GREENBOOK
adapting settlements for the future

Cape Winelands District Municipality

Climate Change Adaptation Plan: Draft 1

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CAPE WINELANDS DISTRICT
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Abbreviations

Abbreviation	Explanation
°C	Degree Celsius
AR5	Fifth Assessment Report
CABLE	CSIRO Atmosphere Biosphere Land Exchange model
CCA	Climate Change Adaptation
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
CWDM	Cape Winelands District Municipality
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
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 draft Climate Change Adaptation Plan, as well as the accompanying Climate Risk Profile report, was developed specifically for Cape Winelands District Municipality (CWDM), to support its strategic climate change response agenda. Both reviews are primarily informed by the GreenBook, which is an open-access online planning support system that provides a scientific evidence base to support local governments in the planning and design of climate-resilient, hazard-resistant settlements. The GreenBook is an information-dense resource and planning support system offered to South African local governments to better understand their risks and vulnerabilities in relation to population growth, climate change, exposure to hazards, and critical resources. In addition to this, the GreenBook also provides guidance on appropriate adaptation measures that can be implemented on a city or settlement scale, providing technical assistance to support South African settlements in reducing the impact of climate hazards on communities and infrastructure, while also contributing to national, provincial and local developmental goals (See Green Book | Adapting settlements for the future).

The GreenBook was initially co-funded by the International Development Research Centre (IDRC) and the Council for Scientific and Industrial Research (CSIR), i.e., from 2016-2019, and in partnership with the NDMC. With more partners coming on board since 2019 to support further research and development, and the roll-out and uptake of the GreenBook. More 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 support resilience-building within local government. The initiative aims to roll out the GreenBook to 32 DMs by 2025 by supporting each District's climate change response and adaptation planning and implementation efforts through the GreenBook. Each of the Districts targeted for support is guided along a value-chain towards the implementation of climate change response and adaptation plans in municipalities (See Figure 1.). Thus, in fulfilment of steps four and five, each target DM is provided with a draft GreenBook Climate Risk Profile report, as well as a draft Climate Change Adaptation Plan.

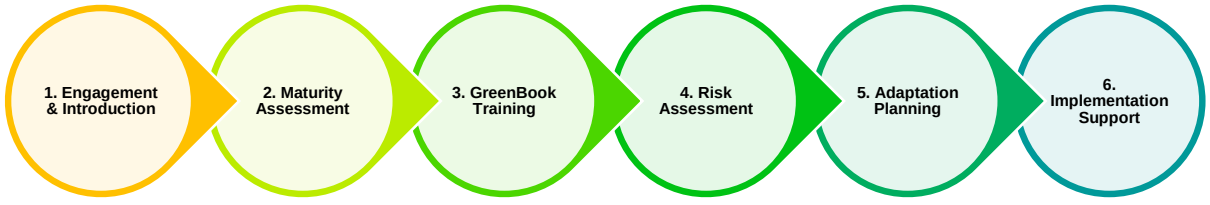

Figure 1: The value-chain towards the implementation of climate change response and adaptation in municipalities.

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 Cape Winelands District Municipality (CWDM) is a critical region within the Western Cape Province of South Africa, renowned for its stunning landscapes, rich biodiversity, and world-class wine production. Enclosing a land area of 22,309 km², it borders the Northern Cape District Municipality of Namakwa to the north and the Cape Metropolitan area to the south. Comprising five local municipalities—Drakenstein, Stellenbosch, Witzenberg, Breede Valley, and Langeberg—it houses a diverse population of around 968,667, the largest among all district municipalities in the province.

From an economic perspective, the district contributes significantly to the GDP, with a gross value of approximately R43.91 billion in 2018. The finance, insurance, real estate, and business services sector were the largest contributors, accounting for 24.04% of economic output. However, agriculture plays a pivotal role in the district's economy, contributing 10.17% to the GDP in 2018. It is also a major employer alongside the wholesale and retail trade, catering, and accommodation sector.

