



GREENBOOK

adapting settlements for the future

Namakwa District Municipality

Climate Change Adaptation Plan: Draft 1

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Abbreviations

Abbreviation	Explanation
°C	Degree Celsius
AR5	Fifth Assessment Report
CABLE	CSIRO Atmosphere Biosphere Land Exchange model
CCAM	Conformal-cubic atmospheric model
CDRF	Climate and Disaster Resilience Fund
CMIP5	Coupled Model Intercomparison Project 5
CoGTA	Department of Cooperative Governance and Traditional Affairs
CRVA	Climate Risk and Vulnerability Assessment
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEA	Department of Environmental Affairs
DM	District Municipality
DRR	Disaster Risk Reduction
DWS	Department of Water and Sanitation
EcVI	Economic Vulnerability Index
EnVI	Environmental Vulnerability Index
GCM	General circulation model
GRiMMS	Groundwater Drought Risk Mapping and Management System
GVA	Gross Value Added
GDP	Gross Domestic Product
IDRC	International Development Research Centre
IPCC	Intergovernmental Panel on Climate Change
km	Kilometre
l/p/d	Litres Per Person Per Day
LM	Local Municipality
MAR	Mean Annual Runoff
mm	Millimetre
NCCRP	National Climate Change Response Policy
NDM	Namakwa District Municipality
NDMC	National Disaster Management Centre
PVI	Physical Vulnerability Index
RCP	Representative Concentration Pathways
SCIMAP	Sensitive Catchment Integrated Modelling and Prediction
SDF	Spatial Development Framework
SEVI	Socio-Economic Vulnerability Index
SPI	Standardised Precipitation Index
SPLUMA	Spatial Planning and Land Use Management Act, 2013 (Act No.16 of 2013)
THI	Temperature Humidity Index
WMAs	Water Management Areas
WMO	World Meteorological Organisation
WRYM	Water Resources Yield Model
WUI	Wildland-Urban Interface

Definitions

Adaptation actions	A range of planning and design actions that can be taken by local government to adapt to the impacts of climate change, reduce exposure to hazards, and exploit opportunities for sustainable development (GreenBook, 2021).
Adaptation planning	The process of using the basis of spatial planning to shape built-up and natural areas to be resilient to the impacts of climate change, to realise co-benefits for long-term sustainable development, and to address the root causes of vulnerability and exposure to risk. Adaptation planning assumes climate change as an important factor while addressing developmental concerns, such as the complexity of rapidly growing urban areas, and considers the uncertainty associated with the impacts of climate change in such areas – thereby contributing to the transformational adaptation of urban spaces. Adaptation planning also provides opportunities to climate proof urban infrastructure, reduce vulnerability and exploit opportunities for sustainable development (National Treasury, 2018; Pieterse, 2020).
Adaptive capacity	“The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences” (IPCC, 2022, p. 2899).
Climate change adaptation	“In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects” (IPCC, 2022, p. 2898).
Climate change mitigation	“A human intervention to reduce emissions, or enhance the sinks, of greenhouse gases (GHGs)” (IPCC, 2022, p. 2915). The goal of climate change mitigation is to achieve a reduction of emissions that will limit global warming to between 1.5°C and 2°C above preindustrial levels (Behsudi, A, 2021).
Risk	The potential for consequences [= impacts] where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk

results from the interaction of vulnerability, exposure, and hazard (DFFE, 2020, p. 11).

Hazard The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (DFFE, 2020, p. 11)..

Exposure The presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected (DFFE, 2020, p. 11).

Vulnerability The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (DFFE, 2020, p. 11).

Sensitivity Factors that directly affect the consequences of a hazard. Sensitivity may include physical attributes of a system (e.g. building material of houses, type of soil on agriculture fields), social, economic and cultural attributes (e.g. age structure, income structure) (DFFE, 2020, p. 11).

Coping Capacity The ability of people, institutions, organisations, and systems, using available skills, values, beliefs, resources, and opportunities, to address, manage, and overcome adverse conditions in the short to medium term (e.g., early warning systems in place) (DFFE, 2020, p. 11).

1. Introduction

This Climate Risk Profile report, along with the accompanying draft Climate Change Adaptation Plan, were developed specifically for Namakwa District Municipality (NDM), to aid its strategic climate change response agenda. Both documents primarily draw from the GreenBook, an open-access online planning support system that offers quantitative scientific evidence supporting local government's pursuit of planning and designing climate-resilient, hazard-resistant settlements. The GreenBook serves as an information-rich resource and planning support system for South African local governments, aiding them to better understand their risks and vulnerabilities in relation to population growth, climate change, exposure to hazards, and vulnerability of critical resources. Additionally, the GreenBook suggests suitable adaptation measures for implementation in cities and towns, enabling South African settlements to mitigate the impact of climate hazards on communities and infrastructure, while also contributing to developmental goals (See [Green Book I Adapting settlements for the future](#)).

Initially co-funded by the International Development Research Centre (IDRC) and the Council for Scientific and Industrial Research (CSIR) from 2016-2019, the GreenBook has seen an increase in supporting partners since 2019, furthering research, development, roll-out and uptake. Recently, Santam, the Climate and Disaster Resilience Fund (CDRF), and the CSIR established the GreenBook Roll-out Initiative to facilitate the uptake of the GreenBook and promote resilience-building within local government. The initiative targets to roll out the GreenBook to 32 District Municipalities by 2025, bolstering each District's climate change response and adaptation planning and implementation efforts through the GreenBook. Each of the Districts targeted for support is guided through a value-chain towards the implementation of climate change response and adaptation plans in municipalities (See Figure 1 below). As part of steps four and five, each target District Municipality is furnished with a draft GreenBook Climate Risk Profile report, as well as a draft Climate Change Adaptation Plan.

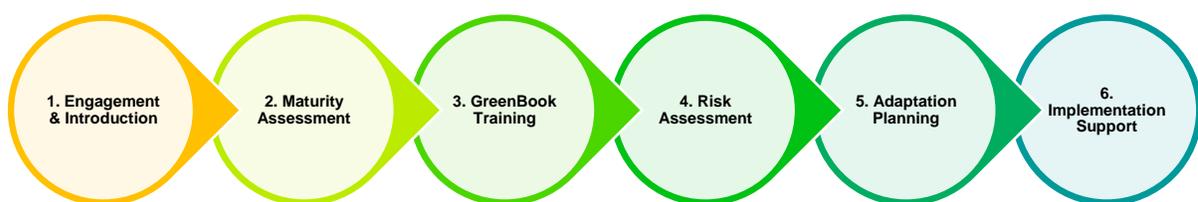


Figure 1: The value-chain towards the implementation of climate change response and adaptation in municipalities

The purpose and strategic objectives of the Climate Risk Profile and the Climate Change Adaptation Plan are to:

- Build and further the climate change response agenda;
- Inform strategy and planning in the district and local municipalities;

- Identify and prioritise risks and vulnerabilities;
- Identify and prioritise interventions and responses; and
- Guide and enable the mainstreaming of climate change response, particularly adaptation.

1.1. Municipal Context

The Namakwa District Municipality, the largest District Municipal Area in the Northern Cape Province of South Africa, comprises six Local Municipalities: Richtersveld, Nama Khoi, Khai Ma, Kamiesberg, Hantam, and Karoo Hoogland. Situated in the northernmost region of the province, Namakwa spans a vast area of about 126,747 square kilometres, making it one of the least densely populated districts in the country. The district stretches from the Atlantic Ocean on the western coast, extending deep into South Africa's arid interior, to the border with the Western Cape province in the south and the North West province in the east. Its geographical diversity with arid desert landscapes, rugged mountains, and a fertile coastal strip contribute to the unique and rich biodiversity of the area.

Each of the six local municipalities within the Namakwa District offers distinct features and contributes to the overall diversity of the region. Richtersveld Municipality, with its administrative centre in Port Nolloth, borders the Atlantic Ocean on the west and the Orange River on the north. The Nama Khoi Municipal area, known as the land of the Nama people, borders the Orange River in the north. Both areas are significantly stimulated by the Orange River's contributions to tourism and agriculture. The Khai Ma Local Municipality, hosting mining activities around Aggeneys, also benefit from the Orange River's economic stimulus. Kamiesberg Municipality, with its Atlantic Ocean western border and the important seaside town of Hondeklipbaai, is a critical area for local business, particularly in the town of Springbok. The Hantam Local Municipality, the largest in the district, has its administrative centre in Calvinia and is known for livestock and rooibos tea production. The Karoo Hoogland Local Municipality, in the southern part of the district with its head office in Springbok, has other main towns including Williston, Fraserburg, and Sutherland.

In accordance with the census data (2016) and extracted from the Namakwa District Municipality's Integrated Waste Management Plan (NDM: IWMP), the population of the Namakwa District Municipality stands at approximately 139,370 individuals. This figure represents roughly a small fraction of the total provincial population, rendering Namakwa the least populous among all district municipalities in the Northern Cape Province. A significant majority of this population communicates primarily in Afrikaans, underscoring the region's historical connections to the Afrikaner community, while a notable segment also speaks isiXhosa and Setswana. Despite the geographical challenges inherent to the region, the district accounted for 10.60% of the Northern Cape Province's GDP in 2020, boasting a GDP of R 10.7 billion. The local economy exhibits a degree of diversification, with the mining sector leading as the largest contributor, responsible for 40.40% of the economy, trailed by community services at 16.70%, and the agriculture sector at 10.20%

From an environmental perspective, Namakwa presents stark contrasts. The western coastline falls within the Succulent Karoo biome, one of the most plant-diverse arid regions globally, housing numerous endemic species. The inland areas transition into the Nama Karoo biome, characterized by sparse shrubland and grassland. Some patches of the Fynbos biome can be observed towards the south and west of the district. Given its largely arid climate, water scarcity is a significant issue across the district, exacerbated by climate change. Several rivers, including the Orange River, traverse the district, providing essential water resources. Despite these environmental pressures, Namakwa's resilience is crucial for maintaining its rich biodiversity and supporting local livelihoods.

1.1.1. Key Risks

Within the Namakwa District Municipality (NDM), the primary hydrometeorological hazards comprise:

- **Wildfires:** These include uncontrolled burning of vegetation in natural environments, escalated by climatic conditions such as heat, wind, and drought. They represent a substantial risk to biodiversity, human habitation, and infrastructure.
- **Drought:** This refers to the prolonged absence or marked deficiency of precipitation, leading to a severe water shortage that adversely affects the ecological system and agricultural activities.
- **Flooding:** Resulting from intense or prolonged precipitation, this hazard can lead to significant infrastructural damage, displacement of communities, increased health risks due to waterborne diseases, and disturbance of agricultural activities.
- **Heat Stress:** This pertains to conditions where extreme temperatures, often combined with elevated humidity, pose significant threats to human health, agricultural production, and the broader ecosystem.
- **Coastal Flooding:** Due to climate change, rising sea levels and increasing storm surge events pose a significant threat to coastal areas within the NDM. Coastal flooding can result in extensive damage to infrastructure, loss of property, displacement of communities, and harm to coastal ecosystems. Coastal flooding is particularly a concern for regions like Richtersveld and Kamiesberg in the Namakwa District.
- **Severe Weather:** This encompasses windstorms, hailstorms, frost, snow, and lightning. These severe weather phenomena can inflict substantial damage to infrastructure, disrupt agricultural activities, pose safety risks, and even lead to fatalities.

The region's arid climate and diverse biomes present unique challenges, such as the risk of wildfires, flooding, drought, heat stress, coastal flooding, and extreme weather events like high winds.

The wildfires or veld fires, pose a significant threat due to the region's dry, arid climate and vegetation, particularly in the Nama Karoo and Fynbos biomes. While wildfires are a natural part

of these ecosystems and contribute to biodiversity, uncontrolled fires can cause extensive damage to property, agriculture, and critical infrastructure. The risk is heightened during periods of drought and high wind speeds, which can facilitate the rapid spread of fires. Topography also significantly influences fire behaviour, with the movement of air over the terrain directing the fire's course. The solar heating of north-facing slopes can also produce upslope thermal winds that complicate fire behaviour.

Flooding is another risk that the Namakwa District Municipality has experienced and will likely continue to experience. The region is traversed by several rivers, including the Orange River, South Africa's longest river. Despite the region's largely arid nature, it is susceptible to flash floods, particularly during summer thunderstorms. These floods can lead to the loss of life and property, disrupt local economies, and cause damage to infrastructure. Flooding has been reported in areas like Springbok, Brandvlei, Williston, Fraserburg, and Sutherland. Flooding can also arise from heavy rain, which has been reported in areas like Alexander Bay. Additionally, coastal areas are at risk due to sea-level rise and storm surges, potentially causing coastal erosion and flooding.

Drought is a recurring and significant risk given Namakwa's arid nature. South Africa, in general, is prone to extended periods of dry weather that could lead to serious water shortages, and the Namakwa District Municipality is no exception. Drought directly impacts agriculture, a critical sector for the local economy and food security, increasing the vulnerability of those depending on farm income. It holds potential risks not only for the immediate but also for future agriculture production practices. Drought conditions also exacerbate the risks of wildfires and heat stress, and strain water resources, leading to water scarcity issues.

Rising global temperatures due to climate change are increasing the risk of heat stress. Namakwa already experiences high summer temperatures, and heatwaves can have severe health impacts, particularly on vulnerable groups such as the elderly, children, and those with chronic diseases. Heat stress can also negatively impact labour productivity, especially in outdoor industries like agriculture and construction. Additionally, the central interior of South Africa, including the Namakwa District, is often exposed to extreme weather scenarios, from heat and rainstorms in Summer to snow and extreme cold in Winter.

Coastal Flooding is a risk for Namakwa's coastline, particularly in areas like Richtersveld and Kamiesberg, which are vulnerable to sea-level rise and storm surges due to climate change. This can lead to coastal flooding, causing damage to coastal settlements, infrastructure, and ecosystems. Changes in the frequency and intensity of coastal storms could exacerbate this risk. For instance, heavy winds have left houses without roofs and coastal flooding has put communities near the coastline at risk.

While not as common as other risks, Namakwa can experience extreme weather events. Heavy rain and high winds can contribute to the rapid spread of wildfires, cause direct damage to

infrastructure and agriculture, and pose a hazard to transportation. Sand and dust storms, for instance, have been reported in Alexander Bay. There's also a slight risk of lightning, with the region expecting between 0 and 1 lightning strike per km² per year.

Mitigation and adaptation strategies for these risks must be a crucial component of the district's disaster management and climate change adaptation plans. This could include measures such as early warning systems, land-use planning, sustainable farming practices, and investment in climate-resilient infrastructure. Furthermore, strengthening the region's healthcare and emergency services and raising public awareness about these risks can help ensure the safety and well-being of residents.

1.1.2. Adaptation Goals and Priorities

The following Adaptation Goals have been identified for and validated by Namakwa District Municipality:

1. To ensure water security and quality for human consumption and agriculture under a changing climate: This implies implementing measures to safeguard the supply and quality of water necessary for human health and crop cultivation, especially in light of climate change. Such measures may involve enhanced water management practices, infrastructure improvements, and the promotion of water-saving technologies and behaviours.
2. To manage physical isolation of communities and potential increased migration to urban and peri-urban areas: This objective aims to address the challenges related to the remoteness of some communities, such as limited access to services and resources, and to manage potential population shifts towards urban areas. Measures might include improving rural infrastructure, promoting rural development, and planning for sustainable urban growth to accommodate newcomers.
3. To manage impacts of heat stress for humans and livestock: This involves taking steps to minimize the negative effects of extreme heat on human health and livestock productivity. This could entail promoting the use of cooling technologies, providing public health guidance during heatwaves, and supporting livestock management practices that protect animals from heat stress.
4. To increase the resilience of the agricultural sector by supporting commercial and small-scale farmers across industries: This goal encompasses efforts to enhance the capacity of the agricultural sector to withstand and recover from various shocks and stresses, such as climate change, market fluctuations, and pests. Support could include providing farmers with access to resilient crop varieties, training in sustainable farming techniques, financial risk management tools, and market opportunities.
5. To protect natural resources and manage loss of high-priority biomes: This aims to preserve and sustainably manage the region's natural resources and biodiversity-rich ecosystems, which are crucial for both ecological integrity and human well-being. Actions might include

establishing or expanding protected areas, enforcing regulations against harmful practices, and promoting the sustainable use of natural resources.

6. To reduce the vulnerability and exposure of human and natural systems to climate change and extreme events: This objective emphasizes the need to decrease the susceptibility of both human communities and natural ecosystems to the harmful effects of climate change and extreme weather events. Strategies may involve improving infrastructure resilience, enhancing disaster risk management capabilities, promoting climate-smart practices, and implementing early warning systems for extreme weather events.

The overarching adaptation goals have been distilled into the following strategic priorities which will guide adaptation planning:

1. Water resource management: Given the water scarcity challenges in the country, developing comprehensive strategies for water resource management is crucial. This includes investing in efficient water infrastructure, prioritising infrastructure maintenance, promoting water conservation practices, implementing rainwater harvesting systems, and exploring alternative water sources such as groundwater and wastewater reuse.
2. Ecosystem conservation: Protecting and restoring natural ecosystems, such as high-priority biomes, wetlands, river ecosystems and riparian areas, to perform critical ecosystem services, enhance biodiversity, support water resource management, and provide natural buffers against climate-related hazards such as wildfires will have to become a priority.
3. Flood management: Developing effective flood management strategies to mitigate the risks associated with heavy rainfall events will need to become essential. This could involve improving stormwater drainage systems, restoring damaged and degraded ecosystems, creating floodplains and retention basins, and implementing advanced early-warning systems for flooding to protect vulnerable communities and infrastructure.
4. Fire management: Targeting fire prevention and strategies to mitigate the risks associated with wildfires is a priority. This could involve identifying areas for designated firebreaks, ensuring water reserves for fire-fighting, and developing advanced early-warning systems for fires to protect vulnerable communities and infrastructure.
5. Social equity and vulnerable populations: It is essential to ensure that adaptation efforts prioritise the needs of vulnerable populations, such as low-income communities and informal settlements. This could involve providing access to basic services, improving housing conditions, and implementing early-warning systems tailored to these communities.
6. Agriculture and food security: Given that food security is a potentially significant future climate change-related impact, developing a food security and agricultural policy that takes climate change impacts into consideration is crucial. This includes increasing the resilience of the agricultural sector by supporting commercial and small-scale farmers across industries, promoting solutions to drought such as highly efficient irrigation systems, exploring alternative crop types, assessing livestock carrying capacity and implementing grazing management and fire management.

1.2. Outline of the Climate Change Adaptation Plan

The figure detailed below provides a schematic representation of the structure of the report, outlining the development process and constituent elements of the Climate Change Adaptation Plan for the District Municipality, informed by the GreenBook tool. The initial chapter delivers an overview of the GreenBook tool and a broad context of the District Municipality, alongside the identification of key climate risks. Chapter 2 proceeds to delve into the intricacies of the adaptation planning process, detailing stakeholder engagement and providing an understanding of the climate policy landscape. Chapter 3 elucidates the Climate Risk Profile tailored for the District Municipality, including an analysis of climate hazards, impacts, and prioritised risks and vulnerabilities. In Chapter 4, the focus pivots to the Adaptation Programmes, Actions, and key activities tailored for the District Municipality, underpinned by the identified goals, priority risks, and developmental priorities of the district. Chapter 5, the final segment, presents a robust framework for the execution of the adaptation programmes and actions, specifying the pivotal departments for implementation, cost estimates, priority levels, indicators, and timelines. Additionally, Chapter 5 proposes strategies for integrating climate change considerations into the District Municipality's operations, contemplating institutional arrangements, governance, information management, and funding mechanisms.

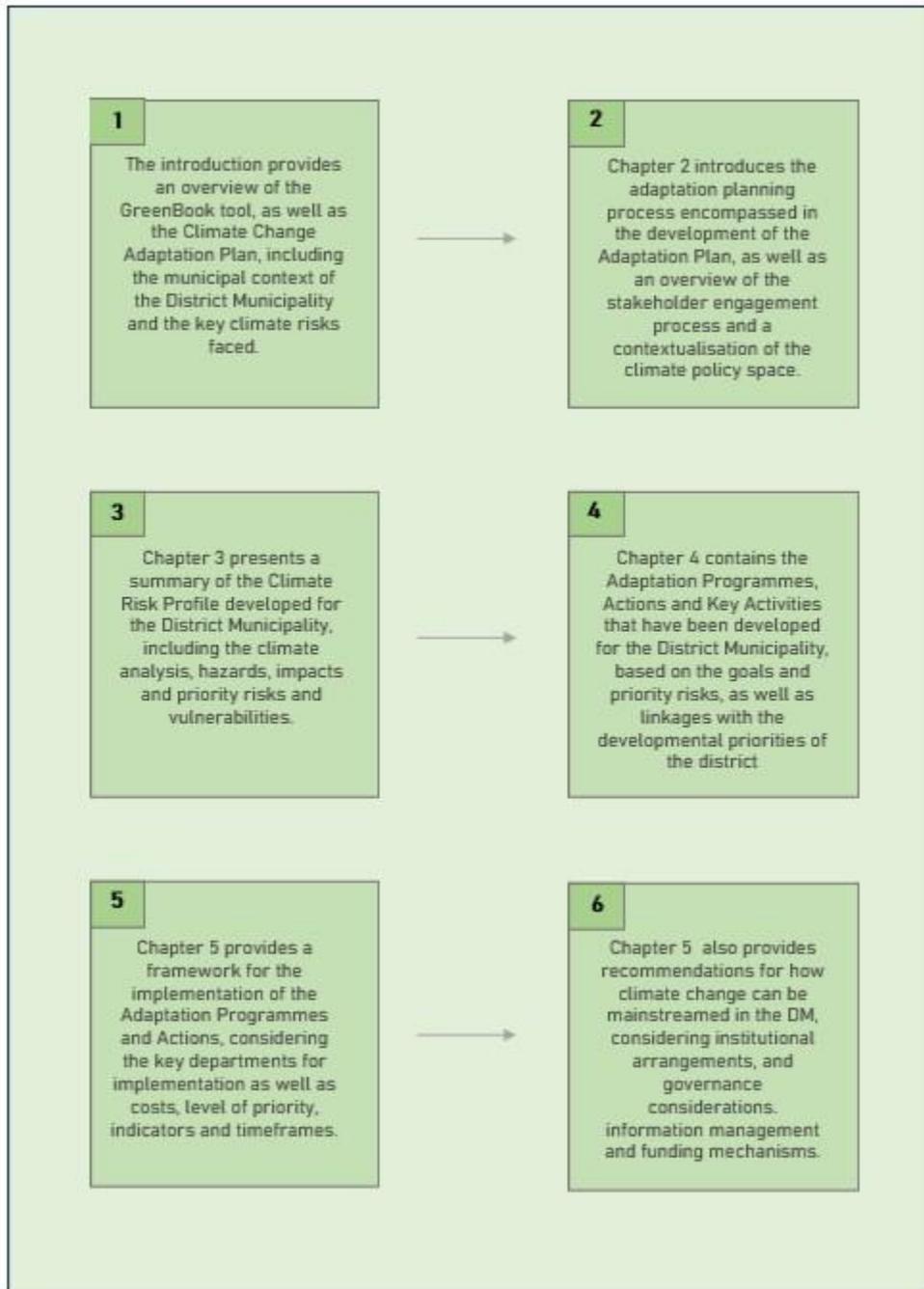


Figure 2: Outline of the climate change adaptation plan.

2. Climate Change Response

Climate change response encapsulates a two-pronged approach, as identified by the United Nations Framework Convention on Climate Change (UNFCCC) (IPCC, 2018), consisting of:

- **Mitigation:** A human intervention to reduce emissions or enhance the sinks of greenhouse gases.
- **Adaptation:** The process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities.

Climate change actions can either fall into one of these two broad categories, or they can encompass co-benefits of both adaptation and mitigation and fall into both categories. Adaptation and mitigation go hand-in-hand in terms of responding to the climate crisis. Mitigation encompasses the reduction of greenhouse gas emissions to curb global warming to 1.5 compared to pre-industrial levels, a target set by the Paris Agreement. Mitigating the causes of climate change is imperative as the rise in temperatures will worsen climate hazards, impacting health, livelihoods, food security, water supply, human security, and economic growth. Climate change adaptation entails altering our behaviour, systems, and ways of life to protect communities, economies, and the environment in which we live from the impacts of climate change. Climate change has resulted in changes in average temperatures, shifts in seasonality as well as increased frequency of extreme weather events. Climate change adaptation and mitigation are both equally important and time-sensitive and we need to do both. The more we reduce emissions right now, the easier it will be to adapt to the changes we can no longer avoid.

Generally, the distinction is made between adaptation approaches, namely anticipatory or reactive adaptation. Anticipatory adaptation refers to acting in preparation for climate change. Reactive adaptation refers to acting when climate change effects are experienced. Future climate trends remain uncertain, highlighting the need for a flexible response and the development of adaptation strategies for the medium and long term. It also follows that adaptation will require greater consideration of local context compared to mitigation strategies.

2.1. Integrated Climate Change Response

Climate change response entails both adaptation and mitigation and is a complex, cross-sectoral, multi-disciplinary process which requires a suitable and accepted approach to ensure success and to maintain consistency and continuity.

Supported by the GreenBook evidence base, the climate change response process is proposed as a point of reference for establishing an overarching approach to climate change response in the NDM and mainstreaming climate resilience into all municipal planning processes to:

- facilitate the implementation of climate change response measures within existing sector plans and budgets; and

- balancing the incremental costs with the municipal development objectives and the economic, environmental, and social benefits produced through integrated climate change response.

NDM’s approach to the climate change response process is conceptualized in the figure below:

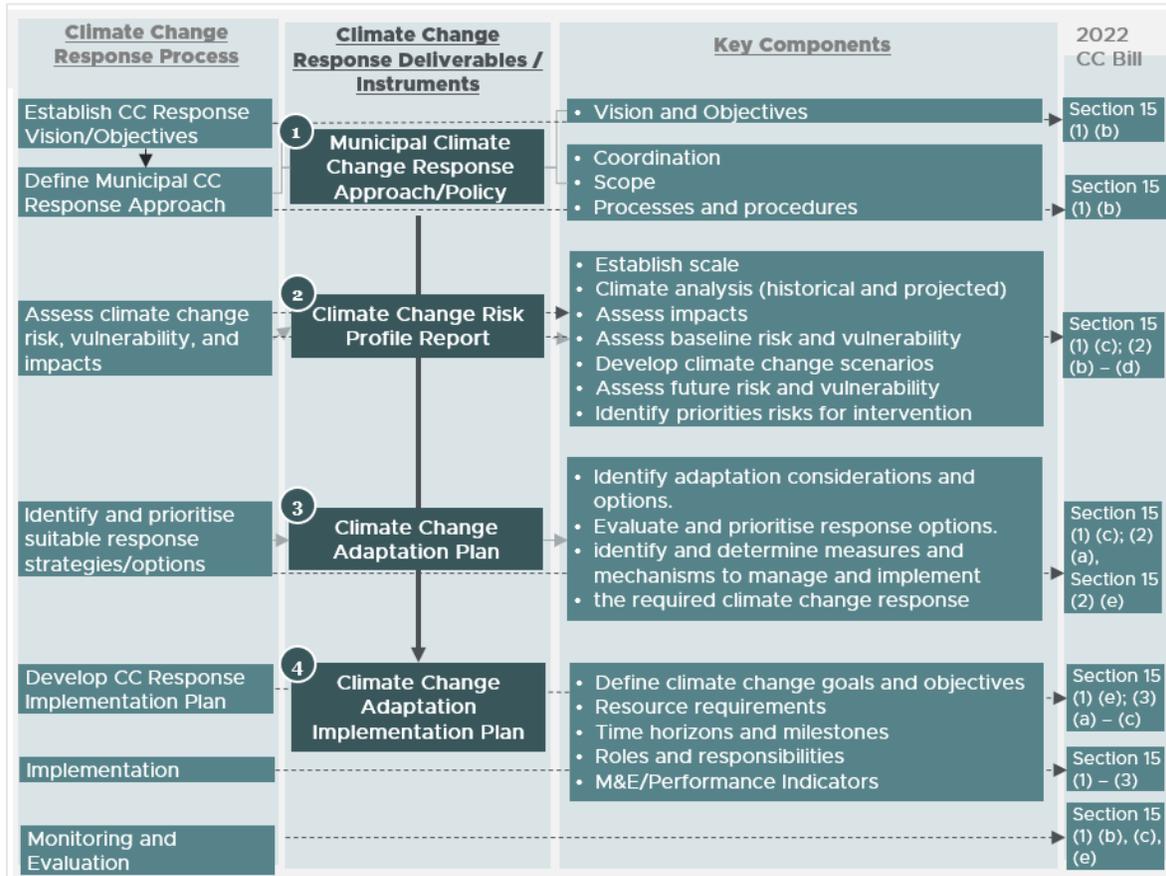


Figure 3: The municipal climate change response process (Brink and Modack, 2022)

Figure 3 illustrates the climate change response process proposed for the NDM, in accordance with the Climate Change Bill (B9-2022) requirements for local government. The development of the Adaptation Plan is a key component of the process outlined above. The specific Adaptation Approach applied in the development of the NDM Adaptation Plan is outlined below.

2.2. Adaptation Approach

The approach used in the GreenBook, and the Climate Risk Profile is centred around understanding climate-related risk. Climate-related risk implies the potential for adverse consequences resulting from the interaction of vulnerability, exposure, and the occurrence of a climate hazard (see Figure 4). “Relevant adverse consequences include those on lives, livelihoods, health and wellbeing, economic, social and cultural assets and investments,

infrastructure, services (including ecosystem services, ecosystems and species)” (Chen, et al., 2021, p. 64). The components of risk are dynamic. Climate hazards are driven by natural climate variability and anthropogenic climate change. Human activity contributes to Greenhouse Gas emissions that increase temperatures and which in turn affect changes in the occurrence of climate hazards such as drought, flooding, coastal flooding, and heat extremes. Planned as well as unplanned development and growth of our settlements drive the exposure of people, the built- and natural environment to climate hazards. Vulnerability includes the inherent characteristics that make systems sensitive to the effects and impacts of climate hazards. Municipal risk is driven by vulnerability and exposure to certain climate-related hazards.

To understand climate risk across the municipal area, the exposure of settlements to certain climate hazards and their vulnerability is unpacked. In this Climate Risk Profile multiple vulnerability indices are provided on the municipal and settlement level, as well as variables for the current and future projected climate. Climate-related hazards such as drought, heat extremes, wildfire, flooding, and coastal flooding and the impact of climate on key resources are also set out for the District and its municipalities.

Climate change adaptation aims to reduce climate-related risks by adjusting a system to the actual or anticipated climate and seeking “to moderate or avoid harm [and] exploit beneficial opportunities” (IPCC, 2022a, p. 2898) that may derive from unavoidable impacts of climate change such as extreme hazards. Through climate change adaptation, the components that makeup risk can be reduced, including exposure and vulnerability. Climate change adaptation consists of measures that range from providing social protection after disasters, to retrofitting habitats or settlements with more resilient infrastructure, protecting coastlines from flooding, securing water resources to rely on during periods of drought, and improving crop production for dryland farming, among others. Although disaster risk reduction and climate change mitigation, form part of the overall climate change response agenda, the focus of this plan is on adaptation.



Figure 4: The interaction between the various components of risk, indicating the opportunity to reduce risk through adaptation (based on IPCC, 2014 and IPCC, 2021)

Adaptation planning utilizes the principles of spatial planning and climate change adaptation to create resilience in both constructed and natural areas against climate change impacts. This approach also leverages opportunities for long-term sustainable development, addressing the fundamental causes of risk exposure and vulnerability. The process for climate change adaptation and planning is outlined in Table 1 below.

