been identified as a vital issue for the WCDM. Following the publication of the Western Cape Climate Change Response Strategy in 2014, the WCDM approved and adopted the Policy Framework for Climate Change Response in the West Coast District in early 2015. The Policy Framework for Climate Change Response in the West Coast District is to present the WCDM's approach to responding to climate change (through adaptation and mitigation) and improving its response capacity and resilience.

It has been acknowledged that key barriers to responding to climate change in the WCDM include: a lack of awareness and capacity, limited financial resources and a lack of certainty concerning roles and responsibilities. The Policy Framework for Climate Change Response in the West Coast District is the first step to reducing these critical barriers to responding to climate change in the district.

The WCDM has also acknowledged that climate change has the potential to affect every sector in the WCDM. This brings light to the need for awareness campaigns and education programmes, in the WCDM, regarding environmental health and climate change. Climate change awareness campaigns and education programmes should focus on the predicted effects and risks of climate change and how it affects all municipal sectors and all communities.

According to the West Coast District Climate Change Response Plan (UrbanEarth, 2019), the Policy Framework for Climate Change Response in the West Coast District, which includes the Cederberg municipality, lists a wide range of possible vulnerabilities for local municipalities. This includes risks in the following areas:

- Infrastructure Projects, including transport, buildings, water management, wastewater treatment and waste management;
- Marine and terrestrial biodiversity;
- Disaster management;
- Water quality and conservation
- Acceptable air quality.

7.6 Appendix VI – Cederberg Spatial Vision and Objectives

7.6.1 Spatial Vision and Strategy

The attainment of the spatial vision includes the establishment of climate change or biodiversity and conservation corridors.

The spatial vision is *"An economically prosperous region and sustainable liveable settlement environments for all Cederberg residents."*

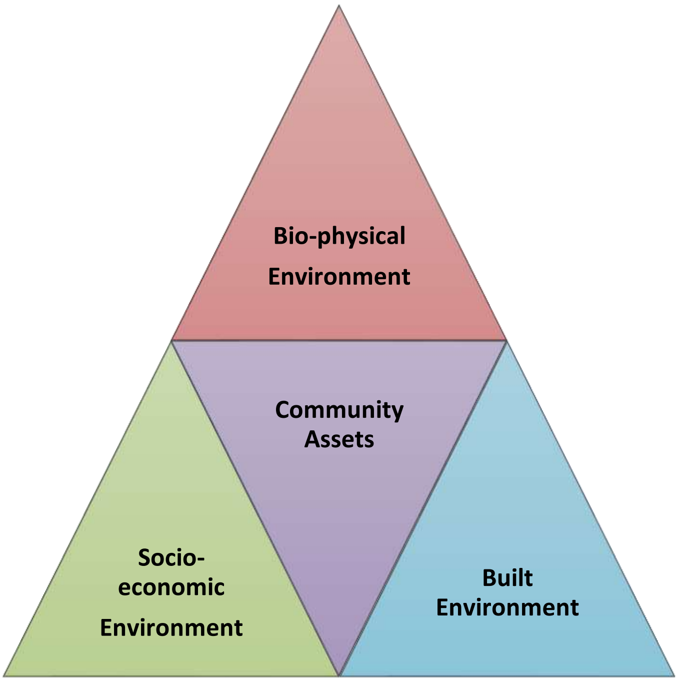
The overall goal or mission is:

- To establish Cederberg as diverse conservation destination and capitalise on its assets: Cederberg Wilderness Area, Nardouw region, Olifants River Valley and along the West Coast;
- To establish Climate Change corridors across the southern half of the municipal area and along all rivers flowing into the sea whilst enhancing agriculture in the Sandveld and along the Olifants River Valley;
- To strengthen sense of place of Cederberg settlements and rural areas whilst enhancing economic opportunities, and particularly at intersections announcing settlements;
- To enhance economic development and provide sufficient business and industrial zoned land.

The SDF Vision is in support of Cederberg IDP vision:
"Cederberg municipality, your home of good governance, service excellence and opportunities for all" (IDP , 2022).

The IDP and SDF objectives have been developed to strategically align with the community assets that will be impacted by climate change (as illustrated in the table below).

Figure 18: Community Assets



Community Assets	IDP Objectives	Spatial Objectives	Spatial Strategies
Biophysical Environment			
Climate	• Financial viability and economically sustainability **(SO 2)**. • Facilitate, expand and nurture sustainable economic growth and eradicate poverty **(SO 4)**.	**Objective 1: Grow (and unlock) economic prosperity**	• Grow the economy & stimulate sector diversification and product development **(SS 1).** • Strengthen mobility and economic links (investor confidence) **(SS 2).** • Develop product and trade advantages (export value chain & agri-industry corridors) and competitive advantage **(SS 3).**
Air Quality *Hydrology & Water Security* *Wildfires*	• Good Governance, community development and community participation. **(SO 3)**. • Enable a resilient, sustainable, quality and inclusive living environment and human settlements i.e. Housing development and informal settlement upgrade. **(SO 5)**. • To facilitate social cohesion, safe and healthy communities**. (SO 6)**.	**Objective 3: Sustain material, physical and social well-being**	• Protect fundamental community resources (air, water & energy) **(SS 6).** • Protect safety and security **(SS 7).** • Provide social infrastructure and services (as per norm) to facilitate smart growth **(SS 9).** • Manage risk and disaster (man-made and natural) **(SS 10).**
Biodiversity & Ecosystems *Coastal Zone & Fisheries* *Hydrology & Water Security*	• Good Governance, Community Development & Public Participation **(SO 3)**. • Facilitate, expand and nurture sustainable economic growth and eradicate poverty **(SO 4).**	**Objective 5: Protect ecological and agricultural integrity**	• Develop competitive advantage (Landscape and cultivation), new markets and economic sectors (e.g. tourism and utilities) **(SS 4).** • Protect food and water security and apply bioregional classification **(SS 13).** • Grow conservation potential and formalise conservation of CBAs and apply coastal management **(SS 14).** • Protect and preserve sensitive habitats and enhancing Ecosystem services **(SS 15).**