CWDM is globally recognised for its viticulture, with nearly 70% of South Africa's wine produced within its borders. These vineyards, in combination with other agricultural activities, have a notable impact on the environment, calling for sustainable management practices.
The district's distinct ecological makeup is mostly covered by the Fynbos Biome, a globally significant component of the Cape Floristic Kingdom. Other biomes, such as the Succulent Karoo, Albany Thicket, and Afro-temperate Forest, are also present in smaller areas. This diverse range of ecosystems hosts an extraordinarily high number of species, some of which are threatened or endemic. However, these natural assets are increasingly under threat from climate change. Warmer temperatures, changing precipitation patterns, and an increase in extreme weather events could significantly impact the district, particularly its sensitive viticulture industry. Increased risks of wildfires and potential shifts in pest and disease patterns also pose substantial threats.

As a result, CWDM is undertaking proactive measures to mitigate these threats and adapt to climate change effects. Strategies span various sectors, focusing on water management and conservation, extreme weather resilience, and integrated pest and disease management. The

collective aim is to ensure the district's environmental health, preserve its agricultural productivity, and secure a prosperous future for its diverse communities.

1.1.1. Key Risks

Within the Cape Winelands District Municipality (CWDM), 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.
- Severe Weather: This encompasses windstorms, hailstorms, frost, snow, lightning. These severe weather phenomena can inflict substantial damage to infrastructure, disrupt agricultural activities, pose safety risks, and even lead to fatalities.

The Cape Winelands District Municipality (CWDM) grapples with notable threats tied to climate change, exacerbated by increasing population pressures, particularly in areas like Stellenbosch and Ceres. These regions are witnessing significant demographic growth, escalating pressure on services and enhancing the vulnerability of larger groups to climate-related hazards.

Primary threats encompass drought, heightened temperatures, and escalating severity of storms. Predictions point towards an increase in the frequency of droughts, posing a considerable risk to water availability, especially given the burgeoning population. With agriculture being a significant part of CWDM's economy, contributing to 40% of the Western Cape's agricultural exports, the district is notably vulnerable to climate-related changes. With much of the agricultural activities being irrigation-dependent, reductions in water availability could significantly hamper crop irrigation and human consumption.

Furthermore, while annual rainfall is predicted to diminish, sporadic extreme rainfall events following droughts could increase. This amplification in rainfall intensity could elevate flood risks, lead to augmented surface runoff, result in escalated soil erosion, soil loss, and degradation, and cause infrastructure damage, particularly in informal settlements.

Environmental vulnerability remains high across the entire District, showcasing pressure on biodiversity due to rapid urbanisation, agricultural expansion, and land-use change. This increases the environment's vulnerability to extreme climate events. Moreover, increased temperatures due to climate change can precipitate ideal conditions for wildfires, especially in Fynbos biome areas, leading to potential loss of life, property damage, and significant natural habitat destruction.

The repercussions of these climatic challenges also impact human health. For instance, the increase in frequency and intensity of heatwaves elevates risks of heatstroke, dehydration, and other heat-related illnesses, especially among vulnerable populations.

Addressing these multifaceted risks requires a robust, comprehensive strategy. This involves the development and implementation of resilient climate adaptation strategies, the improvement of infrastructure to endure extreme weather conditions, and the promotion of sustainable land and water management practices. Additionally, the CWDM needs to invest in early warning systems and prioritize public awareness campaigns about these climate risks and effective response measures. By proactively tackling these issues, CWDM can foster a resilient and sustainable future for its inhabitants and environment.

1.1.2. Adaptation Goals and Priorities

In response to these climate risks and impacts the following adaptation goals are recommended:

1. To ensure water security for human consumption and irrigation under a changing climate.
2. To protect biodiversity and improve the sustainable use of natural resources.
3. To increase the resilience of the agricultural sector to more extreme events such as drought and storms as well as indirect risks such as pests and diseases.
4. Increase the adaptive capacity of human settlements to climate change and extreme events.