This Adaptation Plan has been developed following the stated adaptation logic and planning process. It ensures alignment with local policy, currently identified and future anticipated risks, and vulnerabilities. Moreover, it facilitates the integration and prioritization of climate change adaptation and resilience measures into other planning mechanisms and processes.

Table 1: The adaptation planning process.

1. Understand your context	The Climate Risk Profile unpacks climate hazards and vulnerability in the District Municipality. To be able to develop an appropriate adaptation plan, it is important to understand what contributes to risk and vulnerability.
2. Identify priority climate-related risks	Identify the climate hazards and impacts that pose the greatest risk within the District Municipality. Draw from both the Climate Risk Profile and local expert knowledge.
3. Identify adaptation goals	Identify adaptation goals to address priority risks that speak to policy goals within the District Municipality.
4. Develop adaptation programmes and actions	<p>Develop adaptation programmes that speak to the identified adaptation goals and identify appropriate adaptation actions under each of the programmes that are mutually supportive. Adaptation actions should:</p> <ul style="list-style-type: none"> • Be specific to a climate risk and/or vulnerability. • Suggest a target or an indicator to measure progress. • Be assignable to a primary implementer. • Be realistic and achievable given available resources. • Consider co-benefits and other possible implications. • Include mitigation as far as it builds resilience or reduces exposure and vulnerability.
5. Mainstream adaptation actions into planning	Integrate adaptation goals, programmes, and actions into existing instruments and processes, particularly those related to development and planning. The aim is to ensure that climate change adaptation and resilience are an integral part of all planning.

2.2.1. Stakeholder Engagement Process

In constructing a Climate Change Adaptation Plan that aligns with the specific needs of the District Municipality and adeptly addresses its key risks, an integrated stakeholder engagement phase was incorporated into the adaptation planning process. This consolidated engagement framework was designed to be an efficient platform that seamlessly combines the Risk Profile Engagement and Implementation Engagement into one cohesive workshop. This workshop further allowed District Municipalities (DMs) to benefit from a capacity development module aimed at enhancing their proficiency in using the GreenBook tool. The engagement invitations were channelled to relevant DM departments including Environmental Management, Disaster Management, Spatial Planning, and Water and Sanitation, among others.

The condensed workshop format began with an interaction between the DMs and the CSIR, focused on the Risk Profile engagement. This phase was targeted at validating the primary risks and vulnerabilities identified for the DM through the GreenBook Municipal Risk Tool, as outlined in the Risk Profile Report. A salient outcome of this engagement was the delineation of climate change adaptation goals, designed to confront the DM's significant risks and lay the foundation for the initial draft of the Climate Change Adaptation Plan.

Immediately following the Risk Profile validation, the Implementation Engagement was introduced within the same workshop. This segment showcased the preliminary Climate Change Adaptation Plan, encapsulating the Adaptation Programmes and Actions, providing the DM with an opportunity for review and commentary. The session also featured a presentation on the Implementation Framework crafted for the Adaptation Plan and included a discourse around the strategies for integrating climate change adaptation within the district.

Overall, the integrated stakeholder engagement workshop offered an efficient mechanism for interacting with District stakeholders, fostering a more nuanced understanding of the DM's context. The feedback received from these consolidated engagement processes has been carefully considered and subsequently incorporated into the draft Climate Change Adaptation Plan.

2.3. Policy Context

2.3.1. National Policy Context

South Africa's institutional policy and legislative framework make provision for climate change adaptation at all levels of government, with local governments increasingly identified as the primary drivers of climate change adaptation. For instance, there exists various national policy and legislative mechanisms that promote, necessitate, guide and/or regulate climate change adaptation at the local level. These include the Disaster Management Amendment Act of 2015, the Spatial Planning and Land Use Management Act (SPLUMA) of 2013, the Climate Change Bill

(B9 of 2022), the 2011 National Climate Change Response White Paper, as well as the 2019 National Climate Change Adaptation Strategy.

While the Disaster Management Amendment Act requires each organ of state, as well as provincial and local government to identify measures for, as well as indicate plans to invest in, disaster risk reduction (DRR) and climate change adaptation; SPLUMA identifies the principles of (1) spatial resilience – which “accommodates flexibility in spatial plans, policies and land use management systems, to ensure sustainable livelihoods in communities most likely to suffer the impacts of economic and environmental shocks” (Republic of South Africa., 2013, p. 20) – some of which may be induced by the impacts of climate change, and (2) spatial sustainability, which sets out requirements for municipal planning functions such as spatial planning and land use management to be carried out in ways that consider protecting vital ecosystem features such as agricultural land, i.e., from both anthropogenic and natural threats, including the impacts of climate change, as well as in ways that consider current and future costs of providing infrastructure and social services in certain areas (e.g., uninformed municipal investments may lead to an increase in the exposure of people and valuable assets to extreme climate hazards) as one of the key principles intended to guide municipal planning and development. The Climate Change Bill sets out requirements for every district intergovernmental forum to serve as a Municipal Forum on climate change that coordinates climate response actions and activities in its respective municipality, while also requiring every municipality to report on their climate change response needs and draft resultant climate change response assessments and implementation plans.

Furthermore, the National Climate Change Response White Paper identifies local governments as critical role players that can contribute towards effective climate change adaptation through their various functions, including human settlement planning; urban development; municipal infrastructure and services provision; water and energy demand management; and local disaster response, amongst others. The National Climate Change Adaptation Strategy outlines several actions that are targeted at municipalities, including the development and implementation of adaptation strategies and vulnerability reduction programmes for communities and individuals that are most at risk of the impacts of climate change; the development of municipal early warning systems; as well as the integration of climate change adaptation into municipal development plans and relevant sector plans.

The table that follows presents a summary of both international and national policy instruments relevant to climate change mitigation and adaptation. These policy instruments range from the United Nations Framework Convention on Climate Change (UNFCCC), which governs global action against climate change, to the South African National Climate Change Adaptation Strategy (NCCAS), aimed at enhancing the country's ability to meet its obligations under the Paris Agreement on Climate Change. Other key international instruments include the International Carbon Action Partnership (ICAP), the Sustainable Development Goals (SDGs), and the Convention on Biological Diversity. On the national front, the instruments such as the Climate

Change Bill, the National Development Plan (NDP), the National Climate Change Response Policy (NCCRP), the National Environmental Management Act (NEMA), and the Amended Disaster Management Act are discussed. Each of these policy instruments plays a crucial role in shaping climate change response strategies, establishing frameworks for low-carbon, climate-resilient economies, and ensuring environmental sustainability while promoting socio-economic development.

Table 2: International and national policy context.

International	
United Nations Framework Convention on Climate Change (UNFCCC)	The UNFCCC is the primary multilateral global treaty governing actions to combat climate change through adaptation and mitigation efforts.
International Carbon Action Partnership (ICAP)	The ICAP is an international forum for governments and public authorities that have implemented or are planning to implement carbon trading systems (ETS).
United Nations Sustainable Development Goals (SDGs)	The SDGs are a universal call to action consisting of 17 goals to end poverty, protect the planet and improve the lives and prospects of everyone globally.
Sendai Framework for Disaster Risk Reduction	This framework aims to substantially reduce disaster risk and losses in lives, livelihoods and health in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years.
Nationally Determined Contribution (NDC)	The Paris Agreement requests each Country to outline and communicate their post-2020 climate actions, known as their NDCs. NDCs embody efforts by each Country to reduce national emissions and adapt to the impacts of climate change.
Convention on Biological Diversity	The Convention on Biological Diversity is an international treaty designed to promote biodiversity conservation and ensure the equitable sharing of genetic resources.
National	
Climate Change Bill (2022)	The Climate Change Bill aims to enable the development of an effective climate change response and a long-term, just transition to a low-carbon and climate-resilient economy and society for South Africa in the context of sustainable development and to provide for matters connected in addition to that.
South Africa Low Emission	The South Africa Low Emissions Development Strategy (SA LEDS) aims to succinctly build upon this foundation and articulate the path

Development Strategy 2050 (2020)	going forward in order to place the country on a low carbon trajectory, while at the same time ensuring broader socio-economic development.
National Development Plan Chapter 5: "Transition to Low-Carbon Economy"	The NDP aims to eliminate poverty and reduce inequality by 2030. According to the Plan, South Africa can realise these goals by drawing on the energies of its people, growing an inclusive economy, building capabilities, enhancing the state's capacity, and promoting leadership and partnerships throughout society. Chapter 5 of the NDP outlines 'ensuring environmental sustainability and an equitable transition to a low-carbon economy.
National Climate Change Adaptation Strategy (2020)	South Africa's National Climate Change Adaptation Strategy (NCCAS) supports the Country's ability to meet its obligation in terms of the Paris Agreement on Climate Change.
National Climate Change Response Policy	The NCCRP supports the national vision for a successful climate change response and long-term shift towards a lower-carbon and climate-resilient economy and society. It aims to manage efficiently climate change impacts through strategies that build and sustain South Africa's social, economic and environmental resilience, and the second is to stabilise greenhouse gas concentrations in the atmosphere.
National Environmental Management Act (NEMA)	The NEMA Act 107 of 1998 intends to provide for cooperative environmental governance by establishing principles for decision-making on matters affecting the environment. In addition, these institutions will promote cooperative governance and procedures for coordinating environmental functions by organs of state.
Just Transition Framework	This framework is a planning tool for achieving a just transition in South Africa, setting out the actions that the government and its social partners will take to achieve a just transition and the outcomes to be realised in the short, medium, and long term.
Disaster Management Act (2002)	The Disaster Management Act of 2002 provides for an integrated and coordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery, including climate-related disasters.

2.3.2. Desired Adaptation Outcomes for Monitoring and Evaluating Climate Resilience

The development of Desired Adaptation Outcomes (DAOs) is a crucial objective that informs and directs the monitoring and evaluation of South Africa's progress towards a climate-resilient society. These DAOs are derived from sector-specific adaptation priorities, as outlined in Chapter 5 of the National Climate Change Response White Paper (NCCRWP). To establish these outcomes, consultative sessions have been held with various departments including the

Department of Environmental Affairs (Biodiversity branch), Department of Water and Sanitation (DWS), Department of Health (DOH), Department of Human Settlements (DHS), and the National Disaster Management Centre. During these consultations, the proposed DAOs were widely accepted. It is recommended that the NDM engages with the Desired Adaptation Objectives outlined below, in the implementation and mainstreaming of the Climate Change Adaptation Plan

The Desired Adaptation Outcomes encompass various key aspects to monitor and evaluate climate resilience. These include:

1. Robust policies, programmes and actions for climate change adaptation.
2. Appropriate processes and mechanisms for coordinating climate change adaptation.
3. Accurate weather forecasting, reliable seasonal predictions, climate projections and effective early warning systems for extreme weather and other climate-related events.
4. Capacity development, education, and awareness programmes for climate change adaptation.
5. Resources and capacity to deliver climate change adaptation.
6. Climate change adaptation is fully integrated into development planning.
7. New technologies/knowledge developed for use in climate change adaptation and other cost-effective opportunities optimized.
8. Systems, resources, communities, and sectors are less vulnerable to climate change impacts.
9. Reduction in non-climate pressures and threats to human and natural systems.
10. Secure food, water, and energy supplies are available for all.

These DAOs form a holistic framework aimed at guiding the country's adaptation strategies. They ensure a robust response to climate change impacts while integrating adaptation into broader developmental planning, emphasizing capacity building, education, and the development of new adaptation technologies. Ultimately, the goal is to create a society that is resilient to climate change impacts, ensuring secure food, water, and energy supplies for everyone.

2.3.3. Local Policy Context

Within the Namakwa District Municipality (NDM), climate change response is driven by several strategic plans and initiatives. Key among these is the Climate Change Risk & Vulnerability Assessment and Climate Change Response Plan, adopted by the council on June 9, 2023. This forms the bedrock of the district's proactive climate response strategy, supplemented by the Air Quality Management Plan, the Air Quality By-Law, and the Integrated Waste Management Plan. These plans collectively map out the district's approach to environmental sustainability and resilience, embodying their commitment to mitigating climate change impacts and enhancing the area's environmental quality.

To operationalize these plans, the District established the Environmental Management unit during the 2021/22 fiscal year. This unit, tasked with advancing NDM's climate change response agenda, is led by an Environmental Manager and supported by four interns funded by SANBI (South African National Biodiversity Institute). Moreover, the climate change response in the district is championed by this team, in conjunction with a practitioner from the DFFE (Department of Forestry, Fisheries and the Environment) Local Government Support Program, who is seconded to the district. This unit is therefore responsible for driving the implementation of the Climate Change Response Plan (CCRP) and other associated planning instruments.

To bolster these efforts, the NDM works closely with various partners, stakeholders, and networks. These entities provide essential support in terms of climate change response and adaptation planning and implementation. Notable among these are the DFFE at the national level, the Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform, and Conservation South Africa (CSA). The district is currently involved in several climate-related projects and initiatives, including the "Flooding and Mopping (EPWP)" project, the "Landscapes and Livelihoods: Conserving Kamiesberg communal lands" initiative, and the "Active climate citizenship for a just transition in South Africa" project, among others. These ventures collectively underscore the district's commitment to proactive climate action.

However, NDM faces significant challenges when planning for climate change, including limited financial resources, a lack of awareness and urgency about climate change, and insufficient information, data, and evidence. Despite these obstacles, the district has identified immediate areas requiring attention, such as desertification in Richtersveld and Kamiesberg Local Municipalities, pervasive drought throughout Namakwa, and sea-level rise in Richtersveld and Kamiesberg Local Municipalities.

In line with these challenges and goals, the Climate Change Vulnerability Assessment and Response Plan outline the climate change vulnerability assessment conducted for the NDM, coupled with the responses that address these vulnerabilities. The response plan was developed through the Local Government Climate Change Support Programme (LGCCS), an initiative of the National Department of Forest Fisheries and Environment and the Deutsche Gesellschaft für Internationale (GIZ). The LGCCS initiative aims to assess the municipal landscape to provide a basis for responses, facilitate district-specific engagements, and foster capacity building and knowledge transfer to enhance the implementation of prioritised climate change adaptation options.

The application of the LGCCS Toolkit to the NDM has been crucial in developing this Climate Change Response Plan, providing an essential resource in identifying and prioritising climate change impacts significant to the area. The Climate Change Response Plan also builds upon previous vulnerability assessments conducted for the NDM by Conservation South Africa in 2012 and 2015, further enhancing its contextual relevance and applicability.

2.4. District Municipality Responsibilities

In South Africa, district municipalities play a significant role in climate change adaptation. While the specific powers and functions related to climate change may vary slightly between municipalities, there are several established responsibilities typically associated with district municipalities in South Africa which can be linked to climate change adaptation:

1. **Climate Change Planning:** District municipalities are responsible for developing and implementing climate change adaptation plans at the local level. These plans are required to assess the vulnerability of the district to climate change impacts and outline strategies and actions to minimize risks and enhance resilience.
2. **Infrastructure Development:** District municipalities are tasked with planning and coordinating the development of infrastructure. Infrastructure should be developed to be resilient to climate hazards as well as support resilience objectives as part of an integrated climate change adaptation approach. This includes the construction of climate-resilient roads, bridges, and drainage systems that can withstand extreme weather events and reduces risk to vulnerable assets and communities.
3. **Natural Resource Management:** District municipalities are responsible for managing natural resources within their jurisdiction to support climate change adaptation. This involves conserving and protecting ecosystems, such as wetlands and forests, that provide a natural defence against climate impacts like flooding and erosion.
4. **Disaster Risk Reduction:** District municipalities have key responsibilities in disaster risk reduction, including preparedness, response, and recovery. They should play a role in establishing early warning systems, and emergency response plans, and coordinate efforts with other local government entities, provincial authorities, and national disaster management agencies.
5. **Stakeholder Engagement:** District municipalities facilitate stakeholder engagement processes to raise awareness about climate change adaptation and involve local communities, NGOs, businesses, and other relevant actors in decision-making processes. They often collaborate with local organizations to implement climate change adaptation projects and programs.
6. **Capacity Building and Training:** District municipalities are responsible for building capacity and providing training to local government officials, communities, and relevant stakeholders on climate change adaptation. This helps enhance their knowledge and skills in implementing climate-resilient practices and technologies.
7. **Monitoring and Evaluation:** District municipalities monitor the progress of climate change adaptation initiatives and evaluate their effectiveness. They collect data, measure key performance indicators, and assess the success of implemented strategies to ensure that adaptation measures are delivering the desired outcomes.

It is important to note that while district municipalities have a range of powers and functions related to climate change adaptation, collaboration with other levels of government, such as

provincial and national authorities, is also crucial for effective climate action and coordination of resources and policies.

2.4.1. Power and Functions of the District Municipality

This section entails a high-level overview of the relevant power and functions of District Municipalities in South Africa that can be referenced to assign and assume responsibilities related to climate action. Due to the time- and resource-limited nature of this study, this is by no means an exhaustive review.

According to South Africa's Local Government: Municipal Structures Act, the District Municipality has the following functions and powers:

- a) Integrated development planning for the district municipality as a whole, including a framework for integrated development plans of all municipalities in the area of the district municipality.
- b) Potable water supply systems.
- c) Bulk supply of electricity, which includes for the purposes of such supply, the transmission, distribution and, where applicable, the generation of electricity.
- d) Domestic waste-water and sewage disposal systems.
- e) Solid waste disposal sites, in so far as it relates to—
 - i. the determination of a waste disposal strategy;
 - ii. the regulation of waste disposal;
 - iii. the establishment, operation and control of waste disposal sites, bulk waste transfer facilities and waste disposal facilities for more than one local municipality in the district.
- f) Municipal roads which form an integral part of a road transport system for the area of the district municipality as a whole.
- g) Regulation of passenger transport services.
- h) Municipal airports serving the area of the district municipality as a whole.
- i) Municipal health services.
- j) Fire-fighting services serving the area of the district municipality as a whole, which includes—
 - i. planning, co-ordination and regulation of fire services;
 - ii. specialised fire-fighting services such as mountain, veld and chemical fire services;
 - iii. co-ordination of the standardisation of infrastructure, vehicles, equipment and procedures;
 - iv. training of fire officers.
- k) The establishment, conduct and control of fresh produce markets and abattoirs serving the area of a major proportion of the municipalities in the district.
- l) The establishment, conduct and control of cemeteries and crematoria serving the [district as a whole] area of a major proportion of municipalities in the district.

- m) Promotion of local tourism for the area of the district municipality.
- n) Municipal public works relating to any of the above functions or any other functions assigned to the district municipality.
- o) The receipt, allocation and, if applicable, the distribution of grants made to the district municipality.
- p) The imposition and collection of taxes, levies and duties as related to the above functions or as may be assigned to the district municipality in terms of national legislation.

3. Summary of Climate Risk Profile

This section starts with an overview of vulnerability and population change projections, unpacking the components of vulnerability on both the municipal and settlement level as well as future population pressures. Thereafter the current and future climate is discussed in terms of temperature and rainfall across the district. Current as well as future exposure to drought, heat, wildfire, flooding, coastal flooding, and coastal erosion are set out. The impact of climate on key resources such as water and agriculture is also discussed by the municipalities in the district. Together this information provides an overview of current and future climate risks across the Namakwa District to inform responsive planning and adaptation.

3.1. Overview of Baseline and Future Climate Risk.

In the Namakwa District Municipality (NDM), a strategic ensemble of six Coupled Model Intercomparison Project Phase 5 (CMIP5) General Circulation Models (GCMs) was employed to shape baseline and future climate change scenarios. These models, utilized under both Representative Concentration Pathways (RCP) 4.5 and 8.5 scenarios, served as powerful tools in the scientific assessment of the potential impacts and risks associated with climate change. By analysing a variety of possible climate outcomes under differing greenhouse gas concentration trajectories, the NDM was better equipped to understand and plan for a range of possible climate futures. This integrative approach effectively captured the inherent complexity and uncertainty of climate dynamics, providing the NDM with a robust and comprehensive climate modelling framework.

To further enhance the resolution and applicability of these global-scale models, the Conformal-Cubic Atmospheric Model (CCAM), a regional climate model, was utilized. This advanced model was instrumental in downscaling climate projections from a broader 50km resolution to a more detailed and localized 8km resolution. This downscaling process improved the precision and accuracy of the projections, making them more relevant and applicable to the NDM's specific geographical context. This way, the district could more accurately capture the local nuances of climate variability and change, thereby enhancing the effectiveness of its climate adaptation and mitigation strategies.

The climate analysis conducted within this framework spanned two distinct periods, the baseline (1961 – 1990) and the future (2021 – 2050). The baseline period provided a historical perspective, allowing for the assessment of long-term climate trends and the understanding of climate variability in the context of past observations. The future projection, meanwhile, offered insights into potential future climate conditions under different greenhouse gas emission scenarios. By comparing these two periods, the NDM was able to develop a dynamic understanding of climate change within the district, informing its strategic planning and decision-making processes as it navigates the challenges and opportunities posed by a changing climate.

3.1.1. Climate Analysis

3.1.1.1. Average Temperatures

The Namakwa District Municipality (NDM) experiences a range of climatic conditions, with current average annual temperatures oscillating between 12 and 22°C. The variation is primarily influenced by the geographical location within the district, with higher averages being observed in the northern and western extremities of Namakwa. During the peak of summer, the region witnesses temperatures soaring above 45°C in the afternoons. On the contrary, cooler temperatures are typically experienced in the higher altitude regions, such as the Hantam and Karoo Hoogland Local Municipalities, which enjoy a more temperate climate due to their elevation.

Climate projections, under a Representative Concentration Pathway 8.5 (RCP8.5), predict a considerable increase in average annual temperatures across the NDM by 2050, reflecting a low mitigation scenario. These forecasts indicate an expected rise in temperatures ranging from 1.5°C to 2.8°C, indicative of the escalating impact of climate change in the region. The most significant increases are anticipated in the northeastern parts of the district, around the towns of Pofadder and Aggeneys, where the arid environment is expected to become even hotter. Conversely, a lesser increase in temperatures is projected along the West Coast, indicating spatial variation in the district's vulnerability to warming trends. This underscores the need for the district to implement strategic climate response measures to safeguard the region against the adverse impacts of climate change.

3.1.1.2. Rainfall

The Namakwa District Municipality is predominantly characterized by its dry, semi-arid climate, with the current average annual rainfall varying widely across the district, from as low as 25 mm to as high as 400 mm. The driest areas of the district are primarily located in the northwest of the Richtersveld, reflecting its desert-like conditions. On the other hand, regions along the Bokkeveld escarpment, within the Hantam Local Municipality, tend to receive higher average rainfall, demonstrating the geographical diversity of the district's climate and the complex nature of its water security issues.

Under a low mitigation scenario (RCP 8.5), future projections indicate a general decrease in average annual rainfall by up to 55 mm in certain parts of the district by 2050. However, there is an anticipated spatial variation in these changes across the Namakwa District. General Circulation Models (GCMs) predict small increases in rainfall towards the eastern parts of the district, such as Brandvlei, Williston, and Fraserburg, while most other areas are expected to experience less rainfall than the current average. Locations likely to be more severely impacted by the reduction in rainfall include Sutherland, Calvinia, Garies, Hondeklip Bay, Kleinsee, and Port Nolloth. This potential shift towards more arid conditions underscores the pressing need

for comprehensive climate change adaptation strategies to sustainably manage water resources in the region.

3.1.2. Climate Hazards

A summary of the climate hazards is included below:

3.1.2.1. Drought

Currently, large portions of the Namakwa District Municipality are exposed to high tendencies for drought, a condition that is predicted to escalate towards 2050. An inclination for more intense and frequent droughts is anticipated for the future, raising concerns for all the main settlements in the region. Particularly vulnerable are coastal settlements, such as Port Nolloth, Hondeklip Bay, and Garies, all of which face medium to high drought risk. In addition, some settlements situated in the inland and southern areas of Namakwa, including Calvinia, Loeriesfontein, Williston, Brandvlei, Sutherland, and Fraserburg, are confronted with an extreme risk of drought. This poses significant challenges for these communities, both in terms of water security and economic resilience, as agriculture, a key sector in the district, is highly dependent on reliable water sources.

Furthermore, projections indicate that the entire District will experience a trend toward more intense droughts in the future. This is not a localized issue but one that encompasses the entire Municipality, emphasizing the urgency of devising effective and far-reaching drought mitigation strategies. This scenario could potentially exacerbate existing water scarcity, negatively impact agricultural production, and increase the vulnerability of local communities and ecosystems. As such, developing proactive measures to manage this risk and mitigate its impacts will be crucial to ensure the long-term resilience and sustainability of the Namakwa District Municipality.

3.1.2.2. Heat

The term 'very hot days' refers to those where the day's maximum temperature surpasses 35°C per General Circulation Model (GCM) grid point. Historical climate data for the baseline period of 1961-1990 reveals that large parts of the Namakwa District already experience an average of more than 46 very hot days annually. The areas most affected include those to the southwest, along the west coast, and those bordering Namibia in the north. In fact, some regions north of Pofadder and Aggeneys experience more than 100 very hot days annually, with daily maximum temperatures exceeding 35°C. In contrast, the southern part of the Namakwa District, including Sutherland and Fraserburg, experiences between 0 and 10 very hot days annually, with the number increasing to 11 to 20 very hot days in central areas, such as Calvinia and Williston, and rising further northwards.

Future projections under changing climate conditions indicate that the frequency of very hot days will increase, particularly in areas that are already prone to extreme heat. This signifies

that heatwave events are more likely to occur towards the north of the District, affecting regions in the Richtersveld, Khai-Ma, Nama Khoi, and Hantam Local Municipalities. It's also important to note the unique vulnerability of urban areas. Their built-up, concrete-dominated structures tend to absorb and retain heat, a characteristic known as the "urban heat island effect," making urban residents especially susceptible to increasingly high temperatures.

As these conditions are projected to intensify, certain settlements are expected to be exposed to extreme risk from heat stress in the future. Specifically, Pella, Pofadder, and Aggeneys are predicted to face extreme heat stress risks. On the contrary, coastal settlements, such as Port Nolloth and Kleinsee, are likely to bear a lower risk of heat stress due to their proximity to the sea, which often provides a moderating effect on temperatures. Regardless, these projected increases in heat-related risks necessitate the urgent development of adaptation strategies to protect vulnerable communities and ensure the resilience of the Namakwa District under changing climate conditions.

3.1.2.3. Wildfire

Fire risk is evaluated by combining the typical fire hazard for a fire ecotype (including the likelihood and severity of fires) with the potential social and economic repercussions (which encompass the potential for economic and social losses). For the Namakwa District, the overall fire risk is currently low, with the exception of areas in the Kamiesberg mountains and Nieuwoudtville. In these particular areas, the conditions are more conducive to fire incidents, resulting in a slightly higher likelihood of fires occurring.

However, as we look towards the future, the risk of wildfires across the entire District is projected to rise due to the escalating effects of climate change. It is anticipated that all settlements in the District could face a medium risk of wildfires in the future. This means a substantial increase in the wildfire risk, potentially resulting in more frequent and severe fire incidents that could cause significant social and economic disruption. As such, future climate adaptation and mitigation strategies in the Namakwa District will need to account for this increased risk, developing robust wildfire prevention and management plans to protect both the natural environment and the communities within it.

3.1.2.4. Flooding

The process of assessing flood hazard integrates a variety of information, including climate data, records of previous floods, and the specific characteristics of water catchments which determine their susceptibility to flooding. In the Namakwa District Municipality, the flood hazard varies significantly across the region. The majority of the District experiences low to medium flooding hazards. However, certain areas display medium to high flooding hazards, indicating these areas are more prone to experiencing damaging flood events.

The future outlook suggests that there will be a slight to significant decrease in the number of days with extreme rainfall across most of the District, barring a few areas north of Brandvlei and around Fraserburg and Sutherland that might experience slight increases. This predicted decrease in extreme rainfall days aligns with the overall projected decrease in annual rainfall over the District. The far north of the District, in particular, is likely to experience the most pronounced decrease in extreme rainfall days, which may impact the occurrence and severity of flooding in these areas.

When it comes to flood risk in individual settlements, most display a very low risk, with the exceptions of Fraserburg and Loeriesfontein which have somewhat elevated risks compared to the rest of the District under the baseline climate. As for coastal settlements, they generally present a very low risk of coastal flooding under current conditions. However, the situation is expected to change by 2050 due to the impacts of climate change. For instance, Port Nolloth is projected to face a high risk of coastal flooding, while Hondeklipbaai could face a medium risk, necessitating the implementation of proactive coastal adaptation and resilience measures.

3.1.3. Climate Impacts

3.1.3.1. Water Resources

In South Africa, the role of groundwater in supporting economic development and ensuring water security cannot be understated. It's especially crucial for rural and urban settlements that depend entirely or partially on groundwater supply. However, groundwater is a natural resource that is particularly sensitive to the impacts of climate variability and climate change. These influences can significantly affect the availability and distribution of groundwater, posing challenges for water resource management and planning.

In the context of the Namakwa District, there exists a mix of settlements that depend on either surface water, groundwater, or a combination of both. Notably, towns like Port Nolloth, Kleinsee, and Calvinia depend on both groundwater and surface water sources. On the other hand, some towns like Springbok, Aggenys, and Pofadder rely solely on surface water. Many of the smaller settlements, due to their geographical locations and infrastructure availability, are predominantly reliant on groundwater resources.

The current groundwater recharge potential - the ability of an area to replenish its groundwater resources - varies across the District. It is notably low along the west coast, particularly towards the northwest. In contrast, it is somewhat higher in the interior and eastern parts of the District. This recharge potential is, however, projected to decrease over most of the District, except for a few areas in the south along the escarpment. Given the anticipated future groundwater recharge potential coupled with population growth, most settlements in the Namakwa District are at low to medium risk of groundwater depletion. This is in part due to most Local Municipalities experiencing a downward trend in population growth. However, Fraserburg and

Williston are projected to face a medium risk of groundwater depletion due to decreased recharge potential. Similarly, Port Nolloth also faces a medium risk of groundwater depletion, primarily due to population growth pressures. These scenarios underline the necessity for careful management and sustainable use of groundwater resources.

The current water supply vulnerability is depicted in Table 3, below.

Table 3: Current water supply and vulnerability across NDM.

Local Municipality	Water Demand per Capita (l/p/d)	Water Supply per Capita (l/p/d)	Current Water Supply Vulnerability
Richtersveld	164.42	182.94	0.90
Nama Khoi	680.81	926.15	0.74
Khai-Ma	925.17	1353.79	0.68
Kamiesberg	56.04	No Information	
Hantam	84.63	95.85	0.88
Karoo Hoogland	88.29	93.66	0.94

**Key: A water supply vulnerability score above 1 indicates that demand is more than supply, while a score below 1 indicates that supply is meeting demand.*

3.1.3.2. Sectors

The agricultural sector is a significant component of the Namakwa District's economy, contributing 10.20% to the District's Gross Value Added (GVA). The sector is diverse, encompassing a range of agricultural commodities, including sheep and meat production, irrigated deciduous fruits, and other crops such as table grapes, dates, citrus, rooibos tea, and wheat. However, this crucial industry is facing threats from projected climatic changes, with the District forecasted to experience a hotter and drier climate across all its Local Municipalities in the future.

These projected climatic changes could have varied impacts on the District's agricultural sector. The predicted drier conditions may lead to reduced availability and quality of pastures due to a decline in rainfall, subsequently hampering the regeneration of the veld and forcing farmers to become more reliant on supplemental feed for their flocks. Livestock could also face increased heat stress, leading to reduced growth and reproductive efficiency. While warmer winters may reduce cold weather-associated livestock mortality, they could also favour the survival of pests and parasites that threaten livestock, creating new challenges for livestock farmers.