Community Assets	IDP Objectives	Spatial Objectives	Spatial Strategies
Built Environment			
Water & Sewerage Services *Solid Waste Management* *Energy Sector*	• Improve and sustain basic service delivery and infrastructure development. **(SO 1)**. • Enable a resilient, sustainable, quality and inclusive living environment and human settlements i.e. Housing development and informal settlement upgrade **(SO 5)**.	**Objective 2: Proximate convenient and equal access**	• Protect economic vibrancy **(SS 4).** • Provide sustainable infrastructure and services (smart growth) **(SS 5).** • Provide zoned land for residential and industrial development **(SS 6).**

Community Assets	IDP Objective	Spatial Objective	Spatial Strategies
Socio-Economic Environment			
Rural and Coastal Settlements *Agriculture*	• Facilitate, expand and nurture sustainable economic growth and eradicate poverty **(SO 4)**. • Financial viability and economically sustainability **(SO 2)**.	**Objective 1: Grow (and unlock) economic prosperity**	• Grow the economy (landscape & conservation, tourism & new markets and economic sectors) & stimulate sector diversification and product development **(SS 1).** • Strengthen mobility and economic links (investor confidence) **(SS 2).** • Develop product and trade advantages (export value chain & agri-industry corridors) and competitive advantage **(SS 3).**

			• Develop competitive advantage (Landscape and cultivation), new markets and economic sectors (e.g. tourism and utilities) **(SS 4).**
	• Improve and sustain basic service delivery and infrastructure development. **(SO 1)**. • Enable a resilient, sustainable, quality and inclusive living environment and human settlements i.e. Housing development and informal settlement upgrade **(SO 5)**.	**Objective 2: Proximate convenient and equal access**	• Protect economic vibrancy **(SS 4).** • Provide sustainable infrastructure and services (smart growth) **(SS 5).** • Provide zoned land for residential and industrial development **(SS 6).**
	• To facilitate social cohesion, safe and healthy communities. **(SO 6)**. • Development and transformation of the institution to provide a people-centred human resources and administrative service to citizens, staff and Council **(SO 7)**.	**Objective 4: Protect and grow place identity (sense of place) and cultural integrity**	• Protect heritage resources and place identify **(SS 11).** • Grow cultural potential **(SS 12).**
	• Good governance, community development & public participation **(SO 3)**. • Facilitate, expand and nurture sustainable economic growth and eradicate poverty **(SO 4).**	**Objective 5: Protect ecological and agricultural integrity**	• Protect food and water security and apply bioregional classification **(SS 13).** • Grow conservation potential and formalise conservation of CBAs and apply coastal management **(SS 14).** • Protect and preserve sensitive habitats and enhancing Ecosystem services **(SS 15).**
Terrestrial Flooding *Health* *Disaster Risk Reduction & Management*	• Good Governance, community development and community participation. **(SO 3)**. • Enable a resilient, sustainable, quality and inclusive living environment and human settlements i.e. Housing development and informal settlement upgrade. **(SO 5)**. • To facilitate social cohesion, safe and healthy communities.**(SO 6)**.	**Objective 3: Sustain material, physical and social well-being**	• Protect safety and security **(SS 7).** • Protect fundamental community resources (air, water & energy) **(SS 6).** • Provide social infrastructure and services (as per norm) to facilitate smart growth **(SS 9).** • Manage risk and disaster (man-made and natural) **(SS 10).**

7.6.2 Climate Change, Spatial and IDP Objectives aligned

The Climate Change objectives will subsequently inform the spatial objectives of the SDF that was in turn informed by the IDP strategic objectives and the Cederberg SDF Vision. The Cederberg Municipality Climate Change and spatial objectives and strategies are aligned with the strategic objectives of the IDP (IDP , 2022).

The Cederberg Climate Change objectives specifically align with three key policy areas – knowledge management, organisation and adaptation. This is to ensure a coordinated approach to implementing the climate change adaptation and mitigation strategies across the municipal structures and departments, and within affected Cederberg communities. The table below outlines the identified objectives.

Table 10: Climate Change Objectives

Policy Area	Key Implementation Actions
Knowledge management	1. Understanding climate change risks through conducting impact and vulnerability assessments and developing risk profiles; 2. Co-ordinate identification, prioritisation and support of vulnerable economic sectors; 3. Facilitate stakeholder education and awareness about climate change; 4. Communicate municipal policy and responses to climate change to stakeholders. 5. Collect data on climate change responses and costs incurred.
Organisation	1. Assign responsibility for the coordination of climate change challenges; 2. Develop funding models for climate change mitigation and adaptation; 3. Remove hindrances to response, adaptation and mitigation; 4. Promote partnerships cooperation, and knowledge exchange at all levels; 5. Review and adapt multi-level work processes to support mitigation and adaptation; 6. Ensure the proper resourcing and execution of functions that relate to and can affect climate change mitigation and adaptation.
Adaptation	1. Mainstream adaptation in economic sectors; 2. Mainstream adaptation in development planning; 3. Ensure land use is appropriate for climate expectations; 4. Enable adaptation through municipal infrastructure design and master planning; 5. Develop and maintain security and diversification in critical resource supply; 6. Build resilience against climate change impacts in the West Coast District; 7. Implement context-tailored responses to climate change impacts.

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