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

In response to these climate risks and impacts the following adaptation goals are recommended:

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 regraded 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 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.

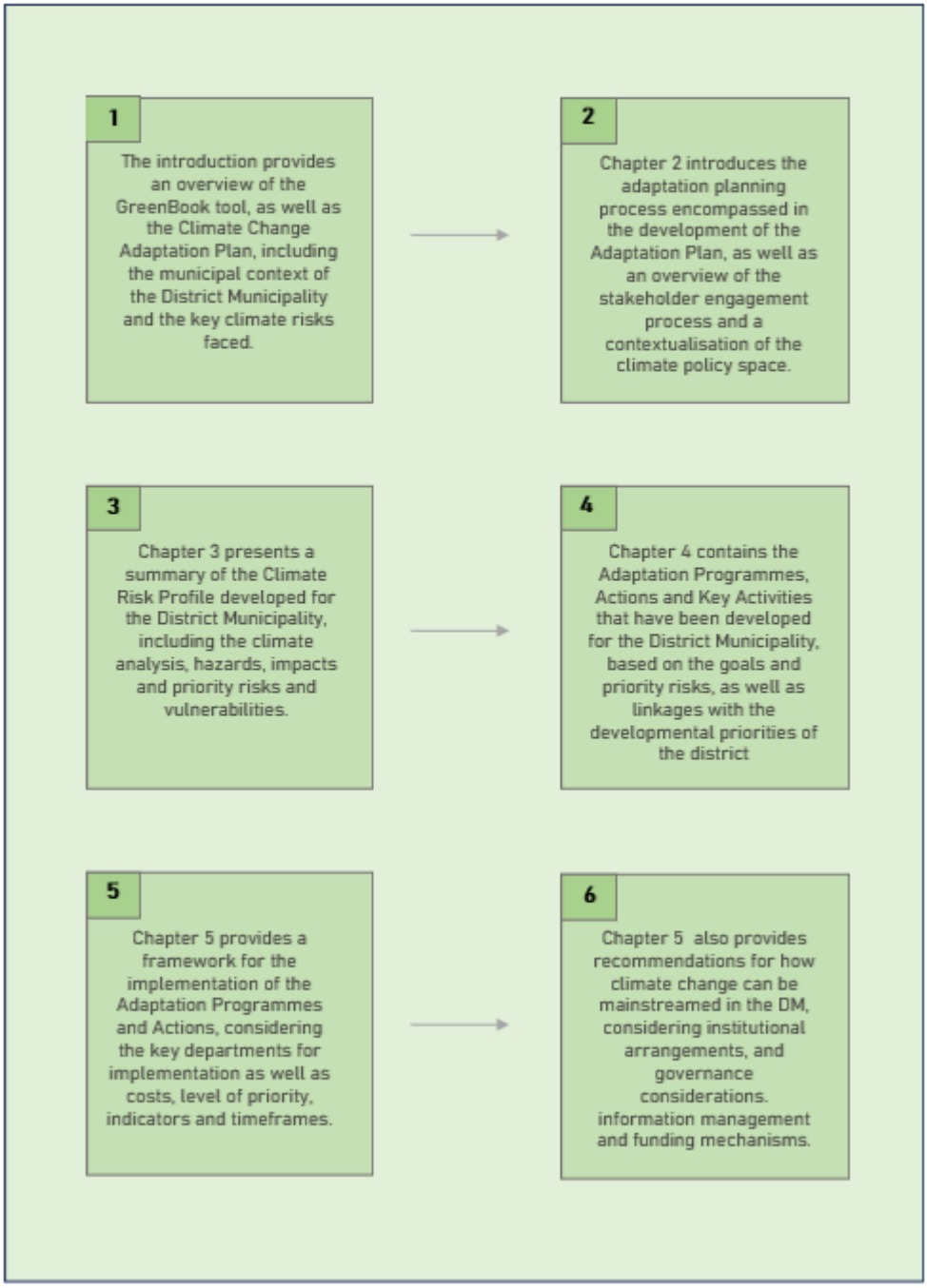

Figure 2: Outline of the Climate Change Adaptation Plan

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 CWDM 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.