On the horticultural front, deciduous fruit crops could suffer from a reduction in the available winter chill and increased summer heat stress, resulting in increased evapotranspiration and irrigation requirements. These changes may alter the suitability of the region for some deciduous fruit cultivars, impacting the productivity and profitability of these operations. However, rooibos tea, being endemic to the region and well-adapted to hot and dry conditions, might fare better under the projected climate changes. Despite the general negative impact, the changing climate could present opportunities for the introduction of more climate-resilient

crops or farming practices, underscoring the need for adaptation strategies to ensure the sustainability of the District's agricultural sector.

3.1.4. Priority Risks and Vulnerabilities

3.1.4.1. Municipal

Municipal vulnerability is unpacked in terms of four vulnerability indices (Socio-Economic Vulnerability Index [SEVI], Economic Vulnerability Index [EcVI], Physical Vulnerability Index [PVI] and Environmental Vulnerability Index [EnVI]).

Each Local Municipality in the NDM is provided with a score out of 10 for each of the vulnerability indices. A score higher than 5 indicates an above-national average, and a score lower than 5 indicates a below-national average for vulnerability. Scores are provided for both 1996 and 2011, where a lower score in 2011 compared to 1996 indicates an improvement and a higher score indicates worsening vulnerability. Trend data are only available for Socio-Economic Vulnerability and Economic Vulnerability.

Table 4: Vulnerability indicators across Namakwa District Municipality

MUNICIPALITY	SEV 1996	SEV 2011	Trend	EVI 1996	EVI 2011	Trend	PV	Trend	EV	Trend
Hantam	4.33	2.69	↓	3.64	1.89	↓	5.97	↓	1.68	No Trend
Kamiesberg	4.26	3.84	↓	8.78	8.65	↓	7.85	↓	2.33	No Trend
Karoo Hoogland	4.75	3.31	↓	4.97	4.77	↓	6.20	↗	1.87	No Trend
Khai-Ma	3.05	2.56	↓	6.80	5.22	↓	5.85	↗	1.62	No Trend
Nama Khoi	2.90	2.19	↓	7.64	5.25	↓	6.85	↓	3.08	No Trend
Richtersveld	2.85	2.09	↓	8.44	5.73	↓	8.18	↓	4.96	No Trend

Socio-economic vulnerability has decreased (improved) across all Local Municipalities between 1996 and 2011. Kamiesberg Local Municipality has the highest economic vulnerability in the District and the third highest in the Northern Province after Joe Morolong and Phokwane Local Municipalities. In 2020 there were around 44.50 % of people living in poverty in the Kamiesberg Local Municipality. Given the vast open spaces and sparsely populated landscape of the Northern Cape Province, especially in the Richtersveld, the Richtersveld Local Municipality has the highest physical vulnerability in the Northern Cape Province. Similarly, the Richtersveld Local Municipality also has the highest environmental vulnerability due to pressures on the biodiversity hotspots in this region.

3.1.4.2. Settlement

The unique set of six (6) indicators listed below highlights the multi-dimensional vulnerabilities of the settlements within the Mopani District and its Local Municipalities.

- Socio-Economic Vulnerability Index;
- Economic Vulnerability Index;
- Environmental Vulnerability Index;
- Growth-Pressure Vulnerability Index;
- Regional Economic Connectivity Vulnerability Index;
- Service Access Vulnerability Index.

Table 5: Anticipated settlement vulnerability for NDM and Local Municipalities.

Local Municipality		Anticipated Settlement Vulnerability
Richtersveld Municipality	Local	<ul style="list-style-type: none"> • Major settlements include Port Nolloth, Eksteenfontein, Sanddrif, Sendelingsdrif and Alexander Bay. • Port Nolloth and Alexander Bay have elevated environmental vulnerability. • Sendelingsdrif is the most remote settlement with very high regional connectivity vulnerability as well as high economic vulnerability.
Nama Khoi Municipality	Local	<ul style="list-style-type: none"> • The major settlements in this municipality include Springbok, Okiep, Kleinzee, Steinkopf, Nababeep and Vioolsdrift. • Kleinzee and Vioolsdrift have the highest vulnerability in terms of regional connectivity, due to their remoteness and distance from other centres. • Okiep and Vioolsdrift have the highest growth pressure. • Springbok faces significant environmental vulnerability.
Khai-Ma Municipality	Local	<ul style="list-style-type: none"> • Major settlements include Pofadder, Pella and Aggeneys. • Pofadder has the highest vulnerability in terms of access to services and also faces significant socioeconomic vulnerability. • Pella has both high socioeconomic as well as economic vulnerability. (The key livelihood activities in Pella are agriculture based and people engage in subsistence farming on the banks of the Orange River).
Kamiesberg Municipality	Local	<ul style="list-style-type: none"> • Major settlements include Garies, Kamieskroon and Hondeklipbaai. • Garies and Hondeklipbaai face significant growth pressure. • Hondeklipbaai faces the greatest vulnerability in terms of regional connectivity.
Hantam Municipality	Local	<ul style="list-style-type: none"> • Major settlements include Calvinia, Nieuwoudtville, Loeriesfontein and Brandvlei. • Both Loeriesfontein and Calvinia have very high vulnerability in terms of access to services and regional connectivity.

		<ul style="list-style-type: none"> • Brandvlei has the highest vulnerability in terms of economic, socio-economic and environmental indicators. It also faces the highest growth pressure in the municipality
Karoo-Hoogland Municipality	Local	<ul style="list-style-type: none"> • Major settlements include Sutherland, Fraserburg and Williston. • Sutherland has the highest economic, socio-economic and access to services vulnerability, while also facing the greatest growth pressure in the municipality. • Williston has the highest environmental and regional connectivity vulnerability.

The Richtersveld Local Municipality, which includes major settlements such as Port Nolloth, Eksteenfontein, Sanddrif, Sendelingsdrif, and Alexander Bay, faces various vulnerabilities. Port Nolloth and Alexander Bay have elevated environmental vulnerability due to their coastal locations, while Sendelingsdrif, the most remote settlement, suffers from high regional connectivity and economic vulnerability. Similarly, the Nama Khoi Local Municipality, home to settlements like Springbok, Okiep, Kleinzee, Steinkopf, Nababeep, and Vioolsdrift, experiences distinct challenges. Kleinzee and Vioolsdrift, due to their remote locations, face the highest vulnerability in terms of regional connectivity, while Okiep and Vioolsdrift have the most growth pressure. Springbok, the administrative capital, faces significant environmental vulnerability due to its geographical location and climatic conditions.

Moving further inland, the Khai-Ma Local Municipality, with its major settlements like Pofadder, Pella, and Aggeneys, encounters considerable socio-economic and economic vulnerabilities. Pofadder stands out with high vulnerability in terms of access to services and socioeconomic vulnerability. Pella, a largely agricultural community, experiences high economic and socioeconomic vulnerability due to its dependency on agriculture and its exposure to the impacts of climate change. Meanwhile, the major settlements in the Kamiesberg Local Municipality, including Garies, Kamieskroon, and Hondeklipbaai, face significant growth pressure, with Hondeklipbaai also facing substantial vulnerability in terms of regional connectivity. In the Hantam Local Municipality, both Loeriesfontein and Calvinia display very high vulnerability in terms of access to services and regional connectivity. Brandvlei, another major settlement, faces significant vulnerability across economic, socio-economic, and environmental indicators, accompanied by high growth pressure. Lastly, in the Karoo-Hoogland Local Municipality, Sutherland experiences the highest economic, socio-economic, and access to services vulnerability, while also encountering the greatest growth pressure. Williston, another major settlement, presents with the highest environmental and regional connectivity vulnerability.

4. Climate Change Adaptation Plan

4.1. Namakwa DM's Strategic Organisational Objectives and the Linkage to Climate Change Adaptation

The Namakwa District Municipality (NDM) has outlined a set of strategic objectives that serve as guiding principles for its long-term vision and operational framework. These objectives include the stimulation of a green, diverse, integrated socio-economy; fostering and strengthening partnerships with all role-players; providing integrated support and capacitating local municipalities for sustainability; ensuring transparent and accountable processes; and providing strategic leadership. Each of these objectives not only contributes to the overall prosperity and resilience of NDM but they are also interconnected with the broader global challenge of climate change. The approach to these objectives needs to consider the dynamic and complex nature of the climate system and the varied impacts it can have on the social, economic, and environmental dimensions of the NDM.

Table 6: NDM's strategic objectives and linkage to climate change.

Development Priority	Link to Climate Change
Stimulation of green, diverse, integrated socio-economy.	NDM's strategic objective to stimulate a green, diverse, integrated socio-economy aligns closely with the imperatives of climate change adaptation and mitigation. The focus on a green economy reflects the intention to create economic growth that is environmentally sustainable, helping to reduce greenhouse gas emissions and manage the impacts of climate change. A diverse and integrated socio-economy is also important for resilience in the face of climate change, as it provides the flexibility to respond to and recover from various climate shocks and stresses.
Fostering and strengthening partnerships with all role-players.	Fostering and strengthening partnerships with all role-players is another key strategic objective that relates to climate change. Climate change is a complex issue that requires concerted effort and collaboration across sectors, institutions, and communities. By engaging stakeholders, pooling resources, sharing knowledge and promoting cooperation, the municipality can more effectively address the multifaceted challenges posed by climate change.
Integrated support and capacitating local municipalities for sustainability.	In terms of integrated support and capacitating local municipalities for sustainability, this objective underscores the importance of building the capacities of local authorities to plan for, and respond to, climate change. This might involve providing technical support for the development and implementation of climate change strategies,

	promoting the use of sustainable technologies, and fostering innovation in climate change resilience.
Transparent and accountable processes.	Transparent and accountable processes play a crucial role in addressing climate change. Clear, open procedures ensure the effective use of resources, encourage public trust and engagement, and facilitate the monitoring and evaluation of climate change initiatives. It's through such transparency and accountability that municipalities can track progress, learn from successes and failures, and make necessary adjustments in their climate change strategies.
Providing strategic leadership.	Providing strategic leadership is key to driving the climate change agenda. As climate change affects multiple sectors, it requires strong leadership to coordinate actions, set priorities, and guide the district towards a sustainable and resilient future. Leaders can set the tone by advocating for climate-smart policies, promoting green practices, and motivating stakeholders to take climate action. Effective leadership can foster a culture of climate resilience that permeates all aspects of life in the municipality.

4.2. Climate Change Adaptation Vision

In the context of the Namakwa District Municipality (NDM), climate change resilience and mainstreaming would mean the integration of climate change response principles into all aspects of municipal planning, development, and operations. This approach resonates with the district's goals to prioritise the health and safety of communities in the face of a changing climate, reduce the exposure and vulnerability of human and natural systems to climate change, ensure water security, and develop climate-resilient, low-carbon, diverse, and inclusive rural economies.

In line with the strategic objectives of the Namakwa District Municipality (NDM), several practices could be considered to increase resilience under the threat of climate change:

1. To ensure water security and quality for human consumption and agriculture under a changing climate, NDM could implement strategies such as public awareness campaigns, leak detection and repairs, water metering and billing, prioritizing infrastructure maintenance, promoting water conservation practices, implementing rainwater harvesting systems, and exploring alternative water sources. An investment in efficient water infrastructure will contribute significantly to water security.
2. The management of the physical isolation of communities and potential increased migration to urban and peri-urban areas could involve improving the connectivity and accessibility of remote communities. This can be achieved by developing rural infrastructure and promoting sustainable urban growth, which will help accommodate newcomers and lessen the risk of overpopulation in urban centres.

3. Managing the impacts of heat stress on humans and livestock could involve implementing measures that minimize the adverse effects of extreme heat. These may include promoting the use of cooling technologies, providing public health guidance during heatwaves, and advocating for livestock management practices that protect animals from heat stress.
4. The resilience of the agricultural sector can be increased by supporting commercial and small-scale farmers across industries. Providing farmers with access to resilient crop varieties, training in sustainable farming techniques, financial risk management tools, and market opportunities can help the agricultural sector withstand shocks and stresses such as climate change, market fluctuations, and pests.
5. To protect natural resources and manage the loss of high-priority biomes, NDM could enforce the protection and restoration of natural ecosystems such as high-priority biomes, wetlands, river ecosystems, and riparian areas. Actions might include establishing or expanding protected areas, enforcing regulations against harmful practices, and promoting the sustainable use of natural resources.
6. Reducing the vulnerability and exposure of human and natural systems to climate change and extreme events involves adopting infrastructure design standards and practices that account for future climate change impacts. This aligns directly with the goal of ensuring that infrastructure and settlements are resilient to changes and that both human communities and natural ecosystems are less susceptible to the harmful effects of climate change and extreme weather events.

By adopting these practices, the Namakwa District Municipality would be taking important steps towards achieving its stated goals and positioning itself as a climate-resilient district that is prepared for the challenges of the future. These best practices are not exhaustive and could be complemented by other strategies tailored to the specific context and needs of the NDM. The key to success is integrating these principles into all aspects of municipal decision-making and operations and engaging the community in these efforts.

The proposed climate change response vision for the NDM reads as follows:

“NDM aspires to be a district that seamlessly incorporates climate change response principles into all areas of municipal planning, development, and operations, with an unwavering commitment to ensuring community safety, reducing human and natural systems’ vulnerability to climate change, securing water resources, and cultivating a resilient, low-carbon, diverse, and inclusive rural economy in the face of a shifting climate.”

The vision of the Namakwa District Municipality (NDM) reflects an ambitious commitment to adapt and thrive in the face of climate change. This vision is deeply embedded in the strategic objectives of the NDM, embracing a future where all municipal operations, planning, and developments are guided by the principles of climate change response. A key aspect of this vision is ensuring community safety, mirrored in the objective of supporting local municipalities for sustainability, thereby reducing the vulnerability of both human and natural systems to the

effects of climate change. As part of its strategic goal to stimulate a green, diverse, integrated socio-economy, NDM envisages securing water resources, fundamental to both the well-being of its residents and the sustainability of its economic sectors. Furthermore, the vision of NDM aligns with its strategic objective of fostering and strengthening partnerships, to cultivate a resilient, low-carbon, diverse, and inclusive rural economy in the face of a changing climate. Transparent, accountable processes and strategic leadership are the key tools in achieving this vision, thus ensuring the successful navigation of NDM through the challenges presented by climate change.

4.3. Climate Change Goals and Programmes

The Namakwa District Municipality (NDM) has recognised the urgency to respond to climate change impacts. These impacts, identified through a comprehensive Climate Change Risk Profile, include drought, increased temperatures, and extreme heat stress. These climate threats pose significant risks to the district's agricultural sector, the health of its residents, and livestock. To navigate these challenges, a sequenced approach to adaptation planning has been adopted, culminating in the development of strategic Adaptation Goals. These goals aim to guide a contextually relevant approach to adaptation planning and have subsequently informed the development and categorisation of specific Adaptation Programmes.

The Climate Change Adaptation Plan for the NDM is framed by the following Adaptation Goals:

1. To ensure water security and quality for human consumption and agriculture under a changing climate: Considering the threats of drought and increased temperatures, strategies such as efficient water management practices, infrastructure improvements, and promotion of water-conserving behaviours will be implemented.
2. To manage physical isolation of communities and potential increased migration to urban and peri-urban areas: This includes improving rural infrastructure, promoting sustainable rural development, and planning for sustainable urban growth to accommodate migration driven by climate changes.
3. Managing the impacts of heat stress on humans and livestock: Measures will be taken to minimize the harmful effects of high temperatures, focusing on public health initiatives during heatwaves for humans and protective measures like shade and heat-tolerant breeds for livestock.
4. To prioritise the health and safety of communities in the face of a changing climate: This is particularly relevant for the agricultural workforce which are exposed to outdoor conditions. Special attention will be given to the health and productivity of livestock, particularly heat-stressed sheep.
5. To protect natural resources and manage the loss of high-priority biomes: Strategies will be designed to manage potential losses of the Nama-Karoo and Fynbos biomes due to hotter and drier conditions and overgrazing. This goal also encompasses protective measures for the coastal ecosystem threatened by sea-level rise, storminess, and rising ocean temperatures.

6. To reduce the vulnerability and exposure of human and natural systems to climate change and extreme events: The declining population projection for 2050 and the large distances between settlements have been considered in developing strategies to improve access to services like health and education and to build resilience in infrastructure and disaster risk management.

These Adaptation Goals serve as the cornerstone of the Adaptation Programmes. Each Programme is further unpacked to provide a detailed breakdown of the key climate actions and support activities required to effectively respond to the unique climate risks faced by the NDM. Through this comprehensive, targeted, and contextually relevant approach, the NDM aims to build a resilient community that can thrive in the face of a changing climate.

Following the development of the contextually relevant Adaptation Goals, a series of Adaptation Programmes have been established to operationalise these objectives. Each programme is designed to address a specific element of the district's response to climate change, and will be implemented through a detailed breakdown of key climate actions and support activities.

1. Adopt an integrated approach to water augmentation, water use and water management.
2. Water conservation and demand management.
3. Assessing alternative water sources.
4. Groundwater management.
5. Rural resilience and livelihoods enhancement.
6. Sustainable urban development and planning.
7. Climate-sensitive migration management.
8. Human health and heat stress management.
9. Livestock heat stress management.
10. Infrastructure resilience to heat stress.
11. Climate-smart agricultural practices.
12. Climate-resilient land management and use.
13. Incentivizing sustainable agricultural practices.
14. Conserve, protect and restore natural open spaces, ecosystems with climate change adaptation benefits.
15. Develop and implement conservation and management plan for vulnerable species.
16. Enhanced natural resource management.
17. Integration of ecological support areas and ecosystem services into sdf and idp.
18. Enhance coastal and marine environmental assessment and protection.
19. Establish and implement comprehensive estuarine management plans.
20. Promote coastal resilience and disaster risk management.
21. Integrated fire management for climate resilience.
22. Comprehensive stormwater and flood management programme.
23. Identify and prioritise climate change risks and develop response measures for settlements.
24. Community-based adaptation in communities most at risk of climate-related hazards.

4.4. Climate Change Goal 1: To Ensure Water Security and Quality for Human Consumption and Agriculture Under A Changing Climate.

Table 7: Climate change goal 1, outcome, linkage to district's strategic objectives.

Goal:	<ul style="list-style-type: none"> Enact strategies ensure universal water availability while minimizing water demand, usage, pollution, and waste in response to the climate change impacts on the water cycle.
Outcome:	<ul style="list-style-type: none"> Realization of a secure and efficient water supply for everyone, marked by a decrease in demand, waste, and pollution.
Linkage to NDM's Strategic Objectives	<ul style="list-style-type: none"> Stimulation of green, diverse, integrated socio-economy: By ensuring water security and quality, NDM can stimulate a green and diverse socio-economy. Sustainable management of water resources contributes to environmental conservation, fostering green economy practices. Moreover, water is a critical resource for various economic sectors including agriculture, manufacturing, and tourism, thus contributing to socio-economic diversity. Fostering and strengthening partnerships with all role-players: Achieving water security under a changing climate requires a collaborative approach, involving partnerships with local municipalities, the private sector, civil society, and communities. This strengthens existing partnerships and fosters new ones, contributing to shared goals and efforts in addressing climate change. Integrated support and capacitating local municipalities for sustainability: Enhancing water security and quality under changing climate conditions calls for integrated support to local municipalities. It necessitates capacity building in areas such as water management, climate change adaptation strategies, and water treatment technologies. This aligns with NDM's objective of strengthening the capabilities of local municipalities towards sustainable development. Transparent and accountable processes: Ensuring water security and quality under a changing climate necessitates transparent and accountable processes. These might involve clear communication of water management strategies, inclusive decision-making, and accountability in the use and conservation of water resources. This reinforces NDM's commitment to transparency and accountability. Providing strategic leadership: Achieving this climate change goal demands strategic leadership from NDM. This involves steering policies, plans, and actions towards water security and quality amidst climate change. It also requires the municipality to lead in advocating for and implementing innovative, sustainable solutions, demonstrating NDM's commitment to strategic leadership.

4.4.1. Rationale/Context:

Namakwa District Municipality (NDM), embedded in the arid Northern Cape Province of South Africa, faces an increasing challenge of water scarcity due to its semi-desert climate and extremely low precipitation patterns. The area's climatic constraints, combined with population growth and essential water demands for agriculture and mining activities, put significant pressure on the local water infrastructure. With the Orange River on the northern boundary and the northwesterly flowing Oliphant's River flowing through the Hantam and Karoo Hoogland Local Municipalities being the two main river systems, much of NDM's water supply is heavily reliant on these rivers and groundwater. However, these river systems and high yielding water catchment areas are under pressure from agricultural practices that pollute the areas. The existing challenges related to water quality and availability are likely to be exacerbated by rising temperatures and changes in rainfall patterns in this water-stressed region. Therefore, maintaining an efficient and resilient water infrastructure is indispensable for the district's sustainability.

The water infrastructure in the district comprises critical components such as dams, pipelines, treatment facilities, and distribution networks that deliver water to consumers - households, industries, and farms. Additionally, wastewater treatment plants manage and treat used water before its discharge back into the environment or reuse. Yet, the challenges posed by ageing infrastructure, inadequate maintenance, and management issues have led to substantial inefficiencies, including water losses and supply disruptions. Therefore, upgrading existing water infrastructure, adopting innovative water-saving technologies, and implementing effective water management strategies becomes a pressing need.

The Northern Cape Province's position within four of South Africa's six hydrological zones exacerbates the significance of water management. The area's main sources of surface water, the Orange River and the Vaal River, along with their tributaries, are under constant pressure due to water abstraction and dam construction. Ecosystem damages from pollution and riverine vegetation removal further diminish these ecosystems' capacity to provide essential services. In the NDM, where large areas in the north of the District regularly receive less than 100mm of rainfall annually, the urgency of robust water management strategies is even more pronounced. Climate change aggravates these challenges, particularly with rising air temperatures leading to increased evaporation from dams, wetlands, and soils, thereby negatively impacting irrigation water quality. Moreover, groundwater, which forms a large part of the Northern Cape's water supply, is subject to significant drops during drought periods, a situation that climate change is expected to worsen. As such, prioritizing "*to ensure water security and quality for human consumption and agriculture under a changing climate*" in NDM's climate adaptation report becomes not just necessary but a strategic priority to safeguard the district's water resources and overall resilience in the face of ongoing climatic shifts.

Several programmes have been identified through which it will aim to achieve the goal and targets of this outcome:

4.4.2. Programme 1: Adopt an Integrated Approach to Water Augmentation, Water Use and Water Management

The programme "*adopt an integrated approach to water augmentation, water use and water management*" seeks to holistically address water-related issues in Namakwa District Municipality (NDM) by consolidating various efforts towards enhancing water resilience. It entails the adoption of multiple strategies and actions designed to augment water supplies, optimize water use, and improve water management.

- A key component of this programme is water-sensitive urban design (WSUD), which is an approach to urban planning that integrates water cycle management into urban development and planning processes. In the NDM context, this might include rainwater harvesting projects at the household level, stormwater management, and wastewater recycling. Such designs aim to reduce pressure on water sources, mitigate flood risks, and increase the sustainability of urban water systems.
- Addressing human resources constraints for effective water management is another crucial aspect of the programme. By reviewing the staff organogram and existing budgets, the programme aims to increase internal capacity to deal with climate change and wastewater issues. It may involve hiring additional personnel, training existing staff, and reconfiguring roles to ensure that the municipality has the expertise necessary for effective water management.
- The programme also plans to Review the bulk water master plan, which could include updating strategies for large-scale water supply, storage, and distribution. Part of this review process will involve the development of an operations and maintenance plan for the water sector, aimed at ensuring the reliability and longevity of water infrastructure.
- Developing a water safety plan (WSP) is another key activity. This process would involve conducting comprehensive water quality risk assessments for availability and consumption, ensuring that water supplied for human use is safe and sustainable. This action aligns with efforts to develop and monitor a water services development plan, which outlines how the district will provide and manage water services over time.

In summary, the programme "*adopt an integrated approach to water augmentation, water use and water management*" reflects a comprehensive and forward-thinking approach to water management in the NDM, bringing together multiple initiatives to enhance water resilience in the face of climatic and other challenges.

Table 8: Programme 1 - Integrated approach to water augmentation, use, and management.

Programme 1: Integrated Approach to Water Augmentation, Use, and Management.	
ACTIONS	KEY ACTIVITIES
Water-sensitive urban design (WSUD).	<ul style="list-style-type: none"> Implementing green infrastructure. To maintain water services efficiently, the municipality can introduce green infrastructure to capture, store, and treat stormwater while improving air quality and biodiversity within the community. Promoting water reuse. Identify and implement opportunities for using treated wastewater for non-potable purposes such as irrigation, industrial processes, and toilet flushing. This will ensure the sustainable use of water resources. Encouraging water-efficient design: Ensure equitable water services, buildings and infrastructure could be designed to minimise water use through the use of low-flow fixtures, water-efficient landscaping, and water recycling systems. Managing urban runoff: Assess the feasibility of capturing and re-using stormwater. Educating and engaging stakeholders: Promote awareness of the benefits of WSUD and encourage participation in the design and implementation of WSUD projects. This will ensure that the community is well-informed and actively involved in sustainable water usage initiatives.
Addressing human resources constraints for effective water management.	<ul style="list-style-type: none"> Advocate for and secure funding for a dedicated water resources manager position: Highlighting the crucial role of a water resources manager in addressing drought and other water-related challenges in the municipality. This would help to ensure the efficient provision of water services. Recruit and train a qualified water resources manager: By implementing a transparent recruitment process to select a skilled and experienced water resources manager, the municipality can ensure they have the necessary skills and knowledge to effectively manage water resources. Strengthen collaboration and communication between the water resources manager and other relevant water management departments: Establishing a cross-functional working group to facilitate communication, collaboration, and information sharing between the water resources manager and other departments responsible for water management.
Review bulk water master plan.	<ul style="list-style-type: none"> Understanding the Current Water Landscape: The initial stage will involve mapping out the current water resources and needs, which includes municipal, industrial, and agricultural sectors. It is crucial to integrate climate change projections into this analysis to anticipate future shifts in water supply and demand. Exploring New Water Sources: The updated plan should investigate potential new sources of water, such as surface water, groundwater, and seawater desalination. This evaluation

	<p>will take into account factors like cost, feasibility, and environmental impact for each potential source.</p> <ul style="list-style-type: none"> • Evaluating Infrastructure Requirements: The plan should conduct an in-depth review of the existing water-related infrastructure, including water treatment facilities, pipelines, and storage units. The aim is to pinpoint areas that may need additional infrastructure to cater to future demands. • Setting Goals and Formulating Strategies: The plan will clear water usage goals and devise strategies to curb water consumption and augment efficiency. These strategies may involve initiatives like water metering, leak detection, and public education drives. • Execution of the Plan: The final stage will involve the roll-out of the plan. Regular monitoring and evaluation will be integral to ensure that the set targets are being met and necessary adjustments are made to the plan as needed. This stage may also necessitate funding for new infrastructure, fostering partnerships with relevant organisations, and ensuring stakeholder alignment with the plan's objectives.
<p>Developing a water safety plan (WSP).</p>	<ul style="list-style-type: none"> • Conducting a risk assessment: Assess the risks that can affect the quality and safety of the water supply, including natural hazards and man-made threats. • Determining control measures: Identify control measures that can be implemented to reduce risks and enhance the safety of the water supply, such as disinfection, filtration, and monitoring. • Developing an emergency response plan: Develop a plan for responding to incidents that could affect the water supply, such as natural disasters or system failures. • Implementing monitoring and reporting: Establish a monitoring programme to ensure that the water supply remains safe and of good quality. The results of monitoring should be reported to relevant authorities and stakeholders. • Training and educating staff: Ensure that all staff involved in the water supply system are trained on WSP development and implementation, including risk assessment, control measures, and emergency response. • Reviewing and updating the plan regularly: The WSP should be reviewed and updated periodically to ensure that it remains relevant and effective in addressing emerging risks and challenges.

4.4.3. Programme 2: Water Conservation and Demand Management

"Programme 2: water conservation and demand management" is a strategic initiative designed to manage and conserve the precious water resources in the arid region of the Namakwa District

Municipality (NDM). This initiative comprises several key activities to address the challenges of water scarcity and to promote efficient and sustainable water use.

- A primary focus of this programme is the implementation of monitoring mechanisms and the protection of water sources by reducing pollution. It involves identifying and implementing innovative groundwater monitoring initiatives that will highlight changes and variability in water salinity. In the context of NDM, these monitoring efforts will be crucial for maintaining the quality of the primary water source, groundwater, and managing its extraction effectively.
- Implementing water conservation measures is another significant activity under this programme. These measures can range from water-efficient practices in agriculture, such as the use of efficient irrigation systems, to the development and implementation of household water harvesting projects. In residential settings, 'Green' approaches could be enforced in developments, promoting water-saving practices such as rainwater harvesting and efficient appliances.
- The programme also includes the development of an alien invasive eradication programme for the removal of alien vegetation, specifically targeted at Proposis. Alien invasive species are known to consume large amounts of water, reducing the availability of water resources. Their removal will assist in conserving water, and it will also help to protect the local ecosystems and biodiversity.
- A further aspect of this programme is to enhance local capacity to deal with water issues. This includes increasing the internal capacity to deal with climate change and wastewater issues, reviewing the staff organogram and existing budgets, and upgrading all wastewater treatment works and water purification plants in the District Municipal Area. Such steps will ensure that the municipality has the necessary infrastructure and human resources to manage water resources effectively.
- Furthermore, the programme involves conducting ongoing infrastructure monitoring programmes with associated upgrading programmes and developing education programmes to promote community monitoring processes. These initiatives aim to create community awareness and involvement in water conservation, fostering a water-conscious culture within the NDM.

In conclusion, the "*water conservation and demand management*" programme embodies an integrative approach to managing and conserving water resources in NDM. By implementing this programme, NDM aims to ensure the sustainability and resilience of the district's water resources in the face of future climatic and population changes.

Table 9: Programme 2 - Protect and conserve water through monitoring mechanisms and water conservation through water conservation and water demand management (WCWDM).

Programme 2: Protect and Conserve Water Through Monitoring Mechanisms and Water Conservation through Water Conservation and Water Demand Management (WCWDM).	
ACTIONS	KEY ACTIVITIES

<p>Implementing monitoring mechanisms and protecting water sources by reducing pollution.</p>	<ul style="list-style-type: none"> • Water quality monitoring: Implement a regular testing schedule to monitor the health of water sources and identify potential pollution sources. This will support the mandate of providing and maintaining efficient and sustainable water services. • Buffer zone establishment: Create and manage buffer zones around water sources, such as rivers and wetlands, to protect them from pollution. The design of these zones should prevent runoff from agricultural and urban areas from entering the water sources, supporting the district government's role in coordinating and integrating water management efforts. • Sustainable agricultural practices promotion: Facilitate awareness campaigns, training, and capacity-building programmes to encourage farmers to use environmentally friendly fertilizers and pesticides. This contributes to the provincial government's mandate of developing and implementing plans and programmes for the sustainable use of water resources. • Effluent discharge regulation: Develop by-laws and regulations to control the discharge of industrial and domestic effluent municipal sewer systems. Regular monitoring of industries will ensure compliance, supporting the mandate of ensuring activities do not negatively impact water resources. • Responsible waste disposal advocacy: further provide facilities for the disposal of hazardous waste and improve public awareness campaigns on the importance of responsible waste disposal. This will help reduce the risk of water source pollution and aligns with the broader mandate of protecting water resources.
<p>Implementing water conservation measures.</p>	<ul style="list-style-type: none"> • Increase public awareness campaigns: Engagement with the public through campaigns, workshops, and educational programmes that promote water conservation practices. The education programmes to promote community monitoring processes could be in collaboration with Conservation South Africa and the Department of Water and Sanitation. • Improve leak detection and repairs: Enhance efforts to identify and repair leaks in water supply systems and infrastructure to prevent water loss. • Continue water metering and billing: Persist with the installation of water meters and implement billing systems that charge consumers based on the amount of water used, as a means to encourage water conservation. Water-efficient infrastructure: The municipality can install water-efficient fixtures and appliances, such as low-flow showerheads, faucets, and toilets and in municipal buildings. • Greywater recycling: Promote the use of greywater for irrigation and other non-potable uses to reduce demand on the municipal water supply.

	<ul style="list-style-type: none"> • Water restrictions: Implement water restrictions during times of drought or water scarcity to limit water use and prevent wastage. • Reclaimed water systems: Install and operate reclaimed water systems that treat wastewater for non-potable uses like irrigation, industrial processes, or firefighting. • Rainwater harvesting: Encourage the installation of rainwater harvesting systems in households and municipal buildings to capture and store rainwater for non-potable uses like irrigation, cleaning, or flushing toilets.
<p>Develop an alien invasive eradication programme for the removal of alien vegetation, especially targeted at Proposis.</p>	<ul style="list-style-type: none"> • Stakeholder collaboration and equitable contribution: Recognising that catchment areas fall outside NDM boundaries and that various water users utilise the it is essential to collaborate with all stakeholders to determine an equitable contribution from all parties to manage catchments. • Identifying and mapping invasive species: A comprehensive survey of invasive species within the catchment areas can be conducted in partnership with relevant stakeholders to identify and map the areas affected by invasive species. • Removal and control of invasive species: This involves the collaborative removal and control of invasive species using various techniques such as mechanical, chemical, and biological control methods, with contributions from all stakeholders. • Rehabilitation of cleared areas: After the removal of invasive species, the cleared areas need to be rehabilitated. This can be done through the restoration of indigenous vegetation and the implementation of erosion control measures, with support from all involved stakeholders. • Education and awareness: Education and awareness campaigns can be implemented in coordination with stakeholders to increase the understanding of the negative impacts of invasive species on catchment areas, and to promote responsible behavior in preventing the spread of invasive species. • Monitoring and evaluation: The effectiveness of invasive species control measures can be monitored and evaluated in partnership with stakeholders to ensure the long-term sustainability of the project, and to assess the contributions and impact of each stakeholder.
<p>Enforce 'green' approaches in residential areas and developments.</p>	<ul style="list-style-type: none"> • Developing and implementing guidelines and standards for sustainable residential and commercial development. • Enforcing compliance with building codes and regulations that promote sustainable water use practices, such as the installation of low-flow fixtures and rainwater harvesting systems. • Providing incentives for property owners to invest in green infrastructure and technologies that reduce water consumption and improve water efficiency.

- Conducting public awareness campaigns to educate residents on the importance of water conservation and the benefits of green infrastructure.
- Implementing water-efficient landscaping practices, such as xeriscaping, in public spaces and parks to reduce water use and promote sustainable development.

4.4.4. Programme 3: Assessing Alternative Water Sources

"*Programme 3: assessing alternative water sources*" is an integral part of the Namakwa District Municipality's (NDM) strategic initiatives to ensure water security amidst changing climate conditions and increasing demand. Given the inherent aridity and scarce water resources in the region, this programme underscores the need to diversify water sources, thereby enhancing the district's resilience to water-related risks.

- A pivotal activity within this programme involves comprehensive water resource management planning, which requires the development and monitoring of a water services development plan. This plan aligns water allocation policies with the district's water demands and projected future needs, ensuring efficient and equitable water distribution.
- Investigating alternative water sources is a core activity under this programme. Potential alternative sources, such as desalination, additional groundwater reserves, and wastewater reuse, are identified and evaluated for their feasibility and sustainability. For instance, considering NDM's coastal locality, investigating the feasibility of a desalination plant in Port Nolloth is a pertinent initiative. Further research into groundwater potential and the development of a Treated Effluent Reuse Strategy also exemplify the district's commitment to sustainable water management.
- Once potential alternative water sources have been identified, the programme advocates investing in the necessary infrastructure and technology to harness these sources. This could entail constructing desalination plants, drilling new boreholes for groundwater extraction, or upgrading wastewater treatment facilities to ensure treated water's safe reuse. In conjunction, a robust operations and maintenance plan would be developed for the water sector to ensure the efficient functioning and longevity of these investments.
- Furthermore, this programme emphasizes the importance of community involvement and education in water management. This is exemplified by the development of education programmes in collaboration with Conservation South Africa and the Department of Water and Sanitation, aimed at promoting community monitoring processes.
- Lastly, institutional strengthening is inherent to the programme's success. This involves increasing the internal capacity to deal with climate change and wastewater issues, and reviewing the staff organogram, and existing budgets. This enhancement will ensure that NDM has the resources and capabilities to manage complex and dynamic water systems effectively.

In summary, "Programme 3: assessing alternative water sources" constitutes a proactive and comprehensive approach to diversifying NDM's water sources, thereby enhancing its water security and resilience to a changing climate and growing demand.

Table 10: Programme 3 - Assessing the feasibility and sustainability of alternative water sources for climate change adaptation.

Programme 3: Assessing the Feasibility and Sustainability of Alternative Water Sources for Climate Change Adaptation.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Water Resource Management Planning.	<ul style="list-style-type: none"> • Conducting a water resource assessment: A comprehensive assessment of the existing water resources should be conducted to determine the available water sources, water quality, and quantity. • Identifying water demands: Understanding the current and future water demands of the municipality, including domestic, industrial, and agricultural water use, is crucial for developing a water resource management plan. • Developing a drought management plan: Droughts can have a significant impact on water resources, so developing a drought management plan can help to prepare for and mitigate the impacts of drought. • Developing water conservation strategies: Water conservation strategies can help to reduce water demand and optimize the use of available water resources. • Engaging stakeholders: Stakeholder engagement is critical for the successful development and implementation of a water resource management plan. It is important to engage with all relevant stakeholders, including the community, industries, and agricultural sectors, to ensure that their needs are considered in the plan
Investigating alternative water sources. (This activity involves identifying potential alternative water sources, such as desalination, groundwater, and wastewater reuse).	<ul style="list-style-type: none"> • Feasibility studies: Conducting feasibility studies to identify and assess the viability of various alternative water sources, such as rainwater harvesting, groundwater extraction, and stormwater capture. • Hydrological assessments: Undertaking hydrological assessments to determine the water availability and potential yield of alternative water sources, such as aquifers and rivers. • Cost-benefit analysis: Conducting cost-benefit analysis of alternative water sources to determine the economic and environmental costs and benefits of investing in them. • Water quality assessments: Conducting water quality assessments to determine the suitability of alternative water sources for various uses, such as drinking water, irrigation, and industrial processes. • Stakeholder engagement: Engaging with stakeholders, including communities, businesses, and other water users, to identify

	<p>their water needs and preferences and to get their input on the development of alternative water sources.</p> <ul style="list-style-type: none"> • Regulatory compliance: Ensuring that any proposed alternative water sources comply with relevant regulations and standards, such as those related to water quality, health and safety, and environmental impact. • Implementation planning: Developing implementation plans for any viable alternative water sources, including detailed designs, procurement of equipment, and construction and operational plans.
<p>Investing in alternative water sources. (Once alternative water sources have been identified, the programme will invest in the infrastructure and technology needed to extract, treat, and distribute these water sources. This may include building desalination plants, drilling new boreholes, and upgrading wastewater treatment facilities).</p>	<ul style="list-style-type: none"> • Researching and evaluating potential alternative water sources: This may involve identifying and assessing the feasibility of various water sources, such as desalination, wastewater reuse, rainwater harvesting, or groundwater. • Developing infrastructure for alternative water sources: This may involve the construction of treatment plants and pipelines necessary for the collection, treatment, and distribution of alternative water sources. • Developing partnerships and collaboration: This may involve partnering with other stakeholders, such as neighbouring municipalities, government agencies, and private sector entities, to develop and implement alternative water source projects. • Identifying and securing funding: This may involve identifying and securing funding from various sources, such as grants, loans, or public-private partnerships. • Educating and raising public awareness: This may involve educating and raising public awareness about the importance of alternative water sources, how they work, and their benefits, to encourage community support and participation in the development and implementation of these projects.
<p>Develop and Implement a Treated Effluent Reuse Strategy For Sustainable Water Management.</p>	<ul style="list-style-type: none"> • Assessing the feasibility and potential benefits of a treated effluent reuse strategy for the NDM. • Identifying and prioritising potential sites for treated effluent reuse, including public spaces, industrial sites, and agriculture. • Developing a comprehensive treated effluent reuse plan, including infrastructure and system requirements, stakeholder engagement, and potential risks and mitigation strategies. • Conducting a cost-benefit analysis of the treated effluent reuse plan and identifying potential funding sources. • Building and implementing the treated effluent reuse infrastructure, including treatment facilities and distribution systems. • Conducting monitoring and evaluation activities to assess the effectiveness of the treated effluent reuse strategy and identify opportunities for improvement.

4.4.5. Programme 4: Groundwater Management

"*Programme 4: groundwater management*" forms an integral part of the Namakwa District Municipality's (NDM) strategic initiatives. With a core mandate to sustainably manage the region's precious groundwater resources, this programme is a strategic response to the escalating challenges of a changing climate, increasing water demand, and other environmental pressures.

- At the heart of the programme lies the execution of comprehensive groundwater resource assessments. These detailed assessments aim to establish the availability and quality of groundwater within the NDM area. In turn, this information shapes the district's water allocation policy, ensuring effective management and distribution of the water resources. Within the scope of these assessments, the programme also supports further research into groundwater potential. Such research plays a crucial role in informing other strategic initiatives, such as the feasibility study for a desalination plant in Port Nolloth.
- The development and establishment of sustainable groundwater use policies and guidelines form another critical dimension of this programme. These policies serve to promote efficient and effective groundwater management, aligning cohesively with the broader water services development plan. In addition, they guide decision-making processes around water allocation, providing a roadmap for sustainable water management.
- Another vital component of this programme is the implementation of groundwater monitoring programmes. These monitoring initiatives observe water levels, water quality, and potential pollution sources, acting as an early warning system for potential problems and enabling timely interventions. Innovative groundwater monitoring strategies, specifically designed to detect changes and variability in water salinity, are an integral part of these programmes.
- In its quest to promote groundwater conservation and efficiency, the programme champions the adoption of water-saving technologies and practices across all sectors. As part of this drive, household water harvesting projects will be developed and implemented, showcasing practical and effective water conservation strategies.
- To bolster groundwater storage capacity, the programme concentrates on formulating groundwater recharge and artificial recharge strategies. By enhancing aquifer recharge rates, these strategies aim to improve groundwater storage, ensuring long-term water availability.
- The programme also prioritises land-use planning and zoning regulations to safeguard groundwater resources from pollution and overuse. Complementing this, it also supports initiatives like an alien invasive eradication programme aimed at the removal of alien vegetation, specifically targeting Prosopis.
- A key administrative element of the programme is the development of an Information Management System for groundwater data. This system will serve to provide accurate and timely information to water users, decision-makers, and the public. It will also play a pivotal role in developing education programmes to promote community monitoring processes,

working in collaboration with Conservation South Africa and the Department of Water and Sanitation.

- Integral to the programme's success is the development of an operations and maintenance plan for the water sector. This involves ongoing infrastructure monitoring programmes and associated upgrading of wastewater treatment works and water purification plants. These actions ensure the continued efficiency and longevity of the water infrastructure.
- Lastly, the programme recognises the need for institutional strengthening to effectively manage complex and dynamic water systems. This involves increasing the internal capacity to deal with climate change and wastewater issues, reviewing the staff organogram, and adjusting budgets to meet the resource demands of the programme.

In summary, "Programme 4: groundwater management" represents a holistic and proactive approach towards the sustainable management of NDM's groundwater resources. By integrating scientific assessments, community engagement, policy development, and infrastructure planning, the programme strengthens the district's water security and resilience in the face of a changing climate and growing demand.

Table 11: Programme 4 - Implementing sustainable groundwater use and development strategy.

Programme 4: Implementing Sustainable Groundwater Use and Development Strategy	
ACTIONS	POSSIBLE KEY ACTIVITIES
Conducting groundwater resource assessments to establish the availability and quality of groundwater in the NDM area.	<ul style="list-style-type: none"> • Desk-based research: Conduct a review of existing literature, data, and reports to gain an understanding of the historical and current state of groundwater resources in the area, as well as any previous studies that have been conducted. • Field investigations: Collect and analyse data from monitoring wells, boreholes, and other sources to determine the quantity and quality of groundwater in the area. This may involve drilling new boreholes or installing monitoring wells to collect data on groundwater levels, water quality, and other relevant parameters. • Hydrogeological modelling: Develop and use computer models to simulate the behaviour of groundwater resources in the area, including the movement of water through the aquifers and the interaction between surface water and groundwater. • Stakeholder engagement: Engage with local communities, water users, and other stakeholders to understand their needs and concerns related to groundwater resources in the area. • Developing a groundwater management plan: Use the data collected and the models developed to develop a plan for the sustainable management and use of groundwater resources in the NDM area. This may include measures such as setting sustainable yield limits, establishing groundwater protection zones, and implementing monitoring programmes to track the status of the resource over time.

<p>Establishing sustainable groundwater use policies and guidelines to promote efficient and effective groundwater management.</p>	<ul style="list-style-type: none"> • Conduct a review of existing policies and guidelines related to groundwater use to identify gaps and areas for improvement. • Consider local conditions and needs, developing new policies and guidelines that promote sustainable and efficient groundwater management. • Develop a stakeholder engagement process to gather input from water users, industry representatives, and other stakeholders in developing sustainable groundwater use policies and guidelines. • Establish mechanisms for ongoing review and revision of policies and guidelines to ensure they remain relevant and effective in promoting sustainable groundwater use.
<p>Implementing groundwater monitoring programmes to monitor water levels, water quality, and potential pollution sources, enabling early detection of potential problems and timely intervention.</p>	<ul style="list-style-type: none"> • Install and maintain a network of groundwater monitoring wells and equipment to collect data on groundwater levels, water quality, and potential pollution sources. • Conduct regular field visits to measure and record groundwater levels and collect water quality samples for laboratory analysis. • Analyse data collected from monitoring programmes to detect changes in groundwater levels, identify trends in water quality, and assess the impact of potential pollution sources. • Develop and implement early warning systems to alert water users and decision-makers to potential problems, enabling timely intervention. • to promote awareness and informed decision-making, providing regular reports on groundwater conditions and trends to water users, decision-makers, and the public. • Collaborate with other agencies and stakeholders to share data and coordinate monitoring efforts to ensure comprehensive coverage of the groundwater resources.
<p>Promoting groundwater conservation and efficiency by encouraging the adoption of water-saving technologies and practices in all sectors.</p>	<ul style="list-style-type: none"> • Encourage water conservation pricing mechanisms, such as tiered water rates, incentivise water users to reduce their water use, water-efficient irrigation systems, drought-resistant crops, and low-flow fixtures. • Develop and implementing water conservation standards for new and existing municipal buildings and properties. • Encourage the adoption of water reuse and recycling technologies to reduce the demand for fresh groundwater resources. • Promote the use of rainwater harvesting systems in households, buildings, and public spaces to reduce the demand for groundwater resources.
<p>Developing groundwater recharge and artificial recharge strategies to enhance aquifer recharge rates and</p>	<ul style="list-style-type: none"> • Conduct studies to identify suitable sites for groundwater recharge, including areas with high permeability, favourable soil conditions, and sufficient rainfall. • Identify potential sources of water for recharge, such as stormwater runoff, treated wastewater, and excess surface water.

<p>improve groundwater storage capacity.</p>	<ul style="list-style-type: none"> • Develop and implement recharge infrastructure, such as recharge basins, injection wells, and spreading grounds. • Monitoring and evaluating the effectiveness of recharge strategies, including assessing changes in water levels, water quality, and aquifer storage capacity. • Developing outreach and education programmes to promote groundwater recharge benefits and encourage participation from stakeholders, such as farmers, local governments, and water users.
<p>Implementing land-use planning and zoning regulations to protect groundwater resources from pollution and overuse.</p>	<ul style="list-style-type: none"> • Conduct a groundwater vulnerability assessment to identify areas where groundwater resources are most at risk from pollution and overuse. • Develop and enforce land-use planning and zoning regulations that limit activities that may threaten groundwater quality, such as restricting the construction of hazardous waste facilities near groundwater sources. • Establish setback requirements that limit the distance between certain land uses and groundwater sources. • Develop best management practices for land uses that have the potential to impact groundwater quality, such as agriculture, mining, and construction. • Encourage the adoption of sustainable development practices that reduce the demand for groundwater, such as green roofs, rainwater harvesting, and greywater recycling. • Establish monitoring programmes to track changes in groundwater quality and quantity over time, and to detect and respond to potential threats to groundwater resources. • Providing education and outreach to stakeholders, including landowners, developers, and the public, about the importance of protecting groundwater resources and the regulations and guidelines in place to do so.
<p>Develop an information management system for groundwater data to provide accurate and timely information to water users, decision-makers, and the public.</p>	<ul style="list-style-type: none"> • Conduct a comprehensive inventory of all groundwater monitoring wells in the NDM area and assess their condition and functionality. • Establish a standard methodology for groundwater data collection, analysis, and reporting to ensure consistency and accuracy of information. • Develop a database and web-based portal for storing and accessing groundwater data, including water levels, quality, and other relevant information. • Establish protocols for sharing groundwater data among relevant stakeholders, including water users, regulators, researchers, and the public. • Develop data visualisation tools and models to help decision-makers interpret and use groundwater data effectively. • Establish procedures for quality control and quality assurance to ensure the accuracy and reliability of groundwater data.

	<ul style="list-style-type: none"> • Provide training and technical assistance to water users, regulators, and other stakeholders on collecting, analysing, and using groundwater data effectively. • Conduct regular reviews and updates of the groundwater information management system to ensure that it remains current, relevant, and effective.
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4.5. Climate Change Goal 2: To Manage Physical Isolation of Communities and Potential Increased Migration to Urban and Peri-Urban Areas

Table 12: Climate change goal 2, outcome, linkage to district's strategic objectives.

Goal:	<ul style="list-style-type: none"> • Establish robust mechanisms to mitigate the impacts of physical isolation and increased urban migration due to climate change.
Outcome:	<ul style="list-style-type: none"> • Effective interventions and policies are in place to improve infrastructure and transportation in isolated areas, coupled with sustainable urban development strategies that accommodate potential population influx, resulting in balanced regional development and decreased pressure on urban and peri-urban resources.
Linkage to NDM's Strategic Objectives	<ul style="list-style-type: none"> • "Stimulation of green, diverse, integrated socio-economy" - By addressing the issues of physical isolation and potential urban migration, NDM can ensure that growth and development are evenly distributed across urban and rural areas, fostering a diverse and integrated socio-economy. • "Integrated support and capacitating local municipalities for sustainability" - The goal aligns with this objective by addressing the need for a comprehensive approach that supports the capacity of local municipalities to handle the impacts of physical isolation and urban migration. • "Providing strategic leadership" - Managing physical isolation and potential migration challenges will require strategic leadership to develop and implement effective policies and programs to address these issues. • "Fostering and strengthening partnerships with all role-players" - This goal can be achieved through strong collaborations between the NDM, other government entities, community organizations, and private sector stakeholders to create solutions for managing isolation and migration issues. • "Transparent and accountable processes" - This links with the goal by ensuring transparency and accountability in how the district handles the challenges of physical isolation and urban migration, ensuring policies and actions are effectively communicated and implemented.

4.5.1. Rational/Context

In the context of the Namakwa District Municipality (NDM), managing the physical isolation of communities and potential increased migration to urban and peri-urban areas is a strategic priority, given the region's unique geographical and climate-related challenges. The NDM area is marked by its rural nature, vast tracts of land, and sparse population, factors that can contribute to the physical isolation of communities. Climate change, with its associated risks such as increased droughts, floods, and extreme temperature events, further exacerbates this isolation by impacting the availability and quality of resources such as water and arable land, vital for rural and agricultural livelihoods. This situation can lead to increased pressure for migration towards urban and peri-urban areas in search of better opportunities and resources.

Such migration trends, while providing opportunities for individuals, can put substantial pressure on urban and peri-urban areas. These areas may not be equipped to cope with a rapid influx of people, leading to problems such as overcrowding, inadequate housing, and strain on infrastructure and services. Climate change compounds these issues, as urban areas are also dealing with their own climate-related challenges such as heat islands, increased flood risks due to impermeable surfaces, and strains on water and energy systems. Consequently, managing these migration patterns effectively becomes essential to prevent exacerbating urban vulnerabilities and ensure sustainable urban development.

Moreover, climate change risks, such as changes in precipitation patterns and increased frequency of extreme weather events, are likely to disproportionately affect vulnerable rural populations. This can contribute to rural-urban migration, further complicating the socio-economic dynamics of the NDM area. Managing this migration, along with reducing the physical isolation of communities, necessitates an integrated approach that includes climate change adaptation and mitigation measures, strengthening rural livelihoods, and improving infrastructure and services in both rural and urban areas. This way, NDM can foster resilient communities capable of withstanding the challenges of a changing climate, while also ensuring that its urban and peri-urban areas are prepared to accommodate population shifts sustainably.

Several programmes have been identified through which it will aim to achieve the goal and targets of this outcome:

4.5.2. Programme 5: Rural Resilience and Livelihoods Enhancement

"Programme 5: rural resilience and livelihoods enhancement" is an integral initiative undertaken by the Namakwa District Municipality (NDM) to fortify the resilience of rural communities in the face of increasing climate change challenges. This program targets the intertwined aspects of rural life, such as agriculture, infrastructure, and livelihoods, that are increasingly under threat from shifting climate patterns.

The cornerstone of this programme is "strengthening climate-smart agriculture". This action recognises the critical role of agriculture in rural livelihoods and the need to enhance its

resilience in a changing climate. Specific activities under this include conducting workshops and training sessions for farmers on climate-smart agricultural techniques, promoting drought-resistant crops, implementing pilot projects to showcase the practicality of these practices, and establishing collaborations with agricultural research institutions. These measures aim to protect agricultural production from climate-related risks and promote sustainable use of resources, thereby securing food availability and farmers' incomes.

"Enhancing rural infrastructure" is another key action aimed at reducing the physical isolation of rural communities, improving access to markets and services, and boosting socio-economic development. This includes investing in road construction and maintenance to improve connectivity between isolated communities and urban centres, establishing or upgrading telecommunications infrastructure to enhance access to information, implementing renewable energy projects to provide reliable power, and constructing community facilities to improve service provision. These activities collectively work towards creating an enabling environment where rural communities can thrive, despite the constraints imposed by geographic isolation.

Finally, "promoting diversification of rural livelihoods" is an important action that recognises the need for income diversification in the face of climate and economic uncertainties. Activities under this action include vocational training programs in areas like handicrafts or renewable energy technology, promoting rural tourism, facilitating access to microfinance or grant schemes, and partnering with conservation organisations to create jobs linked to environmental management. These measures aim to empower rural communities with varied income sources, reducing their dependency on a single sector like agriculture, and increasing their resilience to climate-related and other shocks.

In summary, "*Programme 5: rural resilience and livelihoods enhancement*" seeks to safeguard and enhance rural life in the NDM region amidst the challenges posed by climate change, through a comprehensive approach that combines climate-smart agriculture, infrastructure development, and livelihood diversification strategies.

Table 13: Programme 5 - Rural resilience and livelihoods enhancement.

Programme 5: Rural Resilience and Livelihoods Enhancement.	
ACTIONS	KEY ACTIVITIES
<p>Strengthening climate-smart agriculture. <i>(This involves enhancing the resilience of agricultural practices to climate change, promoting</i></p>	<ul style="list-style-type: none"> • Conducting workshops and training sessions for farmers on climate-smart agricultural techniques such as efficient irrigation, soil conservation methods, and sustainable farming practices. • Introducing and promoting the cultivation of drought-tolerant crop varieties suited to the changing climatic conditions in the region. • Implementing pilot projects to showcase the benefits and practicalities of climate-smart agricultural practices.

<p><i>sustainable use of land and water resources, and introducing drought-tolerant crops).</i></p>	<ul style="list-style-type: none"> • Establishing collaborations with agricultural research institutions for ongoing support and guidance.
<p>Enhancing rural infrastructure. <i>(This includes improving transport and communication networks to reduce physical isolation and improve access to markets and services.</i></p> <p><i>• Promoting Diversification of Rural Livelihoods: This includes initiatives to develop alternative, non-agricultural income sources, such as crafts, tourism, or small-scale renewable energy projects).</i></p>	<ul style="list-style-type: none"> • Investing in road construction and maintenance projects to improve transportation links between isolated communities and urban centres. • Establishing or upgrading telecommunications infrastructure like broadband internet services, enhancing connectivity and access to information. • Implementing renewable energy projects, such as solar or wind power, to provide reliable energy sources to rural communities. • Constructing community facilities like local markets, healthcare centres, and schools to improve rural service provision.
<p>Promoting diversification of rural livelihoods. <i>(This includes initiatives to develop alternative, non-agricultural income sources, such as crafts, tourism, or small-scale renewable energy projects).</i></p>	<ul style="list-style-type: none"> • Organising vocational training programs in areas like handicrafts, hospitality, renewable energy technology, or other skills that can provide alternative sources of income. • Promoting rural tourism by supporting the development of attractions, accommodation facilities, and related services. • Facilitating access to microfinance or grant schemes to support rural entrepreneurship in diverse sectors. • Partnering with conservation organisations to create jobs linked to environmental management, such as reforestation projects or wildlife monitoring.

4.5.3. Programme 6: Sustainable Urban Development and Planning

"Programme 6: sustainable urban development and planning" is a strategic initiative launched by the Namakwa District Municipality (NDM) to ensure the sustainable growth and inclusivity of urban and peri-urban areas. This programme recognises the intertwined challenges of climate

change, population increase, and socio-economic disparities, and seeks to address these through targeted actions and activities.

The first action, "climate-adaptive urban planning", recognises that urban planning strategies must evolve to account for climate risks and growing population pressures. Activities under this action include developing urban zoning policies that consider climate risks, introducing green infrastructure to mitigate heatwaves and flooding, incorporating climate risk assessment into planning processes, and promoting sustainable building materials and techniques. These activities seek to foster urban environments that are resilient to climate change while also accommodating population growth.

The second action, "enhancing urban infrastructure and services", is focused on improving essential services like housing, water, energy, and sanitation to cope with increasing populations. The activities here include upgrading housing to be weather-resilient and energy-efficient, improving water and energy infrastructure with a focus on sustainability, expanding sanitation systems, and undertaking regular maintenance and repair of urban infrastructure. These measures are aimed at enhancing the quality of urban life and ensuring that the infrastructure can adequately support a growing population.

Finally, "promoting inclusive urban development" is an action that emphasises the importance of ensuring equal access to urban services and opportunities for all inhabitants, including migrants. Activities include ensuring equitable access to basic services, promoting affordable housing programs, introducing social inclusion policies, and facilitating community engagement in urban planning processes. This inclusivity is fundamental for fostering social cohesion and reducing disparities within growing urban areas.

In summary, "*Programme 6: sustainable urban development and planning*" is a forward-looking initiative that strives to transform urban areas within the NDM region into inclusive, resilient, and sustainable spaces. The programme aims to address the challenges and opportunities presented by climate change, population growth, and socio-economic disparities through adaptive planning, infrastructure development, and inclusivity promotion.

Table 14: Programme 6 - Sustainable urban development and planning.

Programme 6: Sustainable Urban Development and Planning.	
ACTIONS	KEY ACTIVITIES
Climate-Adaptive Urban Planning. <i>This involves designing and implementing urban planning strategies that account for</i>	<ul style="list-style-type: none"> Developing and implementing urban zoning policies that take into account flood plains and other climate risk areas to minimize potential damages. Introducing green infrastructure, such as parks and green roofs, can help mitigate heat waves and flooding while improving urban biodiversity.

<p><i>climate risks and growing population pressures.</i></p>	<ul style="list-style-type: none"> • Incorporating climate risk assessment into urban planning processes to ensure that new developments are climate resilient. • Promoting the use of sustainable building materials and techniques in urban construction to reduce the environmental impact and increase the resilience of the built environment.
<p>Enhancing Urban Infrastructure and Services. <i>This includes improving housing, water, energy, and sanitation systems to accommodate increasing populations.</i></p>	<ul style="list-style-type: none"> • Implementing upgrades to housing stock to ensure they are weather-resilient and energy efficient. • Improving water and energy infrastructure, including the introduction of renewable energy sources and water-saving technologies. • Expanding sanitation systems to cope with the increased demand, with a focus on sustainable waste management and recycling initiatives. • Undertaking regular maintenance and repair activities to ensure the robustness and longevity of urban infrastructure.
<p>Promoting Inclusive Urban Development. <i>This aims at ensuring that all inhabitants, including migrants, have equal access to urban services and opportunities.</i></p>	<ul style="list-style-type: none"> • Ensuring equitable access to basic services such as water, electricity, sanitation, healthcare, and education for all urban residents, including newly arrived migrants. • Promoting affordable housing programs to ensure diverse socio-economic groups can reside within the city. • Introducing social inclusion policies, such as anti-discrimination laws and integration programmes, to ensure that all inhabitants have equal access to urban opportunities. • Facilitating community engagement in urban planning and decision-making processes, encouraging a sense of ownership and responsibility among diverse groups of inhabitants.

4.5.4. Programme 7: Climate-Sensitive Migration Management

"Programme 7: climate-sensitive migration management" is a strategic initiative by the Namakwa District Municipality (NDM) acknowledging the complex interlinkages between climate change and migration. The programme is a response to the realities of climate-induced migration in the region and the necessity to proactively address this phenomenon through appropriate policies, solutions, and knowledge generation.

The first action, "developing migration policies," involves the formulation of migration policies that consider climate change as a significant driver. Activities under this action include developing a climate-induced migration policy framework, incorporating climate migration considerations into existing planning strategies, and establishing cross-sectoral coordination mechanisms. These activities aim to provide a comprehensive and synergistic policy response

that protects the rights and well-being of migrants while optimising regional development outcomes.

The second action, "promoting climate-sensitive migration solutions," recognises the importance of creating supportive environments to facilitate sustainable and fair migration. Activities include developing participatory relocation plans for high-risk communities, establishing social safety nets in both rural and urban areas, and implementing urban planning strategies that account for potential migrant influxes. The goal is to build resilience among both existing and incoming populations and to ensure a harmonious integration of migrants into new communities.

Finally, "conducting research and awareness" aims at enhancing the understanding of climate-migration dynamics and raising public awareness about these issues. Activities include undertaking targeted research studies, developing education and awareness campaigns, collaborating with various institutions to disseminate findings, and integrating climate change and migration issues into educational curricula. These activities aim to foster a well-informed public and policy discourse and to ensure that interventions are based on solid evidence and broad public understanding.

In summary, "*Programme 7: climate-sensitive migration management*" is a critical initiative that addresses the intersection of climate change and migration in the NDM region. It aims to shape migration trends in a manner that is humane, fair, and beneficial to the overall social and economic development of the region, while also bolstering the resilience of both the migrant and host communities in the face of ongoing climate change.

Table 15: Programme 7 - Climate-sensitive migration management.

Programme 7: Climate-Sensitive Migration Management.	
ACTIONS	KEY ACTIVITIES
Developing migration policies. <i>(This involves the formulation of policies that account for climate-induced migration, ensuring migrants' rights and well-being).</i>	<ul style="list-style-type: none"> Formulating a climate-induced migration policy framework that identifies potential migration paths and includes provisions for the fair and humane treatment of migrants. Incorporating climate migration considerations into existing regional development and land use planning strategies. Establishing cross-sectoral coordination mechanisms to ensure that migration policies are implemented effectively and synergistically with other policies and measures.
Promoting climate-sensitive migration solutions. <i>(This includes creating supportive</i>	<ul style="list-style-type: none"> Developing relocation plans and programmes for communities at high risk of climate impacts, ensuring these are participatory and respect the rights and needs of affected communities.