CWDM's approach to the climate change response process is conceptualized in the figure below:

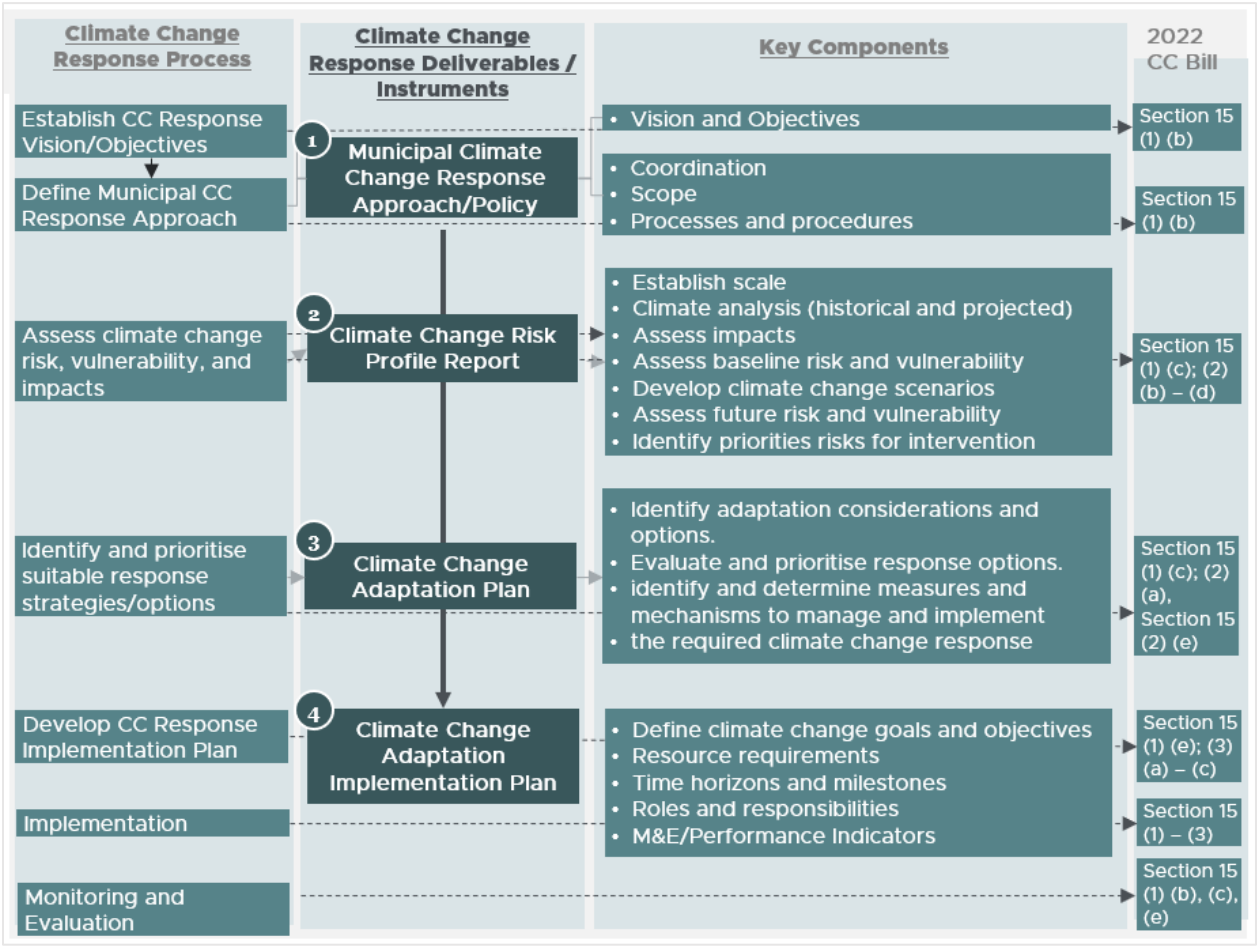

Figure 3: The municipal climate change response process (Brink and Modack, 2022).

Figure 3 illustrates the climate change response process proposed for the CWDM, 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 CWDM Climate Change Adaptation Plan is outlined below.

2.2. Adaptation Approach

The approach framing climate change adaptation in the GreenBook and in this plan is centred around reducing 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 (Figure 4). "*Relevant adverse consequences include impacts 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).

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, 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.

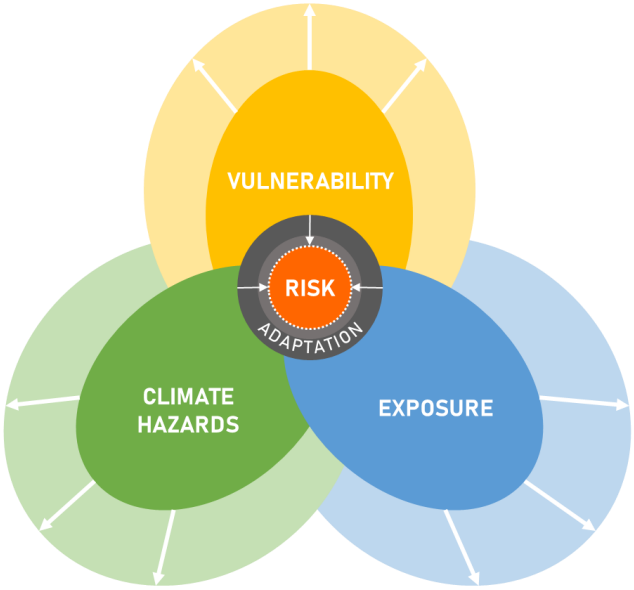

Figure 4: The interaction between the various components of risk, indicating the opportunity to reduce risk through adaptation (based on IPCC, 2014 and IPCC, 2021).

Adaptation planning uses the basis of spatial planning and climate change adaptation to shape built-up and natural areas to be resilient to the impacts of climate change and to realise co-benefits for long-term sustainable development to address root causes of vulnerability and exposure to risk. The process of climate change adaptation and planning is set out in Table 1.

The development of this Adaptation Plan follows this adaptation logic and adaptation planning process to ensure that the plan is aligned with local policy, current and future anticipated risks and vulnerabilities and that it is able to facilitate implementation and mainstreaming of climate change adaptation and resilience priorities into other planning processes and instruments.

Table 1: The adaptation planning process.

1. Understand your context	The Climate Risk Profile that unpacks climate hazards and vulnerability in your 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	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: • 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 in 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

To construct a Climate Change Adaptation Plan resonating with the specific requirements of the District Municipality and appropriately addressing its significant risks, a stakeholder engagement component was factored into the adaptation planning process. The inaugural phase of stakeholder engagement integrated a Risk Profile Engagement, succeeded by an Implementation Engagement designed to shape the Adaptation Plan. Moreover, District Municipalities (DMs) participated in a capacity development workshop intended to facilitate their use of the GreenBook tool. Engagement invitations were disseminated to pertinent DM departments including, but not limited to, Environmental Management, Disaster Management, Spatial Planning, and Water and Sanitation.

The initial interaction between the DMs and the CSIR took the form of the Risk Profile engagement. This virtual meeting, spanning two hours, aimed to validate the primary risks and vulnerabilities identified for the DM through the GreenBook Municipal Risk Tool and encapsulated within the Risk Profile Report. The central outcome of this engagement was the delineation of climate change adaptation goals, tailored to address the significant risks confronted by the DM, serving to inform the development of the preliminary Climate Change Adaptation Plan.

The subsequent DM engagement, the Implementation Engagement, was carried out virtually over a three-hour workshop. This engagement aimed to showcase the draft Climate Change Adaptation Plan, inclusive of the Adaptation Programmes and Actions, thereby allowing the DM to contribute comments. Additionally, the session incorporated a presentation on the Implementation Framework, established for the Adaptation Plan, along with a discourse on the integration of climate change adaptation within the district.