<i>environments in both rural and urban areas to absorb and facilitate migration in a sustainable and fair manner).</i>	<ul style="list-style-type: none"> • Establishing social safety nets and support services in both rural and urban areas to support migrants, such as job placement services, skills training, and housing assistance. • Implementing climate-sensitive urban planning and development strategies that account for potential influxes of migrants, ensuring that infrastructure and services can accommodate and integrate new residents.
Conducting research and awareness: <i>(This involves undertaking research to understand climate migration dynamics better and raising awareness about the same).</i>	<ul style="list-style-type: none"> • Undertaking research studies on climate change impacts, migration patterns, and the effectiveness of policy responses in the NDM region. • Developing and implementing education and awareness campaigns about climate change and migration for communities, policymakers, and other relevant stakeholders. • Collaborating with academic institutions, research organisations, and civil society to disseminate findings and raise awareness about climate change and migration dynamics. • Integrating climate change and migration issues into school curricula and adult education programmes to raise awareness from an early age and across different sectors of society.

4.6. Climate Change Goal 3: Managing the impacts of heat stress on humans and livestock involves taking steps to minimize the harmful effects of high temperatures on human health and livestock productivity.

Table 16: Climate change goal 2, outcome, linkage to district's strategic objectives.

Goal:	<ul style="list-style-type: none"> • Implement comprehensive heat stress management strategies to protect human health and livestock productivity against escalating temperatures due to climate change.
Outcome:	<ul style="list-style-type: none"> • Enhanced public health outcomes and livestock productivity through effective heat stress management strategies, including increased public awareness, efficient early warning systems, and implementation of heat-resistant agricultural practices and livestock breeds.
Linkage to NDM's Strategic Objectives	<ul style="list-style-type: none"> • "Stimulation of green, diverse, integrated socio-economy" - This goal contributes to economic sustainability by ensuring the health of livestock, which are a vital part of the local economy, and the well-being of the district's human population, who are the primary economic actors. • "Integrated support and capacitating local municipalities for sustainability" - Managing heat stress necessitates an integrated support system that empowers local municipalities to respond proactively to heat stress events, thereby safeguarding both human and animal health. • "Providing strategic leadership" - This goal requires strategic leadership to address and reduce the impacts of heat stress,

through measures such as early warning systems, public awareness campaigns, and enhanced health services.

- "Fostering and strengthening partnerships with all role-players" - Achieving this goal requires partnerships with various stakeholders, including healthcare providers, livestock owners, and agencies specializing in climate and weather forecasts.
- "Transparent and accountable processes" - This aligns with the goal by ensuring that measures to combat heat stress are implemented and communicated transparently and that relevant agencies are held accountable for their role in managing this challenge.

4.6.1. Rationale/Context

The NDM region is vulnerable to increased temperatures as a result of climate change, making the management of heat stress on humans and livestock a strategic priority. In terms of human health, prolonged exposure to high temperatures can result in serious health conditions, such as heat exhaustion, heat stroke, and dehydration, among others. Furthermore, heat waves can exacerbate pre-existing health issues, particularly among vulnerable populations such as the elderly, children, and those with chronic illnesses. By focusing on managing the impacts of heat stress, NDM can proactively mitigate the risks of increased mortality and morbidity rates due to heat, ultimately preserving the health and well-being of its residents.

In addition to human health, heat stress also poses a substantial threat to livestock productivity in the NDM region. The local economy is heavily reliant on farming and agriculture, which includes a significant amount of livestock farming. Heat stress in animals can lead to decreased productivity, increased susceptibility to disease, and in severe cases, death. These outcomes can have dire socio-economic implications for farmers, leading to a loss of income and increased vulnerability to poverty. Therefore, taking steps to minimize the harmful effects of high temperatures on livestock is essential for maintaining the region's economic stability and food security.

Lastly, the management of heat stress also ties into broader climate adaptation and resilience efforts in NDM. Increasing resilience to heat stress aligns with climate change mitigation strategies and helps ensure sustainable development within the district. By prioritizing the management of heat stress impacts, NDM demonstrates a commitment to protecting its communities and local economy from climate change-related threats. It also contributes to the achievement of several Sustainable Development Goals (SDGs), including good health and well-being, sustainable cities and communities, and climate action, underscoring NDM's commitment to creating a sustainable future.

4.6.2. Programme 8: Human Health and Heat Stress Management

With the escalating trends of global warming and climate change, areas like the Namakwa District Municipality (NDM) are becoming increasingly susceptible to extreme heat events. These events can lead to heat stress, which, if not properly managed, can have severe health implications for the community, leading to heat strokes, dehydration, and potentially fatal heat-related illnesses. The region's unique climate, characterized by its aridity and intense heat, only amplifies these concerns. Consequently, *Programme 8: human health and heat stress management* becomes a key strategic priority for NDM.

The initiation of heat health action planning is a crucial step to ensure that the community is prepared for extreme heat events. This involves setting up early warning systems to predict heatwaves, developing comprehensive heatwave response plans, and ensuring effective communication of heatwave warnings and safety measures to the community. The actions involved in this planning should not only be anticipatory but also include proactive measures that reduce the health impacts of heat stress. This includes infrastructure modifications for cooling, city planning for heat reduction, and community education about heat risks and protective measures.

Simultaneously, improving access to healthcare services during extreme heat events is equally important. This entails ensuring that healthcare facilities are equipped to handle an influx of heat-related illnesses during heatwaves and have the necessary infrastructure to provide cooling. It also means enhancing the capabilities of healthcare providers to identify and treat heat-related illnesses effectively and swiftly. Additionally, strengthening the accessibility of healthcare services for the most vulnerable populations, such as the elderly, children, and those with chronic diseases, becomes even more vital during extreme heat events. These groups are often the most susceptible to the detrimental effects of heat stress and may need immediate medical attention.

In this context, Programme 8: Human Health and Heat Stress Management is pivotal to safeguarding the health and well-being of the communities within the NDM from the escalating threat of heat stress due to climate change. By addressing heat stress proactively and systematically, NDM can significantly reduce the risk of heat-related illnesses and deaths, and improve the overall resilience of its communities to climate change.

Table 17: Programme 8: - Human health and heat stress management.

Programme 8: Human Health and Heat Stress Management.	
ACTIONS	KEY ACTIVITIES
Heat health action planning.	<ul style="list-style-type: none"> Conducting climate vulnerability assessments for the district's population to identify those most at risk from heat stress.

<p><i>(This involves developing strategies and systems to prepare for heat waves).</i></p>	<ul style="list-style-type: none"> • Developing and implementing public awareness campaigns on heat-related illnesses, their prevention, and the use of innovative personal protective equipment (PPE) to prevent heat stress. • Implementing heat-health warning systems in collaboration with local meteorological agencies. • Appointing and training community representatives in first aid to respond effectively to heat stress incidents.
<p>Improving access to healthcare services. <i>(This aims to enhance healthcare provision during extreme heat events).</i></p>	<ul style="list-style-type: none"> • Training healthcare workers on identifying and treating heat-related illnesses. • Expanding emergency healthcare services during heatwaves, ensuring quick and efficient response to heat stress incidents. • Establishing hydration and cool-down facilities in public spaces to provide immediate relief during high temperatures.

4.6.3. Programme 9: Livestock Heat Stress Management

The Northern Cape is largely a rural area, with a significant portion of the local economy and livelihoods dependent on livestock farming. Climate change and increasing instances of heat stress pose a serious threat to the well-being and productivity of livestock, and by extension, the economic stability and food security of the region. Given this context, *Programme 9: livestock heat stress management* becomes an imperative strategic initiative within the Namakwa District Municipality (NDM).

Adopting climate-smart animal husbandry is a critical aspect of this programme. These practices include modifying grazing times to cooler parts of the day, ensuring access to shade and water, and employing breeds better adapted to the extreme heat conditions of the Northern Cape. Furthermore, it involves introducing technological solutions such as thermotolerant feeds and cooling infrastructure for livestock. The objective of these practices is to improve livestock resilience to heat stress, thereby preserving their health, productivity, and the livelihoods that depend on them.

Simultaneously, enhancing veterinary services is paramount to mitigating the effects of heat stress on animal health. The increased vulnerability of livestock to heat stress may exacerbate existing health issues and introduce new ones. By improving veterinary services, the NDM can ensure prompt detection and treatment of heat-related illnesses in livestock, provide guidance on managing livestock during heat events, and promote preventative health measures. It is also crucial that these services are accessible and affordable, particularly for small-scale and subsistence farmers who may be disproportionately affected by the impacts of climate change. The NDM's *Programme 9: livestock heat stress management* is hence a significant strategy in the face of escalating climate change. By improving livestock resilience to heat stress and enhancing veterinary services, the programme aims to sustain the vital livestock sector, protect livelihoods, and contribute to regional food security.

Table 18: Programme 9 - Livestock heat stress management.

Programme 9: Livestock Heat Stress Management.	
ACTIONS	KEY ACTIVITIES
<p>Adopting climate-smart animal husbandry. <i>(This involves promoting practices that reduce heat stress in livestock).</i></p>	<ul style="list-style-type: none"> • Introducing heat-tolerant livestock breeds that can withstand higher temperatures. • Providing training to farmers on animal care during heatwaves, including the importance of shade, ventilation, and hydration. • Implementing efficient water management practices at farms to ensure sufficient water supply during periods of high heat.
<p>Enhancing veterinary services. <i>(This aims to mitigate the effects of heat stress on animal health).</i></p>	<ul style="list-style-type: none"> • Strengthening disease surveillance and response capabilities during high heat periods, with the objective of early detection and treatment of heat-related illnesses in livestock. • Providing training to farmers on early disease detection and treatment. • Improving access to livestock insurance, enabling farmers to better manage financial risks associated with losses from heat stress.

4.6.4. Programme 10: Infrastructure Resilience to Heat Stress

The Northern Cape is characterised by extreme temperatures, and with climate change, these are set to increase in both frequency and intensity. This poses significant risks to the region's infrastructure, impacting its functionality, longevity, and the safety of those who rely on it. Recognising this, the Namakwa District Municipality (NDM) has identified Infrastructure Resilience to Heat Stress as a key priority in its climate change adaptation strategy, culminating in the development of Programme 10.

Adopting heat-resilient infrastructure design is a critical element of this programme. As the Northern Cape faces more extreme heat events, traditional building materials and design techniques may no longer be adequate. This action encourages the use of innovative materials and designs that can withstand high heat, reducing the need for repairs and replacements, and ensuring the longevity and functionality of the infrastructure. This might include reflective surfaces, green roofs, thermally insulating materials, and designs that facilitate natural cooling.

In tandem with heat-resilient designs, enhancing infrastructure maintenance is vital to preserving the region's built environment in the face of escalating temperatures. Heat can cause materials to expand, contract, or degrade, leading to cracks, warping, and other forms of damage. Regular maintenance checks and timely repairs can help to minimise this heat-induced damage. Innovative solutions, such as heat-resistant coatings and 'self-healing' materials, could also play a role in ensuring the resilience of the infrastructure.

Through the implementation of Programme 10: Infrastructure Resilience to Heat Stress, the NDM aims to safeguard the integrity and functionality of the region's infrastructure. This is crucial in ensuring the continued delivery of key services, promoting economic stability, and protecting the welfare and safety of the region's inhabitants in a changing climate.

Table 19: Programme 10 - Infrastructure resilience to heat stress.

Programme 10: Infrastructure Resilience to Heat Stress	
ACTIONS	KEY ACTIVITIES
Adopting heat-resilient infrastructure design. <i>(This action promotes the use of materials and designs that can withstand high heat).</i>	<ul style="list-style-type: none"> Encouraging the use of heat-reflective materials in construction to reduce indoor temperatures. Implementing green infrastructure initiatives, such as urban greening and green roofs, to reduce the urban heat island effect. Enforcing building codes and standards that incorporate heat resilience considerations to ensure new infrastructure can withstand increased temperatures.
Enhancing infrastructure maintenance. <i>(This involves routine maintenance and innovative solutions to minimize heat-induced damage).</i>	<ul style="list-style-type: none"> Regularly inspecting infrastructure to identify and repair any heat-induced damages promptly. Implementing innovative cooling solutions for public spaces, such as the introduction of cooling centres in urban areas, provides refuge during extreme heat events. Conducting community awareness campaigns about the risks of heat stress and measures to reduce its impacts, including the use of innovative PPE.

4.7. Climate Change Goal 4: To Prioritise the Health and Safety of Communities in the Face of a Changing Climate.

Table 20: Climate change goal 4, outcome, linkage to district's strategic objectives.

Goal:	<ul style="list-style-type: none"> Develop and implement proactive measures that prioritise community health and safety amidst the changing climate, including enhanced disaster management and public health infrastructure.
Outcome:	<ul style="list-style-type: none"> Improved community resilience against climate change-induced health risks and natural disasters, leading to safer living conditions and a reduction in climate-related health incidents and casualties.
Linkage to NDM's Strategic Objectives	<ul style="list-style-type: none"> "Stimulation of green, diverse, integrated socio-economy" - Prioritising health and safety contributes to a resilient and sustainable socio-economy by ensuring that communities are protected from climate-induced health risks, thereby maintaining their capacity to participate in and contribute to the local economy. "Integrated support and capacitating local municipalities for sustainability" - Ensuring the health and safety of communities in the face of a changing climate requires the provision of adequate support to local municipalities, equipping them with the necessary

resources and capacities to effectively respond to climate-related health threats.

- "Providing strategic leadership" - Prioritising community health and safety necessitates strategic decision-making and the implementation of measures such as climate-resilient healthcare infrastructure, disease surveillance systems, and emergency response plans.
- "Fostering and strengthening partnerships with all role-players" - Achieving this goal requires collaboration with a range of stakeholders, including healthcare providers, community organizations, environmental agencies, and research institutions.
- "Transparent and accountable processes" - Ensuring transparency and accountability in the implementation of climate health interventions is crucial for maintaining public trust and ensuring effective and equitable access to health services.

4.7.1. Rational/Context

Agriculture is the backbone of many economies in the NDM region and plays a critical role in providing food security, employment, and income for a large part of the population. Climate change, with its associated shifts in temperature, precipitation, and the increasing occurrence of extreme weather events, poses significant risks to the agricultural sector. For this reason, increasing the resilience of the agricultural sector is a strategic priority. By supporting both commercial and small-scale farmers, NDM ensures the sustenance of this vital sector, thus protecting livelihoods, promoting economic stability, and securing food supplies.

The need to support both commercial and small-scale farmers is particularly important because they face different types of challenges and risks. Commercial farmers often have better access to resources and technology, which can help them adapt to changing climatic conditions. However, their operations are typically more extensive and monoculture-based, making them potentially more vulnerable to climate shocks. On the other hand, small-scale farmers, who often have less access to resources, are critical for local food security and biodiversity. Their farms are often more diverse, but they may lack the technical knowledge and financial resources to implement effective climate adaptation strategies.

Furthermore, supporting farmers across industries is crucial because different agricultural sub-sectors (like livestock, crops) are affected by climate change in different ways. Diversification is a critical strategy for building resilience against climate change. By diversifying agricultural production, the risk is spread out, which can buffer the entire sector against climate-induced shocks. Therefore, building resilience in the agricultural sector by supporting farmers across industries would be a comprehensive strategy to ensure the sector's survival and growth, contributing to sustainable and inclusive development in the face of a changing climate.

4.7.2. Programme 11: Climate-Smart Agricultural Practices

Climate change is imposing considerable stress on agricultural systems in the Northern Cape, with rising temperatures and unpredictable rainfall patterns threatening both crop and livestock productivity. Recognising the fundamental role of agriculture in local livelihoods and the regional economy, the Namakwa District Municipality (NDM) has prioritised the transition to climate-smart agricultural practices. As part of its climate adaptation strategy, NDM has developed Programme 11, which aims to bolster the resilience of the agricultural sector and ensure its sustainability in the face of climate change.

Enhancing sustainable farming resources and infrastructure is a key part of this initiative. Sustainable farming practices not only help to mitigate climate change but are also more resilient to its impacts. This includes measures such as soil and water conservation techniques, efficient irrigation systems, the use of drought-resistant crop varieties, and pasture and livestock management strategies that minimise environmental impact. By promoting these practices and supporting the necessary infrastructure, NDM aims to create a more resilient, productive, and sustainable agricultural sector.

Complementing this, building knowledge and resilience among farmers and agricultural workers is essential. NDM aims to provide education and training on climate-smart agricultural practices, and on understanding and managing climate-related risks. This will help farmers adapt their practices to changing conditions, take informed decisions to manage risks and seize opportunities, and enhance their resilience to climate shocks. With improved knowledge and resilience, farmers can navigate the challenges of a changing climate, ensuring the sustainability and viability of agriculture in the Northern Cape.

Table 21: Programme 11 - Climate-smart agricultural practices.

Programme 11: Climate-Smart Agricultural Practices.	
ACTIONS	KEY ACTIVITIES
Enhancing sustainable farming resources and infrastructure.	<ul style="list-style-type: none"> • Providing solar panels for the use of borehole water to increase the efficiency of irrigation and reduce dependence on fossil fuels. • Supporting farmers through the provision of fertilizers, seeds, and farming equipment to bolster their production capabilities. • Assisting farmers to implement sustainable land and rangeland management measures and soil erosion mitigation strategies to maintain soil health and productivity. • Offering shade nets for grapes through a Provincial Department of Agriculture subsidy to mitigate the impacts of heatwaves and ensure consistent crop quality.
Building Knowledge and Resilience.	<ul style="list-style-type: none"> • Developing education and awareness campaigns targeted at subsistence farmers, small-scale farmers, and commercial

	<p>farmers, to share knowledge and best practices in sustainable farming.</p> <ul style="list-style-type: none"> • Commissioning research to improve understanding of climate change impacts on various farming practices including viticulture production and livestock rearing. • Conducting workshops on farm safety with a focus on proper handling and storage of hazardous substances, and chemical safety.
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4.7.3. Programme 12: Climate-Resilient Land Management and Use

Land management and land use practices have direct implications on climate change vulnerability and resilience. In Northern Cape, where agriculture is a key economic sector and where communities are already grappling with the impacts of climate change, adopting climate-resilient land management and use practices is of paramount importance. Programme 12 of the Namakwa District Municipality's (NDM) climate action plan aims to address this concern by fostering the adoption of land use practices that not only mitigate the effects of climate change but also bolster the resilience of the local communities and the ecosystem.

Promoting climate-resilient land uses and practices is a cornerstone of this initiative. It involves fostering sustainable agricultural practices, such as agroforestry, conservation agriculture, and pasture management, which enhance the resilience of the land to climate shocks. Additionally, this action includes promoting the sustainable use of land resources in urban and rural areas, with measures such as appropriate zoning and building codes, floodplain management, and erosion control. By fostering the adoption of such practices, NDM aims to maintain the productivity and ecological integrity of the land, while reducing the vulnerability of communities and ecosystems to climate impacts.

Moreover, strengthening disaster preparedness is another key component of Programme 12. Recognising that climate change is exacerbating the frequency and intensity of extreme weather events, NDM aims to equip communities with the necessary tools and knowledge to anticipate, respond to, and recover from such events. This involves developing and implementing disaster risk reduction strategies, including early warning systems, evacuation plans, and post-disaster recovery plans. By enhancing disaster preparedness, NDM can safeguard communities and their livelihoods from the impacts of extreme weather events, ensuring the sustainability and resilience of the region in the face of climate change.

Table 22: Programme 12 - Climate-resilient land management and use.

Programme 12: Climate-Resilient Land Management and Use.	
ACTIONS	KEY ACTIVITIES

<p>Promoting climate-resilient land uses and practices.</p>	<ul style="list-style-type: none"> • Developing a framework to assist and educate farmers with adjusting to reduced rainfall to improve water management practices. • Optimising climate-resilient land uses of existing agricultural areas to ensure they remain productive despite changing climate conditions. • Encouraging farmers to rotate their livestock around the land to avoid overgrazing, promoting biodiversity and soil health. • Assisting farmers to implement soil erosion measures to protect agricultural lands from degradation.
<p>Strengthening Disaster Preparedness</p>	<ul style="list-style-type: none"> • Conducting research on possible disaster preparedness measures for farmers through the District Municipality's Disaster Management Centres and Local Development offices to enhance their resilience against climate-related risks. • Developing a climate risk mapping tool to guide farmers on the potential climate risks in different areas and advise them on adaptive measures.

4.7.4. Programme 13: Incentivizing Sustainable Agricultural Practices

Agriculture is central to the economy and livelihoods of the Namakwa District Municipality (NDM) and is significantly vulnerable to climate change impacts. Programme 13 of NDM's climate action plan aims to transform this vulnerability into resilience by incentivizing sustainable agricultural practices. Through the promotion of sustainable practices and the provision of support to nomadic farmers, the programme seeks to ensure the sustainability and resilience of agriculture in the region amidst climate change.

Promoting sustainable practices involves incentivizing farmers to adopt climate-smart agricultural practices that improve productivity, build resilience to climate change, and reduce greenhouse gas emissions. This might involve financial incentives or technical support for practices such as conservation agriculture, crop diversification, agroforestry, and efficient irrigation. These practices can make a significant contribution towards enhancing the resilience of the agricultural sector to climate change and protecting the environment.

In addition to promoting sustainable farming practices among settled farmers, the programme also seeks to support nomadic farmers. Nomadic farming, or pastoralism, is a livelihood strategy adapted to the extreme conditions of the NDM, where conventional, settled agriculture is often unviable. These communities are highly vulnerable to climate change due to their reliance on natural resources for their livelihoods. To support these communities, the programme could provide incentives for adopting sustainable herding practices, improving access to climate information and early warning systems, and enhancing pastoralists' rights to

land and resources. By doing so, the programme would not only protect the livelihoods of nomadic farmers but also contribute to maintaining the resilience and biodiversity of the region's ecosystems.

Table 23: Programme 13 - Incentivizing sustainable agricultural practices.

Programme 13: Incentivizing Sustainable Agricultural Practices	
ACTIONS	KEY ACTIVITIES
Promoting sustainable practices.	<ul style="list-style-type: none"> • Developing incentives for small-scale farmers to promote sustainable land management, such as subsidies or grants for implementing water-efficient irrigation systems or adopting sustainable farming techniques. • Collaborating with organizations like Conservation South Africa, Meat Natural Initiative, Surplus Peoples Project, and the Environmental Monitoring Group for educational awareness campaigns on sustainable farming practices. • Organizing farmer field schools to facilitate peer-to-peer learning and demonstration of successful climate-adaptive farming methods.
Supporting nomadic farmers.	<ul style="list-style-type: none"> • Developing education and awareness campaigns directed at nomadic farmers to help them adapt their unique farming practices to a changing climate. • Implementing a mobile veterinary service to reach out to nomadic farmers, ensuring their livestock receive necessary healthcare and vaccinations.

4.8. Climate Change Goal 5: To Protect Natural Resources and Manage Loss of High-Priority Biomes

Table 24: Climate change goal 5, outcome, linkage to district's strategic objectives.

Goal:	<ul style="list-style-type: none"> • Initiate and maintain comprehensive conservation efforts to protect vital natural resources and halt the degradation of high-priority biomes due to climate change.
Outcome:	<ul style="list-style-type: none"> • Effective preservation and restoration of high-priority biomes, ensuring the sustainability of vital ecosystems, and improved management of natural resources for future generations.
Linkage to NDM's Strategic Objectives	<ul style="list-style-type: none"> • "Stimulation of green, diverse, integrated socio-economy" - Protecting natural resources and managing the loss of biomes contributes to a sustainable, green economy by ensuring the

preservation of ecosystems that provide essential services, from supporting biodiversity to providing livelihoods.

- "Integrated support and capacitating local municipalities for sustainability" - Ensuring the protection of natural resources and managing biomes requires strong support to local municipalities, enabling them with the right tools, capacity, and knowledge to effectively safeguard their natural assets.
- "Providing strategic leadership" - Achieving this goal requires strategic leadership that prioritizes conservation efforts and enforces regulations to protect natural resources and biomes.
- "Fostering and strengthening partnerships with all role-players" - Achieving this goal necessitates collaboration with various stakeholders, including local communities, environmental groups, government agencies, and research institutions to ensure effective protection and management strategies are implemented.
- "Transparent and accountable processes" - Transparency and accountability in decision-making processes related to natural resources management and biodiversity conservation are critical for maintaining public trust and ensuring that conservation efforts are effectively implemented and monitored.

4.8.1. Rational/Context

The "*To protect natural resources and manage loss of high-priority biomes*" initiative is a strategic priority for the Namakwa District Municipality (NDM) in response to the crucial role biodiversity plays in sustaining ecosystem health and human well-being. Six out of South Africa's nine biomes are found in the Northern Cape, making it a region of rich biodiversity. The ecosystems and biomes in the province, such as Nama Karoo, Savannah, and Succulent Karoo, provide essential ecological infrastructure. This infrastructure underpins economic and livelihood activities, such as agriculture and tourism, upon which all South Africans depend.

These natural ecosystems, however, are under considerable pressure from climate change, land use changes, invasive alien species, and human-induced degradation, such as overgrazing and mining. The Nama Karoo biome, covering over 50% of the province and home to many endemic species, is the second most threatened biome in South Africa. Similarly, the Savannah biome, key to the region's agriculture and game farming sectors, and the Succulent Karoo biome, globally significant for its succulent flora, are also suffering from negative impacts of overgrazing, insufficient rainfall, and mining activities.

Climate change is predicted to exacerbate these issues by altering the range and extent of these biomes. Projections show the possibility of the Nama Karoo biome giving way to an expansion of the Grassland and Succulent Karoo biomes or even the Desert biome under high-risk

scenarios. Such drastic changes could undermine local economies and livelihoods that rely heavily on the health and stability of these ecosystems.

Furthermore, well-functioning ecosystems provide natural solutions that build resilience against climate change. For instance, they can buffer communities against extreme weather events and provide resources for diversifying local livelihoods. Therefore, the strategic priority to protect natural resources and manage the loss of high-priority biomes is an investment in the ecological resilience and socio-economic stability of the Northern Cape. It is vital to ensure the continued provision of ecosystem services, the survival of endemic species, and the resilience of communities amidst a changing climate.

4.8.2. Programme 14: Conserve, Protect and Restore Natural Open Spaces, Ecosystems with Climate Change Adaptation Benefits

Programme: conserve, protect, and restore natural open spaces, ecosystems, and natural resources is conceived within the broader context of sustainable development and environmental stewardship. Natural resources and ecosystems form the bedrock of our livelihoods and socio-economic development, providing essential services such as water purification, carbon sequestration, soil fertility, biodiversity, and recreational spaces. However, anthropogenic activities and climate change pose severe threats to these natural systems, causing habitat degradation, species extinction, and disrupting ecological balance. The need for the conservation, protection, and restoration of these natural spaces and resources cannot be overemphasized as they are vital for our survival, economic growth, and climate resilience. This program addresses these concerns by identifying high conservation value areas, developing and implementing conservation and management strategies, and restoring degraded ecosystems to improve their resilience.

The programme also emphasizes the strategic use of open spaces and ecosystems in climate change mitigation and adaptation. Natural spaces such as forests, grasslands, wetlands, and even urban green spaces play crucial roles in climate regulation by sequestering carbon, regulating temperature, and controlling stormwater. The programme seeks to harness these potential climate benefits by integrating green infrastructure into urban development and encouraging sustainable land-use practices. Furthermore, the programme also aims to bolster resilience in climate-risk zones by conducting vulnerability assessments, implementing early warning systems, and promoting nature-based solutions. It is through these multi-faceted approaches that this Programme aims to conserve, protect, and restore natural spaces, ecosystems, and resources, thereby strengthening the municipality's environmental sustainability and resilience to climate change.

Table 25: Programme 14: Conserve, protect and restore natural open spaces, ecosystems and natural resource.

Programme 14: Conserve, Protect and Restore Natural Open Spaces, Ecosystems and Natural Resources.	
ACTIONS	KEY ACTIVITIES
Assessing natural resources and ensuring that natural open spaces, ecosystems, and resources are conserved, protected and restored.	<ul style="list-style-type: none"> • Conduct a comprehensive inventory of natural resources, including land, water, and biological resources, to identify areas of high conservation value and areas of concern. • Assess the current state of natural open spaces, ecosystems, and resources to determine their condition and any threats or vulnerabilities they may face due to climate change. • Develop conservation plans and management strategies for high conservation value areas, ensuring that they are integrated into municipal spatial plans and protected through legislation, policy and land use management. • Implement measures to restore degraded natural open spaces and ecosystems, such as wetlands and riparian areas, to improve their function and resilience in the face of climate change. • Establish protected areas and ensure that they are managed effectively to ensure the conservation of natural resources and ecosystems.
Harnessing the potential of open spaces to absorb and mitigate the impacts of climate change.	<ul style="list-style-type: none"> • Conducting a green infrastructure assessment to identify natural areas that can provide climate benefits such as carbon sequestration, stormwater management, and temperature regulation. • Developing a plan to integrate green infrastructure practices into new development and redevelopment projects, such as using permeable pavement, green roofs, and bioswales to manage stormwater runoff and reduce the urban heat island effect. • Planting trees and other vegetation in strategic locations provides shade, reduces air pollution, and improves overall air quality. • Establishing community gardens and urban agriculture programmes to increase access to fresh, healthy food and provide opportunities for residents to engage with natural areas and learn about sustainable practices. • Protecting and enhancing existing natural areas by preserving wetlands, riparian corridors, and other important habitats. • Creating and maintaining trails, bike paths, and other recreational infrastructure to encourage outdoor activity and promote physical and mental health.

Implementing programmes focused on mitigating the impact of climate change and severe weather, particularly in climate-risk zones.

- Conducting vulnerability assessments to identify areas and communities most at risk from the impacts of climate change and severe weather events.
- Developing and implementing early warning systems and emergency response plans to enable timely evacuation and disaster relief efforts.
- Promoting nature-based solutions, such as restoration of wetlands, and green infrastructure, to help mitigate the impacts of climate change and severe weather events.
- Encouraging the adoption of sustainable land use practices, such as low-impact development, agroforestry, and sustainable agriculture, to help build resilience in the face of climate change.
- Providing education and awareness campaigns to inform residents and businesses about the risks of climate change and the actions they can take to mitigate their impacts.
- Encouraging community participation in climate adaptation and resilience planning efforts, through stakeholder engagement and collaboration with local organisations and community groups.
- Establishing partnerships with other municipalities, government agencies, and non-governmental organisations to leverage resources, share best practices, and coordinate efforts in addressing the impacts of climate change and severe weather.
- Develop natural resource management programmes such as grazing, river and wetland rehabilitation programmes in collaboration with Conservation South Africa, Biodiversity Social Projects and the Department of Environmental Affairs Working for Water and Working for Wetlands.
- Develop Ecosystem-based Adaptation approaches in collaboration with Conservation South Africa, and other associated entities.

4.8.3. Programme 15: Develop and Implement Conservation and Management Plan For Vulnerable Species.

This programme is built upon the recognition of the biodiversity crisis driven by habitat destruction, overexploitation, invasive species, and climate change. Biodiversity in the Northern Drakensberg Municipality (NDM) includes unique and endangered species, whose preservation is critical for maintaining ecological balance, cultural heritage, and future research and development. This programme addresses this crisis by aiming to develop comprehensive conservation and management plans for vulnerable species. These plans involve a thorough

assessment of vulnerable and endangered species, taking into account their level of vulnerability, ecological importance, and cultural significance. It also recognises the need to mitigate the impacts of industrial development on biodiversity through initiatives like biodiversity offsetting.