Collectively, the stakeholder engagement process offered a platform to interact with District stakeholders, promoting a more profound comprehension of the DM's context. Feedback gleaned from these engagement procedures has been deliberated upon and woven 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: Summary of both international and national policy instruments relevant to climate change mitigation and adaptation.

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 Development Strategy 2050 (2020)	The South Africa Low Emissions Development Strategy (SA LEDS) aims to succinctly build upon this foundation and articulate the path going forward in order to place the country on a low carbon trajectory, while at the same time ensuring broader socio-economic development.
National	The NDP aims to eliminate poverty and reduce inequality by 2030. According to the Plan, South Africa can realise these goals by drawing on

Development Plan Chapter 5: "Transition to Low-Carbon Economy"	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 Amendment Act 16 of 2015	The Amended Disaster Management Act encapsulates an integrated and coordinated disaster management policy, striving to prevent or reduce the risk of disasters, mitigate the severity of such incidents, foster emergency preparedness, ensure rapid and effective disaster response, and facilitate post-disaster recovery. The purview of this Act has been expanded to incorporate climate-related disasters.

2.3.2. Desired Adaptation Outcomes

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 CWDM 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

The Cape Winelands District Municipality (CWDM) acknowledges climate change as a critical threat to its environment, residents, and future development. The district is deeply invested in addressing this crisis, underpinned by its Climate Change Vulnerability Assessment and Response Plan, developed under the Local Government Climate Change Support (LGCCS) program (http://www.letsrespondtoolkit.org/). As a strategic measure, the district prioritises reducing or eliminating carbon emissions and enhancing greenhouse gas sinks, echoing the mitigation principles proposed by Böckmann (2015).

Simultaneously, the district understands that due to lag times in climate and biophysical systems, positive impacts from mitigation efforts will only materialise over the next 25 years (Jiri, 2016). Thus, immediate adaptation becomes an indispensable response to the anticipated

climate changes in the district. This concerted effort has culminated in the drafting of the Cape Winelands Climate Change Response Strategy. The framework of this strategy aims to provide a coordinated strategic direction to various departments within the CWDM. It is an initial step in identifying and classifying projects and programmes, with the aim of recognising gaps and planning accordingly. The CWDM's efforts, while primarily adaptive in nature due to function limits, also incorporate elements of mitigation.

Significant value is derived from collaboration with wider stakeholders, such as the Local Municipalities and Western Cape Government. The Western Cape Government lends strategic direction via legislation and policies. The Western Cape Provincial Government's acknowledgment of limited capacity and budget in local and district municipalities, excluding the City of Cape Town, underscores the CWDM's approach to mainstream climate change into its Integrated Development Plan, Spatial Development Framework, Integrated Transport Plan, and other relevant plans.

Through the LGCCS program, key vulnerability indicators to climate change have been identified. These span a range of sectors, including agriculture, biodiversity, environment, human settlements, infrastructure, disaster management, and water resources. Recognising these vulnerabilities, CWDM is set on an all-encompassing climate policy trajectory, emphasising a balance of climate change adaptation, mitigation, and disaster risk reduction. Furthermore, it underscores the necessity for active cooperation among stakeholders, prioritising green economy job creation, vulnerable community protection, and universal access to clean, affordable energy.

In summary, the climate change policy for the CWDM is a sophisticated, multi-pronged strategy. It skillfully integrates mitigation, adaptation, and disaster risk reduction measures, taking into account various sectoral vulnerabilities and resource constraints. Through a coordinated approach, the CWDM is determined to build a resilient future for its environment, residents, and ongoing development.