The second facet of this programme emphasises the importance of community engagement and collaboration in conservation efforts. Given the ecological and cultural interdependencies, the programme acknowledges the role of local communities, organisations, and experts in protecting and managing vulnerable species. By promoting participatory planning and fostering an exchange of knowledge among different biomes, it encourages community ownership and accountability in conservation efforts. Further, this programme recognises the importance of education and outreach in raising awareness about the importance of protecting vulnerable species. Lastly, to ensure the continuity and effectiveness of these efforts, the conservation and management plans developed under this programme are integrated into municipal policies and planning documents, thus creating a strategic and holistic approach towards the conservation of vulnerable species in the NDM.

Table 26: Programme 15 - Develop and implement a conservation and management plan for vulnerable species.

Programme 15: Develop and Implement a Conservation and Management Plan For Vulnerable Species	
ACTIONS	KEY ACTIVITIES
Develop and implement a conservation and management plan for vulnerable species.	<ul style="list-style-type: none"> • Conducting a thorough assessment of vulnerable and endangered species within the municipality, focusing on their level of vulnerability, ecological importance, and cultural significance. • Developing and implementing conservation and management plans that include strategies to protect and restore habitats, manage threats, and monitor populations. Incorporating traditional knowledge, through commissioned research, on the loss of biomes in the district to ensure these plans are well-rounded and contextual. • Investigating options of biodiversity offsetting for industries in the District, through the consideration and purchase of land to replace lost vegetation types and declare the land as a conservation area through Conservation South Africa Stewardship Programmes.
Partnering and public engagement.	<ul style="list-style-type: none"> • Partnering with local organizations, experts, and communities to implement conservation and management plans and ensure their long-term sustainability. This could include conducting community engagements in collaboration with Conservation South Africa and the Department of Agriculture, Forestry, and Fisheries to promote participatory planning in farming communities.

	<ul style="list-style-type: none"> • Organising exchange visits for communities living in different biomes to observe traditional modelling and promote the exchange of knowledge to younger generations, strengthening the overall conservation effort. • Providing education and outreach to raise awareness of the importance of protecting vulnerable species and their habitats, and engage the public in conservation efforts.
<p>Integration of conservation plans into municipal policies.</p>	<ul style="list-style-type: none"> • Integrating conservation and management plans into municipal policies and planning documents, ensuring that they are regularly reviewed and updated to reflect changing ecological conditions and new information. This will help align local policies with broader conservation goals and promote a shared responsibility for protecting vulnerable species.

4.8.4. Programme 16: Enhanced Natural Resource Management

The *Enhanced Natural Resource Management and Use of Ecosystem Services* programme emerges from a critical understanding that the sustainable development of Northern Drakensberg Municipality (NDM) rests on the responsible stewardship of its natural resources. The programme prioritises water quality, a key resource that supports human health, socio-economic growth, and ecological well-being. It highlights the importance of water quality monitoring, pollution prevention measures, and public education campaigns to reduce environmental impact. It also encourages participation in the formulation and enforcement of regulations and policies to manage water resources, especially in areas prone to water scarcity. Furthermore, collaboration with neighbouring municipalities and stakeholders is emphasised for effective shared water resource management and prevention of transboundary pollution.

Additionally, the programme recognises the essential role of soil health in maintaining the productivity of natural ecosystems and the quality of water resources. It calls for proactive measures such as soil erosion risk assessments, erosion control plans, and the promotion of sustainable land use practices to prevent soil erosion. This programme also recognises the crucial need to build capacity and compliance with regulations and guidelines related to biodiversity and natural resource management. A comprehensive training program for municipal staff and stakeholders is proposed to increase understanding and adherence to these regulations. Lastly, the establishment of a District Environmental Management Forum is envisaged to enhance coordination between various sectoral departments, conservation organisations, and agencies, enabling a more unified approach to natural resource management in the NDM. This initiative also ties in KPIs for various sectoral departments to the forum attendance, ensuring accountability and active participation.

Table 27: Programme 16 - Enhanced natural resource management and use of ecosystem services.

Programme 16: Enhanced Natural Resource Management and Use of Ecosystem Services	
ACTIONS	ACTIVITIES
<p>Ensuring the quality of water resources is critical to the sustainable development of NDM, as they play a vital role in maintaining the health of ecosystems, human health, and socio-economic development.</p>	<ul style="list-style-type: none"> • Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals, in water bodies. • Developing and implementing pollution prevention measures to reduce the number of pollutants entering water sources, such as through agricultural and industrial runoff or sewage discharge. • Encouraging the use of environmentally-friendly practices in households, businesses, and industries to reduce the discharge of pollutants into water resources. • Developing and implementing water treatment technologies to remove pollutants from wastewater before discharge or reuse. • Creating public awareness campaigns to educate the public about the importance of protecting water resources and reducing their impact on the environment. • Participating in the development and implementation of regulations and policies to manage and regulate the use of water resources, particularly in areas where water scarcity is a concern. • Collaborating with neighbouring municipalities and stakeholders to manage shared water resources and prevent transboundary pollution.
<p>Monitoring and preventing soil erosion is crucial to ensure the long-term health and productivity of natural ecosystems, as well as to maintain the quality of water resources. <i>(Preventing soil erosion requires a multifaceted approach that involves monitoring, planning, and implementing strategies that protect natural resources).</i></p>	<ul style="list-style-type: none"> • Conducting soil erosion risk assessments on municipal land to identify areas that are most vulnerable to erosion and prioritise action. • Developing and implementing erosion control plans to minimise soil erosion, such as the use of vegetation cover. • Promoting the use of sustainable land use practices that preserve natural vegetation and minimise soil disturbance. • Monitoring soil erosion levels through regular assessments and surveys, and implementing remedial measures where necessary. • Educating the public about the importance of preventing soil erosion and promoting sustainable land use practices through outreach and education campaigns.

<p>Provide training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines. <i>(Providing training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines is an important aspect of ensuring compliance with these regulations. The training can help to build capacity and knowledge of these regulations, ensuring that those involved in natural resource management have the skills and understanding needed to comply with the regulations and guidelines effectively).</i></p>	<ul style="list-style-type: none"> • Developing a training programme that covers key biodiversity and natural resource management regulations and guidelines, as well as the penalties for non-compliance. • Identifying the staff and stakeholders that require training based on their roles and responsibilities in natural resource management. • Delivering the training through a variety of methods, including workshops, seminars, and online courses. • Evaluating the effectiveness of the training programme through feedback from participants and monitoring compliance with regulations after the training has been delivered. • Updating the training programme regularly to reflect changes to regulations and guidelines and new developments in natural resource management practices. • Providing ongoing support and guidance to staff and stakeholders to ensure they have the necessary resources to comply with regulations and guidelines. • Implement the guidelines of the Conservation SA resource handbook and the DEA's 'Let's respond' Toolkit.
<p>Establish a District Environmental Management Forum (DEMF) to enhance collaboration and coordination between Sectoral Departments, Conversation Organisations and agencies related to natural resource management.</p>	<ul style="list-style-type: none"> • Identifying key stakeholders to participate in the forum, such as municipal departments, conservation organisations, and other relevant agencies. • Developing a forum structure, including goals, objectives, and a work plan. • Conducting regular meetings to discuss progress, challenges, and opportunities related to natural resource management. • Coordinating joint efforts on natural resource management, such as collaborative projects or initiatives. • Identifying and leveraging resources to support the goals and objectives of the Forum. • Tracking progress and assessing the impact of the forum on natural resource management. • Updating the forum structure and work plan as needed to ensure continued effectiveness and relevance. • Attach Key Performance Indicators (KPIs) for various sectoral departments to the attendance of the Forum.

4.8.5. Programme 17: Integration of Ecological Support Areas and Ecosystem Services into SDF and IDP

The Programme: "Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Frameworks and IDP" is a critical endeavour of the Namakwa District Municipality (NDM). It aims to ensure sustainable and climate-resilient urban development in the face of a rapidly changing climate. The escalating risks posed by climate change to urban ecosystems and biodiversity require a proactive integration of natural spaces and critical biodiversity areas into spatial and development planning. The rationale for this initiative is dual-faceted: the approach seeks not only to maintain and enhance the ecological health and resilience of urban spaces but also to leverage these natural resources in mitigating and adapting to the impacts of climate change.

The suite of actions and activities under this programme spans a wide range of ecological considerations. These include the identification and protection of high ecological value areas, the mapping and integration of natural open spaces and resources into spatial planning frameworks, the identification of undeveloped spaces ripe for green infrastructure, and the assessment of the value of open spaces and ecosystem services. Each action is intrinsically aimed at weaving ecological and biodiversity considerations into the core fabric of urban planning and development within the NDM. Moreover, the integration of climate change into NDM's Integrated Development Plan (IDP) and Disaster Management Plan forms a crucial part of this comprehensive approach. Through the integration of climate considerations into all stages of IDP development and implementation - including planning, budgeting, and monitoring - this approach not only address the immediate threat of climate change but also equips local officials and communities in the NDM with the necessary tools and knowledge to tackle these global challenges at a local scale.

Table 28: Programme 17 - Integrate critical biodiversity areas and ecological support areas into the spatial frameworks and IDP.

Programme 17: Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Framework and IDP.	
ACTIONS	KEY ACTIVITIES
Ensuring critical biodiversity and ecological support areas are integrated into municipal spatial plans at all scales. <i>(This involves identifying areas of high ecological value</i>	<ul style="list-style-type: none"> • Conduct a comprehensive analysis of existing municipal spatial plans and policies to determine where critical biodiversity and ecological support areas are currently included or excluded. • Identify critical biodiversity areas and ecological support areas within the municipality, using relevant data and information sources, such as aerial imagery, ecological surveys, and other mapping tools.

<p><i>and ensuring that they are given due consideration in the municipality's spatial planning activities).</i></p>	<ul style="list-style-type: none"> • Analyse and map the spatial distribution of critical biodiversity areas and ecological support areas to determine their location and extent, as well as any potential threats or vulnerabilities. • Conduct stakeholder consultations with relevant departments, experts, and community members to gather input and feedback on the inclusion of critical biodiversity and ecological support areas in municipal spatial plans. • Develop policies, guidelines, and standards for the inclusion of critical biodiversity and ecological support areas in municipal spatial plans, including considerations for zoning, land use, and development regulations. • Integrate critical biodiversity and ecological support areas into the municipal spatial plans at all relevant scales, such as the Spatial Development Framework, Open Space Framework, and other relevant plans. • Monitor the implementation and effectiveness of the policies and guidelines for the inclusion of critical biodiversity and ecological support areas in municipal spatial plans and make adjustments as needed to ensure their continued protection and conservation.
<p>Identifying and mapping natural open spaces, ecosystems, and natural resources, and integrating inventories in the Spatial Development Framework and the open space framework.</p>	<ul style="list-style-type: none"> • Conducting surveys and assessments of the natural resources and ecosystems in the municipality. • Collecting and analysing data on the location, size, and ecological value of open spaces and natural resources, such as wetlands, and water bodies. • Identifying areas of high ecological value, such as critical habitats for threatened or endangered species, and designating them as protected areas. • Mapping the location and extent of identified open spaces, ecosystems, and natural resources, using geographic information system (GIS) technology or other mapping tools. • Integrating the mapping and inventory information into the Spatial Development Framework, open space framework, and other relevant plans, to guide future development and land-use decisions. • Updating the mapping and inventory information regularly to ensure it remains accurate and up-to-date with any changes in the natural environment.
<p>Identifying undeveloped open space with potential for green infrastructure.</p>	<ul style="list-style-type: none"> • Conducting an inventory of undeveloped open spaces within the municipality. • Evaluating the potential for green infrastructure development in identified spaces. • Assessing the suitability of undeveloped open spaces for different types of green infrastructure (e.g., parks, urban forests, green roofs, bioswales). • Considering factors such as land ownership, existing land use, soil conditions, topography, and hydrology when identifying

	<p>undeveloped open spaces with potential for green infrastructure.</p> <ul style="list-style-type: none"> • Prioritising undeveloped open spaces based on their potential to provide multiple benefits, such as biodiversity conservation, climate change mitigation and adaptation, and public health and well-being. • Engaging with stakeholders and the public to gather input and support for identifying and prioritising undeveloped open spaces with the potential for green infrastructure.
<p>Assessing the value of open spaces and ecosystem services</p>	<ul style="list-style-type: none"> • Conducting ecological assessments to determine the ecological value of open spaces and ecosystems. • Identifying the ecosystem services these areas provide, such as carbon sequestration, water filtration, and habitat provision. • Assessing the potential impacts of development or other human activities on these ecosystem services and the overall ecological value of the areas. • Using this information to inform decisions about land use and development ensures that these areas' ecological value is protected and enhanced. • Developing policies and regulations to protect and manage these areas, such as zoning restrictions or conservation easements.
<p>Integrate climate change into NDM IDP and disaster management plan.</p>	<ul style="list-style-type: none"> • Set up an annual review and a comprehensive five-year redevelopment process for the Climate Change Vulnerability Assessment and Response Plan. This process should evaluate its efficacy in the face of evolving climate change challenges and ensure it remains relevant and aligned with the Integrated Development Plan (IDP) review process. Additionally, a formal schedule that aligns these review and redevelopment processes with other strategic planning initiatives within NDM should be generated. • Ensure that Disaster Management Plans are updated to adhere to amended climate change legislation. This includes integrating new legal requirements and standards into existing plans. Regular training and workshops should also be provided for disaster management staff to keep them updated on new legislation and ensure its effective implementation. • Regularly liaise with legislative bodies to ensure a clear understanding of any changes in climate-related legislation and their implications for disaster management. • Incorporate climate change considerations into all stages of IDP development and implementation, including planning, budgeting, and monitoring. This will require conducting training and awareness-raising initiatives to equip local officials and community members with the necessary knowledge and skills to mainstream climate change into IDPs effectively.

- Identify specific climate change risks and opportunities in the context of NDM and incorporate these insights into local and municipal IDPs. Further, monitor and evaluate the success of climate change integration into IDPs and adjust strategies as necessary.

4.9. Climate Change Goal 6: To Reduce the Vulnerability and Exposure of Human and Natural Systems to Climate Change and Extreme Events.

Table 29: Climate change goal 6, outcome, linkage to district's strategic objectives.

Goal:	<ul style="list-style-type: none"> • Implement rigorous climate resilience strategies aimed at reducing the vulnerability and exposure of both human communities and natural ecosystems to the adverse effects of climate change and extreme events.
Outcome:	<ul style="list-style-type: none"> • Strengthened human and natural systems that are well-adapted and resilient to climate change impacts and extreme events, ensuring the sustainability of the district and the well-being of its residents.
Linkage to NDM's Strategic Objectives	<ul style="list-style-type: none"> • "Stimulation of green, diverse, integrated socio-economy" - Reducing vulnerability and exposure to climate change impacts and extreme events can help maintain a thriving, resilient socio-economy, minimizing disruptions and promoting sustainable practices. • "Fostering and strengthening partnerships with all role-players" - Building resilience against climate change requires cooperation and coordination among various stakeholders, including local communities, NGOs, and other government agencies. By fostering strong partnerships, the NDM can collectively address the challenges posed by climate change and extreme events. • "Integrated support and capacitating local municipalities for sustainability" - Building resilience against climate change necessitates strengthening local municipalities' capabilities to understand, adapt, and respond to changing climate conditions and extreme events. Providing resources, training, and support to these local municipalities is crucial for sustainable development. • "Providing strategic leadership" - Strategic leadership is vital to steer efforts towards reducing vulnerability and exposure to climate change and extreme events. It involves making informed decisions, setting the right priorities, and guiding the implementation of appropriate measures to achieve this goal. • "Transparent and accountable processes" - Implementing measures to reduce vulnerability and exposure to climate change requires processes that are transparent and accountable, ensuring the fair and effective allocation and use of resources and the credibility of efforts taken in this regard.

4.9.1. Rationale/Context

The strategic priority "To Reduce the Vulnerability and Exposure of Human and Natural Systems to Climate Change and Extreme Events" for the Namakwa District Municipality (NDM) acknowledges the profound threats that climate change poses to both human and natural systems. NDM is home to rich and diverse natural systems, and human communities whose livelihoods are tightly interwoven with the health of these ecosystems. The increasing frequency and severity of extreme climate events, such as floods and droughts, threaten these critical ecosystems, disrupt economic activities and exacerbate poverty and food insecurity.

For the human systems, the region is characterized by a variety of economic activities, including agriculture, tourism, and mining, all of which are vulnerable to the adverse effects of climate change and extreme weather events. A changing climate can lead to less predictable rainfall patterns, causing water scarcity and crop failures, and threatening food security and livelihoods.

Extreme weather events such as floods and storms can cause direct damage to infrastructure and property, leading to economic losses and posing a risk to human safety. Given these challenges, it is paramount to reduce the vulnerability and exposure of communities to climate-related risks, in order to maintain sustainable livelihoods and economic stability.

The natural systems in the Northern Cape, characterized by six out of South Africa's nine biomes, are also at risk due to climate change. Altered rainfall patterns, increasing temperatures, and elevated atmospheric CO₂ levels can disrupt the delicate balance of these ecosystems, leading to loss of biodiversity and the potential collapse of entire ecosystems. This is especially concerning given that these ecosystems provide essential services such as clean air and water, fertile soil for agriculture, and habitats for a multitude of species, including many that are endemic to the region.

Therefore, the strategic priority to reduce the vulnerability and exposure of human and natural systems to climate change and extreme events is a comprehensive approach to safeguard the region's rich biodiversity, ensure the continued provision of essential ecosystem services, and protect the livelihoods and well-being of its residents. By doing so, NDM can build resilience against the impacts of climate change and ensure a sustainable future for all its inhabitants.

4.9.2. Programme 18: Enhance Coastal and Marine Environmental Assessment and Protection

The Programme: "*enhance coastal and marine environmental assessment and protection*" is a strategic initiative within the Namakwa District Municipality (NDM), designed to address the unique environmental challenges faced by this coastal district. The diverse coastal and marine ecosystems of NDM not only contribute to its natural beauty but also hold significant environmental, economic, and social value. These systems provide critical habitats for various

marine species, underpin local livelihoods, particularly fisheries, and offer unique opportunities for tourism and recreation. However, the increasing pressures from urban development, climate change, and pollution have posed significant risks to these vital ecosystems. Therefore, ensuring the protection and sustainable management of these coastal and marine areas is paramount for the overall socio-economic well-being of the district.

Strengthening Coastal Environmental Assessment is a crucial step in this direction. By reviewing and assessing all coastal-specific environmental assessments and proposed land use changes in line with the Integrated Coastal Management Act guidelines and principles, NDM can ensure that development activities do not compromise the health and resilience of coastal ecosystems. Developing an inventory of ongoing coastal research and addressing research gaps will further enhance the understanding of these ecosystems, their vulnerabilities, and the most effective strategies for their conservation. On the other hand, the implementation of the National Protected Area Expansion Strategy will allow for the conservation of critical coastal and marine areas in the Northern Cape. Refining the delineation of the coastal protection zone is another important task, which will help to secure and extend these protected areas. Lastly, improved Coastal Infrastructure Management, including the identification and management of derelict structures in the coastal zone and the enforcement of the coastal management line in EIA decision-making processes and building plans approval, will ensure that infrastructural development respects and preserves the integrity of the coastal environment.

Table 30: Programme 18 - Enhance coastal and marine environmental assessment and protection.

Programme 18: Enhance Coastal and Marine Environmental Assessment and Protection.	
ACTIONS	KEY ACTIVITIES
Strengthen coastal environmental assessment.	<ul style="list-style-type: none"> Review and assess all coastal-specific environmental assessments and proposed land use changes in line with the Integrated Coastal Management Act guidelines and principles. Develop an inventory of all coastal research currently being undertaken along the Northern Cape coast. Identify and address research gaps to ensure comprehensive environmental assessments.
Implement protected area expansion.	<ul style="list-style-type: none"> Implement the National Protected Area Expansion Strategy for the Northern Cape, focusing specifically on coastal and marine areas. Refine the delineation of the coastal protection zone to secure and extend protected areas.
Improve coastal infrastructure management.	<ul style="list-style-type: none"> Identify derelict structures in the coastal zone and engage with landowners for repair or removal according to the Integrated Coastal Management Act. Ensure adherence to the coastal management line in Environmental Impact Assessment (EIA) decision-making processes and building plans approval.

4.9.3. Programme 19: Establish and Implement Comprehensive Estuarine Management Plans

The Programme: "*Establish and implement comprehensive estuarine management plans*" is a central pillar of the Namakwa District Municipality's (NDM) environmental management strategy. The NDM's coastal region features several estuaries, which are crucial ecological hotspots that support diverse flora and fauna. Estuaries serve as crucial breeding grounds and nurseries for many marine species and also play a significant role in nutrient cycling and water purification. Additionally, they provide important social and economic benefits, including recreational opportunities and support for local livelihoods, such as fisheries. However, these valuable ecosystems are increasingly under threat from urban development, pollution, and climate change. Therefore, prioritising and protecting estuaries is a critical environmental and socio-economic imperative for the NDM.

The key actions and activities under this programme are designed to provide a comprehensive and proactive approach to estuary management. Prioritising estuaries based on their ecological significance and vulnerability to climate change is an important first step towards targeted and effective management. Implementing buffer zones around these estuaries, as stipulated by the Integrated Coastal Management Act and the National Environmental Management: Protected Areas Act, will help protect these areas from encroaching urban development and other potential threats. The development and implementation of comprehensive Estuarine Management Plans will provide a strategic roadmap for the protection, management, and sustainable use of these vital ecosystems. Establishing a basic estuary monitoring programme will help assess the effectiveness of these management plans, enable prompt identification and response to emerging threats, and contribute to scientific knowledge about these unique ecosystems. Increasing scientific data and knowledge generation on all estuaries through regular monitoring and research will also inform the continual improvement of management plans and contribute to broader environmental knowledge and understanding.

Table 31: Programme 19 - Establish and implement comprehensive estuarine management plans.

Programme 19: Establish and Implement Comprehensive Estuarine Management Plans.	
ACTIONS	KEY ACTIVITIES
Prioritise estuaries.	<ul style="list-style-type: none"> Identify and prioritise estuaries based on ecological significance and vulnerability to climate change. Apply Integrated Coastal Management Act / National Environmental Management: Protected Areas Act buffer zones around all prioritised estuaries.
Develop estuarine management plans.	<ul style="list-style-type: none"> Develop and implement comprehensive Estuarine Management Plans to protect and manage prioritised estuaries.

	<ul style="list-style-type: none"> Establish a basic estuary monitoring programme to evaluate the effectiveness of the management plans and gather scientific data.
Enhance scientific data and knowledge generation.	<ul style="list-style-type: none"> Increase scientific data and knowledge generation on all estuaries through regular monitoring and research activities. Formalise and implement the Northern Cape coastal management line for the coast including estuaries.

4.9.4. Programme 20: Promote Coastal Resilience and Disaster Risk Management

The Programme: "Promote coastal resilience and disaster risk management" is a strategic initiative of the Namakwa District Municipality (NDM), aligning with the global and national agenda of fostering climate resilience and reducing disaster risks. NDM's coastal areas, like many other coastal regions worldwide, are highly vulnerable to climate change impacts, including sea-level rise, coastal erosion, and increased frequency and intensity of storms. These changes pose significant risks to human settlements, infrastructure, and ecosystems along the coast. Thus, strengthening coastal resilience and improving disaster risk management is not only essential for protecting the lives and livelihoods of local communities but also for preserving the ecological integrity and economic value of the coastal region.

The key actions and activities under this programme are designed to enable a proactive and integrated approach to coastal resilience and disaster risk management. Regular coastal audits and reporting will facilitate the early detection of potential issues and risks and inform timely and targeted responses. The development of a comprehensive Coastal Disaster Management Plan, in coordination with the Northern Cape Integrated Pollution and Waste Management Plan, will provide a strategic framework for mitigating and responding to coastal disasters, incorporating potential impacts from pollution and waste. Monitoring sea-level rise, particularly in vulnerable areas such as the Richtersveld and Kamiesberg Local Municipalities, is critical for understanding and planning for future risks. Engaging with the Surveyor General's office to clarify provincial boundary locations in the context of sea-level rise and coastal erosion will help address legal and administrative issues arising from these changes. Lastly, identifying funding mechanisms for mitigation measures can provide crucial support for implementing adaptation strategies and building coastal resilience.

Table 32: Programme 20 - Promote coastal resilience and disaster risk management.

Programme 20: Promote Coastal Resilience and Disaster Risk Management.	
ACTIONS	KEY ACTIVITIES
Conduct regular coastal audits and reporting.	<ul style="list-style-type: none"> Undertake annual coastal audits to assess the state of the coast and identify potential risks and issues. Maintain ongoing databases of issues identified and report on the State of the Coast regularly.

Develop a coastal disaster management plan.	<ul style="list-style-type: none"> • Develop a comprehensive Coastal Disaster Management Plan that outlines strategies and actions for mitigating and responding to coastal disasters. • Incorporate coastal and marine issues into the Northern Cape Integrated Pollution and Waste Management Plan to ensure coordinated management of environmental risks.
Monitor and address sea-level rise.	<ul style="list-style-type: none"> • Monitor sea-level rise, especially in Richtersveld and Kamiesberg Local Municipalities (LMs) where impacts are already reported and incorporate these findings into disaster management and spatial planning activities. • Engage the Surveyor General's office to clarify provincial boundary locations in the context of sea-level rise and coastal erosion. • Identify funding mechanisms to assist with mitigation measures such as gabions and seawalls.

4.9.5. Programme 21: Integrated Fire Management for Climate Resilience

The "*integrated fire management for climate resilience*" programme bears significant relevance for the Namakwa District Municipality given its unique environmental conditions and potential vulnerability to wildfires. A substantial proportion of its population resides in remote rural areas scattered across a diverse terrain comprising the semi-arid Karoo region, coastal areas, and high-altitude areas of Namaqualand, characterized by a rich biodiversity but also presenting wildfire risks. These challenges are further intensified by climate change, which brings forth increasing temperatures, shifting rainfall patterns, and extreme weather events, creating conditions conducive to the ignition and spread of wildfires.

The programme aims to address these risks through a strategic and multi-faceted approach. beginning with an in-depth "assessment of fire risks and vulnerabilities," the programme will identify areas susceptible to wildfires, evaluate potential fire behaviour, and estimate the socio-economic implications of wildfire incidences. this assessment will form the basis for the "strategic fire management plan," which will delineate preventive and reactive measures to minimize the impact of wildfires, such as regular maintenance of firebreaks, management of flammable vegetation, and enforcing safe land use practices.

A "community engagement and fire safety education" segment will involve empowering the local communities with knowledge about fire prevention techniques and strategies to employ during a wildfire. to facilitate the early detection of wildfires, the programme will incorporate an "advanced fire detection and monitoring system," possibly integrating the use of cutting-edge technologies for real-time monitoring and early warning.

In the case of a fire outbreak, a well-defined "emergency preparedness and response plan" will ensure rapid and effective containment efforts, while a subsequent "post-fire rehabilitation and

ecosystem restoration" phase will help restore the ecosystem and rehabilitate affected areas. the programme will also include a "policy and regulatory framework" to provide guidelines for robust fire management practices and climate resilience.

Through "research and innovation in fire management techniques," the programme will foster the development of innovative strategies for managing wildfires. it will also encourage "inter-organizational collaboration and strategic partnerships" to foster a collective and integrated response to wildfire risks. finally, the "strengthening fire management capacities and resource utilization" component will focus on building the competencies of fire management personnel and ensuring the efficient use of resources.

In essence, the programme endeavours to enhance the resilience of the Namakwa District Municipality to wildfires, taking a comprehensive and integrated approach in light of the looming challenges of climate change.

Table 33: Programme 21 - Integrated fire management for climate resilience.

Programme 21: Integrated Fire Management for Climate Resilience	
ACTIONS	POSSIBLE KEY ACTIVITIES
Comprehensive evaluation of fire hazards.	<ul style="list-style-type: none"> • Hazard identification: Identify areas prone to wildfires due to factors such as vegetation type, topography, climate, and historical fire patterns. • Vulnerability assessment: Analyze the vulnerability of human settlements, critical infrastructure, and ecosystems in the identified high-risk areas. • Climate change impact analysis: Assess how climate change could affect fire risk in the future, considering factors such as increasing temperatures, changing rainfall patterns, and frequency of extreme weather events. • Resource evaluation: Evaluate the current capacity and resources (human, technical, and financial) available to manage fire risks and respond to fire incidents. • Infrastructure assessment: Assess the condition of existing fire management infrastructure, such as fire breaks, firefighting equipment, and emergency access routes. • Fire behavior modeling: Use fire behaviour models to predict how fires could spread under different conditions in the identified high-risk areas. • Risk mapping: Develop risk maps using GIS tools to visualize areas of high fire risk, the potential spread of fires, and vulnerable ecosystems or infrastructure. • Review and update: Regularly review and update the fire risk assessment to account for changes in land use, climate, and other relevant factors.

<p>Strategic fire prevention roadmap.</p>	<ul style="list-style-type: none"> • Firebreak creation: Identify and create strategic firebreaks to halt the progress of wildfires. This may involve clearing vegetation or using controlled burns to remove fuel sources. • Controlled burns: Conduct controlled or prescribed burns to reduce excess vegetation that could fuel wildfires. This needs to be done under strict supervision and under specific weather conditions. • Public Education campaigns: Develop and deliver education programs to raise community awareness about fire risks and prevention measures. This can include information on safe practices for outdoor burning, campfires, and disposal of cigarettes. • Legislation and policy: Advocate for and implement local regulations that reduce fire risk, such as restrictions on burning during high-risk periods and regulations around building materials and designs in fire-prone areas. • Vegetation management: Implement a program for managing vegetation, including the removal of dead or dying trees, pruning overgrown areas, and planting fire-resistant species in high-risk areas. • Infrastructure planning: Plan infrastructure considering fire prevention, such as the design and location of roads, utilities, and buildings to minimize fire risks. • Emergency access routes: Ensure clear and accessible emergency routes for firefighters and residents in the event of a fire. This includes regularly inspecting and maintaining these routes. • Community fire plans: Help communities in high-risk areas develop comprehensive fire plans, including evacuation routes, emergency contact numbers, and plans for livestock and pets. • Fire detection systems: Install and maintain early fire detection systems to identify and respond to fires as quickly as possible. • Collaboration and cooperation: Cooperate with regional, national, and international fire management agencies, sharing knowledge, resources, and best practices in fire prevention.
<p>Community engagement and fire safety education.</p>	<ul style="list-style-type: none"> • Community workshops and seminars: Conduct educational workshops and seminars about climate change, fire risks, and fire prevention. Explain the connections between climate change and increased fire risks, and what actions individuals can take to mitigate these risks. • Development of educational materials: Develop and distribute educational materials such as brochures, posters, and online resources that provide information on fire prevention, response measures, and the importance of environmental management. • Fire safety training: Organize practical fire safety training sessions, including demonstrations on how to use firefighting equipment, evacuation drills, and basic firefighting skills.

	<ul style="list-style-type: none"> • School programs: Implement education programs in schools to raise awareness among younger generations about climate change and fire prevention. • Community fire plans: Assist communities in developing comprehensive fire management plans, including evacuation routes and emergency procedures. Ensure each member of the community understands the plan and their role in it. • Public meetings: Hold regular public meetings to discuss fire risks, prevention strategies, and any updates or changes to the fire management plan. • Social media campaigns: Utilize social media platforms to disseminate information, provide updates on fire incidents, and engage the community in dialogues about fire management. • Collaborative community projects: Organize community projects such as tree planting, vegetation management, and firebreak maintenance. This not only helps reduce fire risks but also fosters community involvement in environmental conservation. • Emergency services open days: Organize open days at local fire stations to educate the community about their work, demonstrate equipment, and provide information on volunteering opportunities. • Partnerships with local organizations: Collaborate with local NGOs, community groups, and businesses to spread the message of fire prevention and climate change mitigation.
<p>Advanced fire and detection monitoring infrastructure.</p>	<ul style="list-style-type: none"> • Satellite monitoring: Utilize satellite imagery to monitor fire incidents across the district. Satellites can provide real-time data on the location, size, and spread of fires. • Ground-based sensors: Deploy ground-based sensors in high-risk areas that can detect smoke or heat and send an immediate alert when a fire starts. • Drone surveillance: Use drones equipped with thermal cameras for real-time surveillance of high-risk areas, especially during high-risk periods. Drones can provide detailed images of fires, helping to assess their severity and direction of spread. • Fire towers: Construct or make use of existing fire towers where personnel can visually monitor large areas for signs of smoke, especially in remote or inaccessible regions. • Community reporting systems: Establish a clear and efficient system for community members to report suspected fires. This could be a dedicated phone line or a mobile app. • Weather monitoring: Regularly monitor weather conditions, as certain conditions such as high temperatures, low humidity, and strong winds can increase fire risk. • Fire risk mapping: Use GIS and remote sensing data to create dynamic fire risk maps that can help in prioritizing monitoring efforts.

	<ul style="list-style-type: none"> • Data integration and analysis: Integrate data from different monitoring sources and use advanced analytics to identify patterns, predict fire behaviour, and improve response strategies. • Regular system maintenance and upgrades: Regularly maintain and upgrade monitoring equipment to ensure it is functioning correctly and taking advantage of the latest technology. • Collaboration with national and regional agencies: Collaborate with national and regional agencies for data sharing and to improve the effectiveness of fire monitoring efforts.
<p>Emergency preparedness and response strategy.</p>	<ul style="list-style-type: none"> • Emergency response plan development: Develop comprehensive emergency response plans outlining procedures for fire detection, suppression, evacuation, communication, and post-fire recovery. • Evacuation plans: Create evacuation plans for at-risk communities, including clear escape routes, assembly points, and emergency shelters. • Firefighting equipment and infrastructure: Ensure the availability of adequate firefighting equipment and infrastructure, such as fire trucks, water supplies, and protective clothing. Regularly check and maintain these resources to ensure they are always ready to use. • Training and drills: Conduct regular training exercises and drills for emergency services and the community to ensure everyone understands their roles and responsibilities during a fire incident. • Emergency communication systems: Establish reliable communication systems to quickly alert emergency services, community members, and neighbouring regions about a fire incident. • Collaboration and coordination: Coordinate with local, regional, and national fire services, law enforcement, healthcare providers, and other relevant stakeholders to ensure a cohesive response during an emergency. • Public education: Educate the public about what to do in case of a fire, including when and how to evacuate, the importance of adhering to alerts and directives, and basic fire safety measures. • Resource mobilization: Ensure mechanisms are in place for quick mobilization of resources such as personnel, equipment, and financial assistance during a fire emergency. • Post-fire assessment and recovery: Develop and implement strategies for rapid post-fire assessment and recovery, including immediate steps to prevent further damage (like soil erosion) and long-term plans for rehabilitation and restoration. • Regular plan review and update: Regularly review and update the emergency preparedness and response plan based on

	<p>lessons learned from previous fire incidents, changes in the community or environment, and advancements in technology.</p>
<p>Post-fire restoration and ecosystem rehabilitation.</p>	<ul style="list-style-type: none"> • Damage assessment: Conduct post-fire assessments to determine the extent of the damage to ecosystems, infrastructure, and communities. This will guide the restoration efforts. • Erosion control: Implement immediate erosion control measures to prevent soil loss and water pollution, especially in areas where vegetation has been destroyed by fire. • Revegetation: Undertake revegetation efforts, which may include planting native trees and plants or facilitating natural regeneration processes. • Soil restoration: Implement measures to restore soil health, such as adding organic matter or compost, which can help to promote plant growth and restore soil fertility. • Wildlife management: Implement measures to protect and support wildlife after a fire, including providing temporary food and water sources, creating safe habitats, and monitoring injured animals. • Infrastructure repair and rebuilding: Repair or rebuild damaged infrastructure, considering fire-resistant materials and designs to reduce future fire risks. • Monitoring: Regularly monitor the progress of rehabilitation and restoration activities to assess their effectiveness and make necessary adjustments. • Community support: Provide support to affected communities, which may include psychological support, temporary housing, financial assistance, and help with rebuilding efforts. • Research and learning: Conduct research to understand the impact of the fire and the effectiveness of restoration efforts, and use the findings to improve future rehabilitation strategies. • Adaptive management: Apply an adaptive management approach to restoration, which involves learning from ongoing activities and adjusting management strategies accordingly.
<p>Policy and by-law development.</p>	<ul style="list-style-type: none"> • Policy and by-law development: Develop local policies and by-laws related to fire management and environmental conservation, such as regulations on controlled burns, vegetation management, and building codes in fire-prone areas. • Policy review and revision: Regularly review and revise existing policies and by-laws to ensure they are up-to-date, effective, and aligned with current fire management practices and climate change realities. • Legislation advocacy: Advocate for state and national legislation that supports fire management, climate resilience, and environmental conservation efforts. This might involve lobbying, partnership with other municipalities, and collaboration with NGOs and civil society organizations.

	<ul style="list-style-type: none"> • Compliance monitoring: Set up systems to monitor compliance with local by-laws and policies related to fire management and environmental conservation. • Enforcement measures: Establish and implement measures to enforce local by-laws, such as fines for non-compliance, and ensure these measures are well-publicized and understood by the community. • Public consultation: Engage in public consultation when developing or revising policies and by-laws to ensure they reflect community needs and perspectives, and to encourage community buy-in and compliance. • Interdepartmental coordination: Coordinate with other local government departments to ensure policies and by-laws are integrated across different sectors and align with broader municipal strategies and plans. • Training and education: Conduct training and education programs for local government staff, stakeholders, and the community about new and existing policies and by-laws, why they are important, and what is required for compliance. • Policy research: Conduct and use research to inform policy development, including best practices from other municipalities and regions, and evidence on the effectiveness of different fire management strategies. • Partnerships: Build partnerships with other levels of government, research institutions, NGOs, and the private sector to support policy development and legislation efforts.
<p>Innovation and Research in Fire Management Techniques.</p>	<ul style="list-style-type: none"> • Collaborative research initiatives: Establish collaborations with local universities, research institutions, and NGOs to conduct R&D projects related to fire management and climate change adaptation. • Consultant appointments: Hire consultants with expertise in fire management, climate change, and related fields to conduct research, analysis, and provide recommendations. • Grant applications: Apply for research grants from national, provincial, or international funding sources. These funds can be used to conduct R&D projects or hire consultants. • Data gathering and analysis: Conduct surveys, interviews, and community meetings to gather local knowledge and experiences related to fire management. Analyze this data to inform strategies and policies. • Technology adoption: Explore and adopt existing technologies for fire detection, monitoring, and management, taking into account local conditions and resources. • Research dissemination and utilization: Ensure that research findings are communicated to all relevant stakeholders, including local communities, and are used to inform policies, programs, and practices.

	<ul style="list-style-type: none"> • Training and capacity building: Organize training sessions and workshops to increase the capacity of local staff in using and interpreting research findings. • Policy impact research: Commission or conduct studies to assess the impact of current policies and programs, and use the findings to improve them. • Community-based research: Engage local communities in research activities, such as citizen science projects, to leverage local knowledge and increase community buy-in. • Monitoring and evaluation: Monitor and evaluate the effectiveness of R&D activities and use the findings to improve future R&D efforts.
<p>Inter-organizational collaboration and strategic partnerships.</p>	<ul style="list-style-type: none"> • Inter-municipal collaboration: Collaborate with other district municipalities to share knowledge, best practices, and resources related to fire management and climate adaptation. This can involve formal agreements or more informal networks. • Partnerships with higher levels of government: Work closely with provincial and national government agencies responsible for the environment, fire management, and disaster response. This can help to align strategies, access resources, and advocate for supportive policies. • Partnerships with universities and research institutions: Establish partnerships with academic and research institutions to access technical expertise, conduct joint research projects, and provide training opportunities. • Community engagement: Work closely with local communities, involve them in decision-making processes, and tap into local knowledge and resources. This can increase community buy-in and resilience. • Private sector engagement: Engage with the private sector, including businesses and industry groups, to leverage their resources, skills, and influence. This can involve partnerships for specific projects or initiatives, sponsorship agreements, or corporate social responsibility programs. • Collaboration with non-governmental organizations (NGOs): Partner with local, national, or international NGOs that focus on the environment, climate change, or disaster response. NGOs can provide various types of support, from technical expertise and funding to advocacy and community mobilization. • International collaboration: Engage with international networks, organizations, and initiatives focused on climate adaptation and fire management to share experiences, learn from others, and access international resources and funding. • Joint funding applications: Collaborate with partners to apply for funding from national, provincial, or international sources. Joint applications can be more competitive and enable larger and more impactful projects.

	<ul style="list-style-type: none"> • Collaborative training and capacity building: Work with partners to organize training programs and capacity-building activities for municipal staff, community members, and other stakeholders. • Joint monitoring and evaluation: collaborate with partners to monitor and evaluate the impact of partnership activities, learn from experiences, and improve future collaboration.
<p>Strengthening fire management capacities and efficient resource allocation.</p>	<ul style="list-style-type: none"> • Training programs: Organize training programs for municipal staff, community members, and other stakeholders to enhance their knowledge and skills related to fire management, climate change adaptation, environmental conservation, policy development, and other relevant topics. • Recruitment and staffing: Hire and retain qualified personnel with the necessary skills for effective fire management and climate change adaptation. This may also involve providing ongoing professional development opportunities. • Volunteer programs: Develop and manage volunteer programs to supplement municipal efforts. Training local volunteers in fire management and climate adaptation techniques can not only boost capacity but also increase community resilience. • Resource assessment: Conduct regular assessments of resource needs (financial, human, technical, etc.) and develop strategies to fill any gaps. • Resource mobilization: Seek funding and other resources from national, provincial, and international sources. This may involve grant writing, advocacy, and establishing partnerships. • Equipment acquisition and maintenance: Secure and maintain necessary equipment for fire management and climate adaptation, such as fire trucks, firefighting gear, monitoring equipment, etc. • Information management systems: Develop and manage systems for information and data management to support decision-making and coordination. • Community capacity building: Implement programs to build capacity at the community level, such as training in fire preparedness, risk reduction, and climate adaptation. • Stakeholder engagement: Build capacity among various stakeholders, including local businesses, schools, community organizations, and others, to effectively contribute to fire management and climate adaptation efforts. • Evaluation and improvement: Regularly evaluate capacity building and resource mobilization activities to ensure they are effective and make improvements as needed.

4.9.6. Programme 22: Comprehensive Stormwater and Flood Management Programme

The *comprehensive stormwater and flood management programme* holds profound significance for the Namakwa District Municipality, located within a predominantly arid region, but still susceptible to occasional, yet intense rainfall events causing flash floods. The district's expansive geographical footprint, which encompasses various landscapes from mountains, and river valleys, to coastal areas, necessitates the need for a comprehensive approach to stormwater and flood management. Climate change further compounds these vulnerabilities, as projections indicate an increase in the frequency and intensity of extreme weather events, leading to increased risks of flooding. Thus, the implementation of an extensive, climate-resilient programme is crucial to safeguard the communities and the local economy of the district.

In the programme's early stages, detailed field surveys and data collection will be performed to understand the district's current flood-prone areas, drainage network, and stormwater infrastructure. Utilising Geographic Information System (GIS) technology and advanced hydrological modelling, the collected data will be analysed to map the current scenario and forecast future risks. This will guide the design and implementation of the necessary infrastructure improvements, encompassing both traditional infrastructures like drainage channels and innovative green infrastructure solutions. Green infrastructure, such as constructed wetlands, rain gardens, and permeable pavements, provide a cost-effective and sustainable approach to managing stormwater runoff while enhancing the local biodiversity and contributing to the overall health of the district's ecosystems.

This programme emphasises the involvement of all relevant stakeholders, from local communities, and businesses, to governmental and non-governmental organisations, to ensure an integrative and comprehensive approach to stormwater and flood management. Public awareness campaigns will focus on educating residents about stormwater and flood risks and the steps they can take to reduce these risks at an individual and community level. Concurrently, an early warning system will be established to alert communities about impending weather events, enabling proactive measures to minimise potential damage. Training will be provided to local officials and community representatives to enhance their capacity in managing these risks and responding effectively to flood events. A robust monitoring and evaluation system will also be put in place to assess the programme's effectiveness and adapt the strategies to evolving conditions and feedback. In essence, the programme aims to improve the resilience of the Namakwa District Municipality to stormwater and flood risks in a holistic, sustainable, and adaptive manner.

Table 34: Programme 22 – Comprehensive stormwater and flood management programme.

Programme 22: Comprehensive Stormwater and Flood Management Programme	
Actions	Activities
Assessment of current infrastructure.	<ul style="list-style-type: none"> A comprehensive evaluation of current stormwater drainage systems.

	<ul style="list-style-type: none"> • Identification of flood-prone areas for upgrade, repair, or new infrastructure needs.
Mapping of the drainage network.	<ul style="list-style-type: none"> • Charting of existing drainage network and district • Evaluation of capacity and conditions. • Identification of bottlenecks, blockages, or flood-prone areas.
Infrastructure design and construction.	<ul style="list-style-type: none"> • Design and construction of new stormwater drainage and flood management infrastructure. • Integration of future climate scenarios, urban growth trends, and land use changes into planning and design, including the creation or enhancement of floodplains and retention basins.
Green infrastructure advocacy.	<ul style="list-style-type: none"> • Promotion and integration of green infrastructure like rain gardens, bioswales, and permeable pavements to supplement traditional drainage systems.
GIS and hydraulic modelling usage.	<ul style="list-style-type: none"> • Utilization of Geographic Information Systems (GIS) and hydraulic modelling tools. • Simulation of stormwater flow and identification of areas at risk of flooding.
Implementation of monitoring, maintenance, and management plan.	<ul style="list-style-type: none"> • Establishment of a detailed monitoring, maintenance, and management plan for stormwater drainage and flood management infrastructure. • Assured routine inspections, debris removal, and efficient system function.
Stakeholder engagement.	<ul style="list-style-type: none"> • Engagement with engineers, architects, urban planners, landscape architects, local communities, and stakeholders in the design and management of drainage infrastructure, floodplains, and retention basins.
Field surveys and data collection.	<ul style="list-style-type: none"> • Conduct field surveys and data collection on existing infrastructure, water levels, biodiversity, and usage of flood management areas.
Establishment of an early warning system.	<ul style="list-style-type: none"> • Creation of an early warning system, including the installation of monitoring equipment for real-time data collection and analysis. • Development of efficient communication channels for disseminating information.
Public awareness campaigns and education.	<ul style="list-style-type: none"> • Implementation of public awareness campaigns and educational programmes on stormwater management, flood risk awareness, responsible waste management, and emergency preparedness. • Emphasis on the importance of maintaining clean stormwater drains.
Training.	<ul style="list-style-type: none"> • Provision of training for maintenance crews, engineers, and urban planners. • Ensuring they are equipped with the necessary skills and knowledge for effective infrastructure maintenance, management, and development.

Monitoring and evaluation.

and

- Regular monitoring and evaluation to assess the effectiveness of the programme, flood risk reduction, and necessary system upgrades.

4.9.7. Programme 23: Identify and Prioritise Climate Change Risks and Develop Response Measures for Settlements.

The Programme: "identify and prioritise climate change risks and develop response measures for settlements" is a core initiative by the Namakwa District Municipality (NDM) to safeguard its communities from the escalating threats posed by climate change. As the world grapples with increasingly frequent and severe weather events, it becomes clear that the costs of inaction far outweigh the costs of proactive measures. For a region like NDM, with its unique environmental challenges and socio-economic dynamics, it's crucial to identify and prioritise the specific climate risks that its communities face and then develop tailored effective response measures.

This programme's key actions and activities are centred around building a comprehensive understanding of climate vulnerabilities and strengthening adaptive capacities at both the community and institutional levels. Conducting a vulnerability assessment to identify populations and locations most at risk of climate change impacts serves as the starting point, offering insights into targeted interventions. An early warning system, leveraging modern weather monitoring technologies, will enhance communities' preparedness and responsiveness to extreme weather events, reducing potential loss and damage. Partnerships with local stakeholders, such as community groups and NGOs, will further build local capacity for climate change adaptation and resilience, fostering a sense of ownership and community-led innovation. Lastly, integrating climate considerations into land use planning and zoning regulations will ensure that settlements are developed in a climate-smart way, reducing exposure to climate hazards and promoting sustainable development in the long run.

Table 35: Programme 23 - Identify and prioritise climate change risks and develop response measures for settlements.

Programme 23: Identify and Prioritise Climate Change Risks and Develop Response Measures for Settlements.	
ACTIONS	KEY ACTIVITIES
Conducting a vulnerability assessment to identify the populations and locations most at risk of climate change impacts.	<ul style="list-style-type: none">• Analysing climate data to determine the frequency and severity of extreme weather events.• Assessing the vulnerability of infrastructure to flooding.• Mapping areas with high concentrations of vulnerable populations.

<p>Developing and implementing an early warning system to help communities prepare for and respond to climate change risks.</p>	<ul style="list-style-type: none"> • Installing weather monitoring systems to provide real-time data on extreme weather events. • Developing protocols for disseminating warnings to the public. • Establishing community response plans for different types of extreme weather events.
<p>Establishing partnerships with local stakeholders, such as community groups and NGOs, to build local capacity for climate change adaptation and resilience.</p>	<ul style="list-style-type: none"> • Building partnerships with community groups to identify local needs and priorities for adaptation and resilience measures. • Providing capacity-building training to community members on disaster preparedness and response. • Collaborating with local NGOs to implement small-scale adaptation measures, such as rainwater harvesting and urban agriculture.
<p>Developing and implementing land use planning and zoning regulations that take into account the potential impacts of climate change, including, and flooding.</p>	<ul style="list-style-type: none"> • Analysing maps of projected climate change impacts to identify areas at risk. • Developing land use and zoning regulations to ensure that settlements are built in safe and sustainable locations. • Providing technical assistance and support to developers to ensure that new projects are designed to withstand climate change impacts.

4.9.8. Programme 24: Community-Based Adaptation in Communities Most at Risk of Climate-Related Hazards

The Programme: "Community-Based Adaptation in Communities Most at Risk Of Climate-related Hazards" launched by Namakwa District Municipality (NDM) is focused on taking a granular, community-centred approach to climate change adaptation. The climate crisis is a global phenomenon, but its impacts are felt most acutely at the local level, with some communities bearing a disproportionate share of the burden due to their heightened vulnerability. Recognising this, the programme is designed to conduct detailed risk and vulnerability assessments within these communities, to identify the drivers of risk and to formulate suitable adaptation measures. This data-driven approach not only helps to ensure that the adaptation measures are fit for purpose, but it also allows for the prioritisation of efforts and resources where they are needed most.

In the context of NDM, agriculture and water management play pivotal roles in sustaining local livelihoods and maintaining ecological balance. Thus, a key part of the programme involves supporting relevant departments like the Department of Forestry, Fisheries, and the Environment (DFFE) at the national level, and Agriculture extension services at the provincial

level, to promote climate-smart agricultural practices, enhance food security, and build community resilience. These departments are tasked with introducing initiatives such as rainwater harvesting, crop diversification, and soil conservation techniques, as well as installing rainwater harvesting systems and greywater recycling systems. Another significant element of this programme is to provide training and education to community members about climate change impacts and adaptation strategies. This effort aims to build local capacity to design, implement, and monitor adaptation measures, thus fostering a culture of sustainable practices and enhancing community resilience in the face of mounting climate challenges.

Table 36: Programme 24 - Community-based adaptation in communities most at risk of climate-related hazards.

Programme 24: Community-Based Adaptation in Communities Most at Risk Of Climate-related Hazards.	
ACTIONS	KEY ACTIVITIES
Conducting granular risk and vulnerability assessments in communities to identify drivers of risk and develop appropriate adaptation measures.	<ul style="list-style-type: none"> Identifying populations most at risk in the community, such as the elderly, children, and those with chronic illnesses, and developing strategies to protect them. Assessing and mapping the distribution of the drivers of risk and burnability across communities related to exposure and sensitivity to climate hazards.
Developing and implementing community-based adaptation measures to reduce risks and build resilience falls under the purview of relevant departments, including the Department of Forestry, Fisheries, and the Environment (DFFE) at the national level. These departments play a crucial role in promoting climate-smart agricultural practices, enhancing food security, and building community resilience.	<ul style="list-style-type: none"> Support the DFFE and Province and Agriculture extension services to promote the use of climate-smart agricultural practices, such as rainwater harvesting, crop diversification, and soil conservation techniques, to improve food security and build community resilience. Partnering with stakeholders (such as Provincial Departments and the National Department of Human Settlement) to build water security through the installation of rainwater harvesting systems, greywater recycling systems, and other water management strategies. Supporting national and provincial initiatives to encourage the establishment of community gardens and promote sustainable agricultural practices that enhance community resilience and increase food security.

Providing training and education to build community capacity and promote sustainability.

- Providing training and education to community members on climate change impacts and adaptation strategies.
- Building local capacity to design, implement, and monitor adaptation measures.
- Promoting sustainable land-use practices and sustainable resource management to reduce pressure on natural resources and build community resilience.

5. Implementation Framework

	Key Risk/Vulnerability Addressed	Responsible Department	Target	Implications and costs	Timeframe			Priority Level
					0-2 years	3- 5 years	6 - 10 years	
Adaptation Goal: To ensure water security in the face of Climate Change.								
Adaptation Programme 1: Integrated Approach to Water Augmentation, Use and Management.								
Water Sensitive Urban Design (WSUD)	Drought	Water and Sanitation	Year 0-2: Completed feasibility studies and preliminary design, private sector uptake of water reuse technologies. Year 3 - 5: Green infrastructure pilot projects, all new residential development applying water-efficient designs. Year 6-10: Scaling green infrastructure	High	Feasibility studies and design. Promotion of water reuse and water-efficient design.	Implementation of green infrastructure stormwater attenuation.	Implementation of green infrastructure stormwater attenuation.	High
Addressing Human Resources Constraints for	Drought	Water and Sanitation	Year 0-2: Complete needs assessment, assign	Low	Advocate for and secure funding for a	Recruit a qualified water resources manager.	Maintain	High

Effective Water Management			funds implement WRM KPIs Year 3-5: Recruit water resource manager and establish partnerships.		dedicated water resources manager position and			
Review Bulk Water Master Plan	Drought	Water and Sanitation	Year 0-2: Status quo assessment, Develop Plan, Assign budget. Year 3-5: Implement	Medium	Status Quo Assessment and Plan Development	Execution of the Bulk Water Master Plan	Maintain	High
Developing a Water Safety Plan (WSP)	Drought	Water and Sanitation	Year 0 – 2: Develop Emergency Response Plan Year 3-5: Implementation and Review. Improved Blue Drop Scores. Year 6-10: Review of plan and continuous improvements	Medium	Development and Implementation of a Water Safety Plan	Implementation, Monitoring and Evaluation	Execution of the Bulk Water Master Plan	
Adaptation Programme 2: Protect and Conserve Water Through Monitoring Mechanisms and Water Conservation through Water Conservation and Water Demand Management (WCWDM).								
Implementing monitoring	Drought	Water and	Year 0 – 2: Develop monitoring	Medium	Implement a regular water	Implement	Implement	High

mechanisms and protecting water sources by reducing pollution.		Sanitation	g schedule, establish buffer zone and integrate in spatial frameworks Year 3-5: Implement by-laws		quality monitoring schedule, create and manage municipal buffer zones and develop by-laws to regulate effluent discharge.			
Implementing water conservation measures.	Drought	Water and Sanitation	Year 0-2: Achieve set number of awareness campaigns and loss reduction. Year 3-5: Implement greywater-based irrigation on municipal land. Year 6-10: Large scale re-use systems operational.	Low to High	Establish targets for awareness campaigns and loss reduction. Feasibility Studies and pilot projects	Water re-use systems installed on municipal property.	Large scale water re-use systems implement for non-potable uses.	High
Alien Invasive Species Clearing Initiatives In Catchment Areas.	Flooding	Water and Sanitation	Year 0-2: Map alien invasive hotspots. Continue current operation and campaign	Medium	Identify, map and control areas containing alien invasive species.	Scale	Scale	

			s. Source funds. Year 3-5: Scale alien invasive clearing and establish green economy initiatives. Year 6-10: Self-sustaining operations in key areas.					
Enforce 'Green' Approaches in Residential Areas and Developments.	Drought	Water and Sanitation	Year 0-2: Guidelines developed for residential and commercial development Year 3-5: Establish technical and funding partnerships in order to establish an incentive programme.	Low	Developing and implementing guidelines and standards for sustainable residential and commercial development	Incentive programme. Enforcement	Enforcement.	
Adaptation Programme 3: Assessing the Feasibility and Sustainability of Alternative Water Sources for Climate Change Adaptation.								
Water Resource Management Planning	Drought	Water and Sanitation	Year 0-2: Status quo assessment of water resources	Medium	Conduct a water resource assessment, develop a drought	Implement	Implement	Medium

			Integrated drought management plan developed		management plan and develop and implement water conservation strategies			
Investigating alternative water resources	Drought	Water and Sanitation	Year 0-2: Completion of feasibility studies Year 3-5: Pilot project implemented.	Medium	Conduct a feasibility study to identify alternate water sources, and undertake hydrological assessments to determine water availability and potential yield of alternative water sources.			High
Investing in alternative water resources	Drought	Water and Sanitation	Year 3 – 5: Pilot Projects Year 6 – 10: Scaling	High		Implement	Implement	
Develop and Implement a Treated Effluent Reuse Strategy For Sustainable Water Management.	Drought	Water and Sanitation	Year 0-2: Develop Strategy and Resource. Year 3 – 5: Implement	Medium	Developing a comprehensive treated effluent reuse plan, including infrastructure and system requirements	Implement	Implement	

					ents, stakeholder engagement, and potential risks and mitigation strategies			
Adaptation Programme 4: Implementing Sustainable Groundwater Use and Development Strategy								
Conducting Groundwater Resource Assessments to Establish the Availability and Quality of Groundwater in the NDM Area.	Drought	Water and Sanitation	Year 0-2: Completion of groundwater management plan.	Medium	Develop a groundwater management plan	Implement	Implement	Medium
Establishing Sustainable Groundwater Use Policies and Guidelines to Promote Efficient and Effective Groundwater Management.	Drought	Water and Sanitation	Year 0 – 2: Updated policy and guidelines Year 3 – 5: Source Additional funding and partnerships for enforcement.	Medium	Conduct a review of existing policies and guidelines related to groundwater use to identify gaps and areas for improvement.	Implement	Implement	Medium
Implementing Groundwater Monitoring Program	Drought	Water and Sanitation	Year 0 – 2: Establish partnerships with irrigation boards	Medium	Establish Partnerships	Install and maintain a network of groundwater monitoring wells and		High

es to Monitor Water Levels, Water Quality, and Potential Pollution Sources, Enabling Early Detection of Potential Problems and Timely Intervention.			and large water users.			equipment to collect data on groundwater levels, water quality, and potential pollution sources.		
Promoting Groundwater Conservation and Efficiency by Encouraging the Adoption of Water-Saving Technologies and Practices in all Sectors.	Drought	Water and Sanitation	Year 0-2: Awareness campaigns. Year 3 -5: Launch technical partnership with spheres of government or private sector to promote water efficient technologies.	Medium	Develop and implement water conservation standards for new and existing municipal buildings and properties and encourage the adoption of water reuse/recycling technologies.	Establish technical support structure.	Maintain	
Developing Groundwater Recharge and Artificial Recharge Strategies to	Drought	Water and Sanitation	Year 0-2: Feasibility and recharge sites established. Year 3-5: Recharge infrastruc	Medium	Conduct studies to identify suitable sites for groundwater recharge, including areas	Implement	Maintain	Medium

Enhance Aquifer Recharge Rates and Improve Groundwater Storage Capacity.			ture established		with high permeability, favourable soil conditions, and sufficient rainfall.			
Implementing Land-Use Planning and Zoning Regulations to Protect Groundwater Resources from Pollution and Overuse.	Drought	Water and Sanitation/ Urban Planning	Year 0-2: Define setback lines Year 3-5: Monitoring and evaluation programme implemented	Medium	Conduct a groundwater vulnerability assessment and develop and enforce land-use planning and zoning regulations.	Implement and monitor.	Implement and monitor	
Develop an Information Management System for Groundwater Data to Provide Accurate and Timely Information to Water Users, Decision-Makers, and The Public.	Drought	Water and Sanitation	Year 0-2: Partner with DWS to establish system. Year 2-5: Maintain	Low	Develop and update a database and web-based portal for storing and accessing groundwater data, including water levels, quality, and other relevant information.	Maintain	Maintain	
Climate Change Goal 2: To prioritise the health and safety of communities in the face of a changing climate.								
Programme 5: Promote Public Health and Safety in the Face of Climate Change and Extreme Climate Events in Collaboration with the Department of Health								

Promoting public health and safety in the face of climate change and extreme weather events, in collaboration with the Department of Health, is a fundamental climate change response programme for Namakwa DM.	All	Disaster Management/ Health	Year 0-2: Develop and implement public health programmes and emergency response plans. Conduct a health risk assessment. Year 3 - 5: Implement.	Medium	Conduct a health risk assessment and develop and implement public health programmes. Develop and implement emergency response plans for extreme weather events.	Implement	Implement	High
Adaptation Programme 6: Innovative Urban and Township Design and Development								
Innovative urban and township design and development is an essential component of climate change response, as it helps to minimise the risk and impact of climate change on urban areas.	Flooding	Urban Planning	Year 0-2: Developing guidelines for innovative township design and encouraging the use of green infrastructure in urban design. Year 3-5: Implement.	Medium	Developing guidelines in collaboration with relevant government departments for innovative township design. Encouraging the use of green infrastructure in urban design.	Implement	Implement	High
Harnessing the potential of open	Flooding	Environmental Management	Year 0-2: Develop a plan to integrate green	Medium	Conduct a green infrastructure assessment	Implement the green infrastructure.	Implement green infrastructure.	High

spaces to absorb and mitigate the impacts of climate change.			infrastructure practices into new development Year 2-5: Implement.		nt and develop a plan to integrate green infrastructure practices into new development.			
Adaptation Programme 7: Public Awareness Campaigns – Involve Communities in, Raise Awareness of and Conduct Training on Climate Change								
Comprehensive Community Engagement and Public Awareness Initiative on Climate Change. This initiative aims to raise awareness, educate, and involve the community in addressing climate change. community.	All	Environmental Management	Year 0-2: Climate change awareness raising. Year 3-5: Climate change awareness raising.	Low	Designing and distributing educational materials on climate change and holding educational workshops and seminars.	Developing a comprehensive public awareness campaign.	Continue with awareness raising.	High
Climate Change Goal 3: Reduce the vulnerability and exposure of human and natural systems to climate change and extreme events								
Programme 8: Conserve, Protect and Restore Natural Open Spaces, Ecosystems and Natural Resources.								
Assessing natural resources and ensuring that natural open spaces,	Flooding/Drought / Wildfires	Environmental Health	Year 0-2: Identify high ecological value areas Year 3 – 5: Integrate	Medium	Develop conservation plans and management strategies for high-conservat	Integrate into SDF	Review.	Medium

ecosystems, and resources are conserved, protected and restored.			into SDF on review.		ion value areas			
Harnessing the potential of open spaces to absorb and mitigate the impacts of climate change.	Flooding	Environmental Health	Year 0-2: Ecosystem service supply and demand assessment including status quo.	Medium	Compile natural resources inventory and ecosystem services assessment.	Implement maintenance and restoration projects.	Establish new protected areas.	High
Implementing programmes focused on mitigating the impact of climate change and severe weather, particularly in climate-risk zones.	Flooding	Environmental Health	Year 0-2: Develop an Ecosystem-Based Adaptation Plan. Year 3-5: Resource Plan and Implement	Medium	EBA Plan	Implement	Implement	High
Programme 9: Enhanced Natural Resource Management								
Ensuring the quality of water resources is critical to the sustainable development of UDM, as they play a vital role in maintaining the	Health	Water and Sanitation	Year 0-2: Water quality monitoring sites identified and monitored.	Low	Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals	Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals,	Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals	High

health of ecosystems, human health, and socio-economic development.					, in water bodies.	in water bodies.	, in water bodies.	
Monitoring and preventing soil erosion is crucial to ensure the long-term health and productivity of natural ecosystems, as well as to maintain the quality of water resources.	Flooding	Environmental Health	Year 0-2: Erosion Risk Assessment Year 3-5: Develop and implement erosion control plans for high-risk areas.	Medium	Conduct a soil erosion risk assessment on municipal land.	Implement control plans for high priority areas.	Review and maintain.	High
Provide training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines.	Flooding/Drought/ Fire/ Heat Stress	Environmental Health	Year 0-2: Number of officials trained. Year 3-5: Number of officials trained. Monitoring and evaluation. Year 6-10: Number of officials trained. Monitoring and evaluation.	Low	Implement training programme.	Monitor	Monitor	Medium
Establish a District Environmental	Flooding/Drought/ Fire/ Heat Stress	Environmental Health	Year 0-2: Establish a forum with	Low	Conduct regular meetings. Track	Conduct regular meetings. Track	Conduct regular meetings. Track	Medium

Management Forum (DEMF) to enhance collaboration and coordination between Sectoral Departments, Conversation Organisation and agencies related to natural resource management.			terms of reference		progress and performance.	progress and performance. Review Terms of Reference.	progress and performance. Review Terms of Reference.	
Programme 8: Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Development Framework								
Ensuring critical biodiversity and ecological support areas are integrated into municipal spatial plans at all scales.	Flooding/Fire/Heat Stress/Drought	Disaster Management	Year 0-2: Integrate critical biodiversity and ecological support areas into municipal spatial plans Year 3-5: Implement Year	Low	Integrate critical biodiversity and ecological support areas into the municipal spatial plans.	Implement municipal spatial plans.	Implement municipal spatial plans.	High
Identifying and mapping natural open spaces, ecosystems, and natural resources, and integrating	Drought/Flooding/Heat Stress	Environmental Health	Year 0-2: Integrate and map the inventory information into the SDF Year 3-5: Implement	Low	Integrating the mapping and inventory information into the Spatial Development Framework, open	Integrate and implement the mapped inventory information from the SDF.	Monitor.	High

inventories in the Spatial Development Framework and the open space framework.					space framework.			
Identifying undeveloped open space with potential for green infrastructure.	Flooding	Environmental Health	Year 0-2: Assess the suitability for undeveloped open spaces. Year 3-5: Implement	Low	Assess the suitability of undeveloped open spaces for different types of green infrastructure.	Implement green infrastructure.	Implement green infrastructure.	High
Assessing the value of open spaces and ecosystem services	Health	Water and Sanitation	Year 0-2: Develop policies and regulations to assess the value of open spaces. Year 3-5: Implement	Low	Develop policies and regulations to protect and manage these areas.	Implement	Implement	High
Programme 11: Identify and Prioritise Climate Change Risks and Develop Response Measures for Settlements.								
Conducting a vulnerability assessment to identify the populations and locations most at risk of climate	Flooding, wildfire, drought	Environmental Management	Year 0-2: Assess the vulnerability of infrastructure to climate change. Year 3-5: Implement	Medium	Assess the vulnerability of infrastructure to climate risk	Develop and implement climate-resilient infrastructure.	Implement and maintain.	Medium

change impacts.								
Developing and implementing an early warning system to help communities prepare for and respond to climate change risks.	All	Disaster Management	Year 0-2: Install weather monitoring systems. Year 3-5: Enforce early warning system.	Medium	Install weather monitoring systems to provide real-time data on extreme weather events and develop warning protocols.	Enforce early warning system	Enforce early warning system	High
Establishing partnerships with local stakeholders, such as community groups and NGOs, to build local capacity for climate change adaptation and resilience.	Flooding/ Drought	Disaster Management	Year 0-2: Building partnerships. Year 3-5: Implement	Low	Building partnerships with community groups.	Collaborate with local NGOs to implement small-scale adaptation measures.	Implement	Medium
Developing and implementing land use planning and zoning regulations that take into account the potential impacts of	Flooding	Urban Planning	Year 0-2: Develop land use and zoning regulations Year 3-5: Implement	Medium	Developing land use and zoning regulations to ensure that settlements are built in safe and sustainable locations.	Implement land use and zoning regulations	Implement	High

climate change.								
Programme 12: Community-Based Adaptation in Communities Most at risk of climate-related hazards								
Conducting granular risk and vulnerability assessments in communities to identify drivers of risk and develop appropriate adaptation measures.	All	Environmental Management	Year 0-2: Develop adaptation measures . Year 3-5: Implement	Low	Develop adaptation measures for populations most at risk.	Implement	Implement	High
Developing and implementing community-based adaptation measures to reduce risks and build resilience falls under the purview of relevant departments.	Flooding/ Drought	Environmental Management	Year 0-2: Develop adaptation measures . Year 3-5: Support and Implement	Low	Support the DFFE and Province and Agriculture extension services to promote the use of climate-smart agricultural practices.	Support and implement sustainable agricultural practices.	Implement and monitor.	High
Providing training and education to build community capacity and promote sustainability.	All	Environmental Management	Year 0-2: Provision of training Year 3-5: Design, implementation and monitoring of adaptation measures .	Low	Providing training and education to community members on climate change impacts and	Design, implement and monitor adaptation measures.	Implement and monitor adaptation measures .	High

					adaptation strategies			
Programme 13: Climate Resilient Spatial Planning for Climate Resilient Growth and Development								
Ensure that spatial planning frameworks consider a long-term view of climate hazards and incorporate natural infrastructure.	All	Urban Planning	Year 0-2: Develop guidelines for climate-resilient spatial planning. Year 3-5: Implement guidelines	Low	Develop guidelines for climate-resilient spatial planning.	Implement guidelines	Implement and monitor	
Develop local-level climate-resilient planning mechanisms - Precinct Plans.	All	Urban Planning	Year 0-2: Develop climate resilient precinct plans Year 3-5: Implement	Low	Develop climate-resilient precinct plans that incorporate the needs and concerns of the community.	Implement precinct plans	Implement and monitor	
Ensure collaborative strategic planning that incorporates all relevant departments (in both strategic planning and project implementation).	All	Urban Planning	Year 0-2: Develop guidelines for collaboration in strategic planning and project implementation. Year 3-5: Implementation of guidelines	Low	Develop guidelines for collaboration and coordination in strategic planning and project implementation.	Implement guidelines	Implement and monitor guidelines	

Create mechanisms to strengthen public participation in planning and decision-making processes.	All	Urban Planning	Year 0-2: Ensure that public feedback is incorporated into the decision-making process. Year 3-5: Ensure that public feedback is incorporated into the decision-making process.	Low	Ensure that public feedback is incorporated into the decision-making process.	Ensure that public feedback is incorporated into the decision-making process.	Ensure that public feedback is incorporated into the decision-making process.	
To identify climate risk zones and hotspots that affect vulnerable municipal infrastructure and assets, SBM could undertake various activities.	All	Urban Planning	Year 0-2: Develop strategies to manage risks. Year 3-5: Implement.	Medium	Develop strategies to manage risks and protect infrastructure and assets from climate change impacts.	Implement strategies.	Implement and monitor strategies.	
Goal 4: To develop climate-resilient, low-carbon, diverse and inclusive rural economies that are socially responsible, environmentally sustainable and that provide job opportunities for unskilled, semi-skilled and skilled local residences.								
Programme 14: Advancing Towards a Climate-Smart Circular Economy								
Shift Towards a Circular Economy	All	Waste Management	0-2 years: Develop and implement a circular economy policy and action plan, conduct	Medium to High	Circular economy policy and action plan established, comprehensive waste audit	Waste reduction targets met, recycling programs operational, product stewardship initiatives in place, local businesses	Ongoing achievement of targets and further refinement of strategies based on evidence	High

			<p>waste audit, develop initial circular economy strategies , initiate collaborations with research institutions</p> <p>3-5 years: Implementation of waste reduction targets, initiation of recycling programs and product stewardship initiatives, education and outreach programs, promotion of green procurement policies, support to local businesses</p> <p>6-10 years: Monitor and update circular economy policies and action plans, continue</p>		<p>completed, initial strategies developed</p>	<p>adopting circular economy practices, green procurement policies implemented</p>	<p>and experience, with an established and robust circular economy in place</p>	
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			supporting local businesses, expand and refine recycling programs, and continue research collaboration and education programs.					
Climate-Smart Waste Management	Flooding, Heat Stress, Wildfires, Drought.	Waste Management	0-2 years: Conduct feasibility study, develop initial recycling programs 3-5 years: Establish recycling centres, fully implement recycling programs, start monitoring and evaluation 6-10 years: Continue to monitor and adjust recycling programs for maximum effectiveness, expand as necessary	Medium to High	Complete feasibility study, design and initiate recycling programs	Recycling centres are established and operational, recycling programs are fully functional, and monitoring systems are in place.	Achieve targeted recycling rates, and show evidence of reduced waste through continued monitoring and evaluation.	High
Staff Training and Capacity Building	Flooding, Environmental Health, Heat Stress,	Waste Management	0-2 years: Identify key areas of knowledge	Low to Medium	Key knowledge areas identified, initial	Training program fully operational, ongoing	Continued implementation, review, and	High

	Wildfires, Drought.		e, develop and start implementing the training program 3-5 years: Fully implement the training program, provide ongoing support, start regular reviews and updates 6-10 years: Continue providing ongoing support, regular reviews, and updates, assess the overall impact and adjust as necessary		version of the training program developed , start of implementation	support provided, regular review process established	updating of the training program, demonstrated improvement in staff skills and effectiveness	
Improved Waste Collection and Transportation	Flooding, Environmental Health, Heat Stress, Wildfires, Drought	Waste Management	0-2 years: Assessment completed, upgrade plan developed 3-5 years: Commence the implementation of the	High	Conduct the assessment, develop the upgrade plan	Begin implementation of the upgrade plan, and monitor its effectiveness	Continue implementation, routine maintenance, monitoring, and adjustments	High

			upgrade plan 6-10 years: Continued implementation, maintenance, and effectiveness monitoring, demonstrating improved efficiency and reliability					
Public Awareness and Illegal Dumping Reduction	Flooding, Environmental Health, Heat Stress, Wildfires, Drought	Environmental Health	0-2 years: Develop and launch a public awareness campaign, begin organizing community clean-up events, collaborate with law enforcement 3-5 years: Continue with these activities while beginning to monitor and evaluate effectiveness, adjust strategies	Medium	Successful launch of the public awareness campaign and community clean-up events, agreements with law enforcement in place	Observable reduction in illegal dumping incidents, higher public awareness levels	Sustainable reduction in illegal dumping incidents, maintenance of high public awareness, ongoing effectiveness of law enforcement	High

			as necessary 6-10 years: Ongoing activities, monitoring and evaluation, and continuous adjustments as necessary					
Programme 15: Climate-Smart Transport Strategy for Resilience and Efficiency								
Establish a Baseline and Assess Vulnerability	Flooding, Environmental Health issues, Heat Stress, Wildfires, and Drought.	Infrastructure	Create the group and gather data in the first 2 years. Complete the assessment in 3-5 years.	Low-High	Have a working group and data within 2 years..	Complete the assessment within 5 years		High
Develop and Implement a Low-Carbon, Inclusive Transport Plan	Environmental Health, Heat Stress.	Infrastructure	Vision and goals ready within 2 years. Low-carbon options identified and efficiency improvements in place within 5 years. Accessibility and equity ensured within 10 years.	Low-High	Develop vision and goals in the first 2 years.	Identify low-carbon options and improve efficiency in 3-5 years.	Ensure accessibility and social equity in 6-10 years.	High

Enhance the Resilience of Local Transport Infrastructure to Climate Shocks	Flooding, Environmental Health, Heat Stress, Wildfires, Drought.	Infrastructure	Risk assessments done within 2 years. Resilience plans developed and maintenance programmes initiated within 5 years. Investments in resilience technologies made within 10 years.	Medium-High	Conduct risk assessments in 0-2 years.	Develop resilience plans and start maintenance programme in 3-5 years.	Invest in resilience technologies in 6-10 years.	High
Monitor, Evaluate, and Continually Improve the Transport Plan and Infrastructure Resilience	Flooding, Environmental Health, Heat Stress, Wildfires, Drought.	Infrastructure	Establish a monitoring and evaluation system within 1 year. Complete evaluation of resilience strategies within 2 years. Implement action plans within 5 years.	Medium-High	Monitoring and evaluation to be started immediately and conducted regularly over 0-10 years. Evaluation of resilience strategies in 0-2 years.	Development and implementation of action plans in 3-5 years.		High
Programme 16: Climate-Resilient Agricultural Innovation								
Invest in research and development for drought-resistant	Drought		Partner identification in 0-2 years. Resource allocation for	Low-High	Establish R&D partnerships within 2 years. Set up research	Conduct the first workshop or conference within 5 years. Begin field trials of		High

and climate-resilient crop varieties.			research in 0-2 years. Workshops and conferences in 3-5 years. Field trials coordination in 3-5 years.		laboratories within 2 years.	drought-resistant crops within 5 years.		
Establish Agri-Parks as hubs of innovation for climate-resilient agricultural techniques, offering training, logistics support, and marketing assistance.	Environmental Health, Drought.		Location identification and partnership establishment in 0-2 years. Delivery of training programs and logistics infrastructure setup in 3-5 years. Implementation of marketing initiatives in 3-5 years.	Low-High	Location identification and partnership establishment in 0-2 years.	Delivery of training programs and logistics infrastructure setup in 3-5 years.	Implementation of marketing initiatives in 3-5 years.	High
Develop and implement water conservation strategies, such as efficient irrigation techniques and rainwater harvesting, to mitigate	Drought		Surveys and guidelines development in 0-2 years. Rainwater harvesting system installation and awareness campaigns in 3-5 years.	Low-Medium	Complete surveys and develop guidelines within 2 years.	Install rainwater harvesting systems and launch awareness campaigns within 5 years.	Monitor and assess strategies within 10 years.	High

water scarcity in agriculture.			Monitoring and assessment in 6-10 years.					
Programme 17: Low-Carbon Rural Economy Transformation								
Promote the use of renewable energy technologies in agricultural, mining, and local industries to reduce carbon emissions.	Environmental Health.		Complete seminars, workshops, and partnerships establishment within 2 years. Launch awareness campaign and implement pilot projects within 5 years.	Seminars and workshops: Low. Partnerships: Medium. Awareness campaign: Low. Pilot projects: High.	Seminars, workshops, and partnerships in 0-2 years.	Awareness campaign and pilot projects in 3-5 years.		High
Establish incentives for businesses in the district to switch to low-carbon operations, such as subsidies or tax reductions for green technology adoption.	Environmental Health.		Establish incentive scheme and platform within 2 years. Conduct regular assessments and publicize success stories within 5 years.	Investigation and platform establishment: Low. Regular assessments: Medium. Publicization of success stories: Low.	Investigation and platform establishment in 0-2 years.	Regular assessments and publicization in 3-5 years.		
Introduce sustainable mining techniques that minimize environmental	Environmental Health.		Complete collaboration, training programs, and set regulations within 2	Collaboration and training programs: Medium. Regulations and guidelines	Collaboration, training programs, and regulations in 0-2 years.	Site inspections, audits, and assessment system in 3-5 years.		High

impact and carbon footprint.			years. Implement site inspections, audits, and assessment system within 5 years.	s: Low. Site inspections and audits: Medium. Assessment and reporting system: Medium.				
Programme 17: Inclusive and Diverse Economic Development								
Implement skills training programs aimed at different levels (unskilled, semi-skilled, skilled) to facilitate diverse job creation in agriculture, mining, tourism, and other sectors.	Environmental Health, Heat Stress, Drought.		Identification of skill gaps, partnership, and promotion in 0-2 years. Implementation of training programs and establishing pathways in 3-5 years.	Identification of skill gaps: Low. Partnership: Medium. Promotion: Low. Implementation of training programs: High. Establishing pathways: Medium.	Complete identification of skill gaps, establish partnerships, and start promotion within 2 years.	Implement training programs and establish pathways within 5 years.		High
Develop policies to support the growth of Small and Medium-sized Enterprises (SMEs) in sectors such as agricultural value addition, mining services, and tourism.	Environmental Health, Heat Stress, Drought.		Research, policy development, and stakeholder engagement in 0-2 years. Policy formalization, communication, and evaluation in 3-5 years.	Research: Low. Policy development: Medium. Stakeholder engagement: Low. Policy formalization and communication: Medium. Policy evaluation: Low.	Complete research, policy development, and stakeholder engagement within 2 years.	Formalize, communicate, and evaluate policies within 5 years.		High

Introduce economic diversification initiatives that can create new industries, such as eco-tourism, renewable energy, and organic farming, while reducing dependence on any single sector.	Environmental Health, Heat Stress, Drought.		Market research, plan development, and stakeholder engagement in 0-2 years. Initiative launch and using results to attract investment in 3-5 years.	Market research: Low. Plan development: Medium. Stakeholder engagement: Low. Initiative launch: High. Using results to attract investment: Low.	Complete market research, plan development, and stakeholder engagement within 2 years.	Launch initiatives and use results to attract investment within 5 years.		High
Programme 19: Social Responsibility and Environmental Stewardship								
Develop and implement environmental protection regulations to safeguard natural resources, biodiversity, and ecosystems.	Flooding, Environmental Health, Heat Stress, Wildfires, Drought.		Task force establishment, research, drafting, and public consultations in 0-2 years. Formalization, communication, and compliance monitoring in 3-5 years.	Establishment of a task force: Low. Research and drafting: Medium. Public consultations: Low. Formalization and communication of regulations: Medium. Compliance monitoring: Medium.	Complete task force establishment, research, drafting, and public consultations within 2 years.	Formalize, communicate, and monitor compliance within 5 years.		High
Launch community	Flooding, Environmental Health,		Identification of key messages	Identification of key messages	Complete identification of key	Measure effectiveness and adjust		High

<p>awareness campaigns to highlight the importance of environmental sustainability and responsible practices in agriculture, mining, and tourism.</p>	<p>Heat Stress, Wildfires, Drought.</p>		<p>, development of campaign materials, and campaign deployment in 0-2 years. Measurement and adjustment in 3-5 years.</p>	<p>: Low. Development of campaign materials: Medium. Campaign deployment: Medium. Campaign effectiveness measurement: Low. Adjustment of future campaigns: Low.</p>	<p>messages, development of materials, and campaign deployment within 2 years.</p>	<p>future campaigns within 5 years.</p>		
<p>Establish partnerships with local communities, businesses, and NGOs to engage in socially responsible initiatives such as reforestation, cleanup drives, and community-based tourism.</p>	<p>Flooding, Environmental Health, Heat Stress, Wildfires, Drought.</p>		<p>Complete identification of partners, outreach, and agreements development within 2 years. Implement initiatives and assess impact within 5 years.</p>	<p>Identification of potential partners: Low. Outreach: Low. Development of partnership agreements: Medium. Joint planning and execution of initiatives: High. Regular review and assessment: Low.</p>	<p>Identification of potential partners, outreach, and development of agreements in 0-2 years.</p>	<p>Joint planning, execution, and review/assessment in 3-5 years.</p>		<p>High</p>

5.1. Enabling Mechanisms for Implementation

5.1.1. Institutional Arrangements

Climate change, an urgent global concern, imposes significant environmental and economic challenges. The Namakwa District Municipality (NDM) will not be immune to these challenges, especially given the uncertainties of long-term local climate change impacts and existing limitations such as institutional capacity and budgetary constraints. Yet, local governments, such as NDM, play an integral role in reinforcing climate change resilience through the effective execution of their duties. In line with other municipalities, the Namakwa District must strategically plan and respond to meet its aim of providing sustainable and equitable services, promoting socio-economic development, and ensuring a safe and healthy environment for all its residents.

NDM's response to climate change is guided by several strategic plans and initiatives. Central to these is the Climate Change Risk & Vulnerability Assessment and Climate Change Response Plan, adopted by the council on June 9, 2023. This forms the backbone of the district's proactive climate response strategy, supplemented by the Air Quality Management plan, the Air Quality By-Law, and the Integrated Waste Management Plan. Collectively, these plans outline the district's approach to environmental sustainability and resilience, embodying their commitment to mitigating climate change impacts and enhancing environmental quality.

To implement these plans, the District established the Environmental Management unit during the 2021/22 fiscal year. The unit, led by an Environmental Manager and supported by four interns funded by the South African National Biodiversity Institute (SANBI), is tasked with driving NDM's climate change response agenda. Furthermore, a practitioner from the Department of Forestry, Fisheries and the Environment (DFFE) Local Government Support Program is seconded to the district to champion the climate change response. Consequently, this unit drives the implementation of the Climate Change Response Plan (CCRP) and other associated planning instruments.

NDM works closely with various partners, stakeholders, and networks to bolster these efforts. These include the DFFE at the national level, the Northern Cape Department of Agriculture, Environmental Affairs, Rural Development and Land Reform, and Conservation South Africa (CSA). The district is currently participating in several climate-related projects and initiatives, underlining its commitment to proactive climate action.

However, NDM encounters significant challenges when planning for climate change, including limited financial resources, a lack of awareness and urgency about climate change, and insufficient data and evidence. Yet, the district has identified immediate areas of focus, such as desertification in Richtersveld and Kamiesberg Local Municipalities, pervasive drought throughout Namakwa, and sea-level rise in Richtersveld and Kamiesberg Local Municipalities.

In accordance with these challenges and goals, the Climate Change Vulnerability Assessment and Response Plan outlines the vulnerability assessment conducted for the NDM, along with the responses that address these vulnerabilities. The response plan was developed through the Local Government Climate Change Support Programme (LGCCS), facilitated by the National Department of Forest Fisheries and Environment and the Deutsche Gesellschaft für Internationale (GIZ). The LGCCS initiative aims to provide a basis for responses, foster district-specific engagements, and promote capacity building and knowledge transfer to enhance the implementation of prioritised climate change adaptation options.

The use of the LGCCS Toolkit has been instrumental in developing this Climate Change Response Plan, offering an essential resource in identifying and prioritising climate change impacts significant to the area. Furthermore, the Climate Change Response Plan builds upon previous vulnerability assessments conducted by Conservation South Africa in 2012 and 2015, enhancing its contextual relevance and applicability. Despite the evident challenges, NDM is unwavering in its commitment to enhance the district's resilience to the impacts of climate change.

5.1.2. Governance Considerations

It is recommended that the Namakwa District Municipality (NDM) delineate clear responsibilities for each department regarding climate change mitigation and adaptation, linking these responsibilities to Key Performance Indicators (KPIs) to measure progress towards achieving climate objectives. This can be accomplished by integrating climate change goals into existing plans and policies and tracking the outcomes through specific KPIs. For instance, various Sectoral Departments within NDM can align its strategies, including the Integrated Development Plan (IDP), Spatial Development Framework, and Local Economic Development Strategy, with broader climate change objectives.

Moreover, the department can establish KPIs such as the number of local enterprises adopting sustainable practices or the amount of renewable energy produced within the district, to monitor advancements towards climate goals. It is also crucial for the municipality to be prepared to respond to climate-related disasters, including desertification and prolonged droughts, whose frequency and severity are projected to increase with climate change. By aligning climate change objectives with existing plans and policies and tracking progress using KPIs, NDM can ensure the incorporation of climate change considerations into every aspect of its municipal operations. This approach will not only facilitate progress towards a sustainable future but also equip the district with the necessary resources to effectively respond to the impacts of climate change.

5.1.3. Information Management

To implement the Climate Change Response Plan effectively in the Namakwa District Municipality (NDM), fostering a culture of risk avoidance among all stakeholders is crucial. This means enhancing the capacity of officials, politicians, residents, and other key players through extensive education, training, and public awareness initiatives, all backed by scientific research. By increasing awareness and comprehension of climate change impacts and responses, a sense of responsibility and ownership among these stakeholders can be instilled.

To accomplish this, NDM can undertake the following actions:

- Firstly, the municipality can design and deliver an integrated education and training programme on climate change and its implications for the district. This should be targeted at officials, politicians, and residents, promoting a common understanding of climate change and the urgency to act.
- Secondly, NDM can leverage scientific research and data to inform its educational and training materials, ensuring that stakeholders receive accurate and up-to-date information. This can also help identify key risk areas and zones where intervention is most urgently needed.
- Thirdly, the municipality can enhance public awareness campaigns about climate change and its effects. These campaigns can be disseminated through various channels, such as social media, community workshops, and public events. These initiatives can raise public awareness and understanding of climate change and the need for action, offering practical advice on measures individuals can take to minimize their impact.
- Fourthly, the municipality can encourage the participation of residents, civil society organizations, and the private sector in climate change mitigation and adaptation actions by providing opportunities for engagement and collaboration. This might include the establishment of partnerships with relevant stakeholders to design and execute joint initiatives and provide resources and support to individuals and organizations taking action.
- Lastly, NDM can form partnerships with academic institutions and research organizations to ensure continuous access to the latest research and expertise in the field of climate change. This can help keep the municipality informed about the latest developments in the field and enable the use of up-to-date knowledge and tools to inform decision-making and actions.
- By cultivating a culture of risk avoidance and empowering all key players, NDM can create a conducive environment for the effective implementation of the Climate Change Response Plan, ultimately contributing to a more resilient and sustainable district. This will require enduring commitment and effort, along with continuous engagement with stakeholders to ensure their needs and perspectives are incorporated into climate change policies and initiatives.

5.1.4. Funding Mechanisms

Climate change is an increasingly pressing challenge for local municipalities in South Africa, and addressing it requires significant funding. Various funding mechanisms are available to support climate change response initiatives, including national and international grants, public-

private partnerships, and municipal budgets. However, local municipalities may face issues such as insufficient funds, limited capacity to manage funds effectively, and limited access to funding sources.

One such mechanism is the Municipal Infrastructure Grant (MIG). The MIG provides funding to municipalities for the development of basic infrastructure such as water, sanitation, and solid waste management. The MIG can be used to fund climate change response projects that are related to these infrastructure needs. However, the MIG is limited in scope, and municipalities may struggle to fund all necessary climate change projects using this mechanism alone.

Another funding mechanism available to municipalities is the Green Fund. The Green Fund is a national funding mechanism that provides financing for green initiatives. The Green Fund can be used to finance projects related to renewable energy, energy efficiency, and climate change adaptation and mitigation. However, the Green Fund has limited resources, and there is significant competition for funding from other municipalities and organisations.

Municipalities can also access funding from international organisations such as the Global Environment Facility (GEF) and the Green Climate Fund (GCF). These organisations provide financing for climate change response programmes in developing countries. However, accessing funding from these organisations can be challenging, as there are stringent requirements that municipalities must meet to be eligible for funding.

In addition to these funding mechanisms, municipalities can explore public-private partnerships (PPPs) as a means of financing climate change response programmes. PPPs involve collaboration between the public and private sectors to finance and implement infrastructure projects. PPPs can provide municipalities with access to additional funding sources, as well as private sector expertise in project management and implementation. However, municipalities must ensure that the terms of the partnership are equitable and that the private sector partner is committed to the project's goals.

There are several issues that municipalities may face when accessing funding for climate change response programmes. One challenge is the lack of technical expertise within municipalities to develop and implement climate change projects. This can make it difficult for municipalities to access funding from organisations such as the Green Fund, as these organisations often require detailed project proposals and technical expertise.

Another issue is the limited resources available to municipalities for climate change response. Many municipalities in South Africa are already facing significant financial constraints, and funding climate change response programmes may be seen as a lower priority than other basic service delivery needs. This can make it challenging for municipalities to allocate resources to climate change response programmes.

To overcome these challenges, municipalities should focus on building technical capacity in-house and forming partnerships with private sector organisations to access additional funding sources. Municipalities should also explore innovative financing mechanisms such as green bonds and crowdfunding, which have been successful in other jurisdictions.

In conclusion, funding mechanisms are available for local municipalities in South Africa to finance their climate change response programmes. However, municipalities must navigate a complex landscape of funding sources and ensure that they have the technical expertise and capacity to develop and implement successful projects. Municipalities can access the resources they need to build more resilient and sustainable communities by exploring innovative financing mechanisms and forming partnerships with private sector organisations. Recommendations for Mainstreaming

Mainstreaming climate adaptation within the Namakwa District Municipality (NDM) necessitates a multifaceted approach that takes into account the current institutional structures, processes, and instruments within the district. This comprehensive strategy should aim to integrate climate-responsive thinking into all aspects of the municipality's work, making it a standard consideration rather than a separate concern.

1. **Opportunities for Mainstreaming:** There exist various opportunities for mainstreaming within NDM. For instance, the District Development Model (DDM), with its integrated approach to planning and delivery across different spheres of government, provides an excellent platform for embedding climate adaptation into existing strategies. Climate adaptation considerations can be introduced into the joint "One Plan" approach that the DDM utilises.
2. **Leveraging Existing Decision-making Structures:** Existing decision-making structures, like the Project Management Unit (PMU), can be harnessed for climate adaptation. For example, the PMU's framework for assessing and approving projects can be updated to incorporate climate responsiveness/adaptation/sustainability, thereby ensuring that all new initiatives are climate-friendly.
3. **Targeting Planning Instruments for Mainstreaming:** Key planning instruments such as the Integrated Development Plan (IDP), Spatial development frameworks, and Local Economic Development Strategy can be targeted for mainstreaming climate adaptation. These documents can be revised to include climate evidence and adaptation actions.

Some specific mainstreaming recommendations include:

- **Key Performance Indicators (KPIs):** Climate response/adaptation/sustainability outcomes should be included in the KPIs of all departments, ensuring that progress towards climate goals can be tracked and measured.
- **Raising Awareness:** Conducting awareness training with groups like the Project Management Unit, Strategic Procurement, Councillors, and other relevant entities can facilitate mainstreaming. By improving their understanding of climate change and the need for adaptation, these groups can better integrate climate considerations into their work.

- **Policy and Plan Updates:** Existing policies and plans should be updated to reflect the climate risk profile and adaptation actions. This could include incorporating climate change considerations into land use plans, infrastructure development strategies, and emergency management plans.
- **Funding:** NDM should explore existing and new revenue streams to support climate adaptation/response efforts. This could include applying for grants from government agencies, engaging in public-private partnerships, and incorporating climate adaptation into budget planning processes.
- **Capacity Building:** There is a need for ongoing training and capacity building of officials in all departments to enhance their understanding of climate change and their ability to incorporate climate considerations into their work.
- **Establishing Networks or Partnerships:** NDM should consider establishing networks or partnerships with civil society organisations, the private sector, government, and other relevant entities to bolster climate adaptation efforts.

Underpinning all these strategies is the DDM, which can serve as the backbone of these efforts. By adopting a "*One District, One Plan, One Budget*" approach, NDM can ensure that all development initiatives in the district are climate-friendly. The DDM's objectives of breaking down silos, maximising impact, narrowing the distance between people and government, and ensuring sustainable development align well with the goal of mainstreaming climate adaptation.

To conclude, mainstreaming climate adaptation in NDM requires a comprehensive, integrated approach that leverages existing structures and processes, builds capacity, and involves all stakeholders. By taking these steps, NDM can ensure a more sustainable and resilient future for its people and the environment.

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