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 regional 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, 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:

1. 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.
2. While the Cape Winelands District Municipality (CWDM) does not directly manage water supply systems or infrastructure, such as dams, its role is critical in supporting local municipalities. Infrastructure within the CWDM, including all dams, is under the jurisdiction of local municipalities, the City of Cape Town, the Department of Water Affairs, or, in certain cases, 'water services authorities', as is the case with the Koekedouw dam in the Ceres region. As part of its mandate, CWDM provides crucial support to these local municipalities, particularly in managing invasive alien species in local supply catchments. By focusing on these areas, the CWDM assists in preserving the health of these vital water catchments, indirectly contributing to the stability and sustainability of the potable water supply. This activity forms a part of the broader strategy of the CWDM to safeguard its water resources amid the escalating pressures of climate change and population growth.
3. While the Cape Winelands District Municipality (CWDM) does not directly manage the bulk supply of electricity, including the transmission, distribution, and generation of electricity, it nonetheless plays an important role in facilitating access to these services. This is mainly achieved through collaborations and partnerships with entities that are responsible for these functions, ensuring that the needs of the municipality's residents are taken into account and served effectively. CWDM's role lies in advocating for sustainable and reliable energy provision while fostering an environment conducive to renewable energy initiatives and energy efficiency practices within the district.
4. While the Cape Winelands District Municipality (CWDM) doesn't directly manage extensive domestic waste-water and sewage disposal systems, it does have a role in overseeing specific, smaller-scale waste disposal processes. For example, the municipality is responsible for managing conservancy tanks at rural schools, which is carried out on an ad hoc basis. These measures, although modest in scale, reflect CWDM's commitment to maintaining health and sanitation standards in less accessible, rural parts of the district, in line with its broader objective of ensuring the welfare and wellbeing of all communities within its jurisdiction.
5. 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.
6. Municipal roads which form an integral part of a road transport system for the area of the district municipality as a whole.
7. Regulation of passenger transport services.

8. Municipal airports serving the area of the district municipality as a whole.
9. Municipal health services.
10. 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.
11. While the Cape Winelands District Municipality (CWDM) doesn't directly establish, conduct, or control fresh produce markets and abattoirs, cemeteries and crematoria, or local tourism, its overarching role in fostering regional development and sustainability indirectly supports these functions. Through partnerships and collaborations with local municipalities and private entities, CWDM supports an enabling environment where these functions can thrive and serve the communities effectively.
12. CWDM's emphasis on sustainable practices, public safety, and economic development can indirectly influence the operation of fresh produce markets and abattoirs, ensuring they meet appropriate standards and contribute positively to the district's economy.
13. Even though the CWDM does not directly manage cemeteries and crematoria, its responsibilities in public health and land use planning can contribute to the suitable siting and maintenance of these facilities. Similarly, while the CWDM does not directly manage local tourism, its work in promoting infrastructure development, environmental conservation, and community development can indirectly boost tourism in the region. By fostering a safe, vibrant, and sustainable district, the CWDM indirectly attracts visitors and stimulates tourism-related economic growth.
14. Municipal public works relating to any of the above functions or any other functions assigned to the district municipality.
15. While the Cape Winelands District Municipality (CWDM) previously had the responsibility to impose and collect taxes, levies, and duties, this is no longer within its mandate since around 2006/7. Currently, the CWDM does not engage in the collection of such levies or taxes. Its operations and functions are now primarily funded through other sources such as national government grants, subsidies, or internally generated funds. The CWDM continues to deliver its responsibilities and services, supporting local municipalities, without the direct imposition or collection of taxes or levies from its constituents.

3. Summary of Climate Risk Profile

In line with global trends, CWDM is being confronted by the consequences of climate change, which are projected to result in the escalated intensity and frequency of climate hazards in the future. Recognizing the scale of this challenge, the District and five Local Municipalities has acknowledged the importance of enhancing resilience and safeguarding its populace, natural resources, economic endeavours, and livelihoods against climate change impacts.

The sections below provide a summarised overview of climate vulnerability in the CWDM, and the priority risks and climate impacts which provide the basis for the identification of suitable climate change adaptation actions.

3.3. Overview of Baseline and Future Climate Risk.

An ensemble of six General Circulation Models (GCMs) from the fifth phase of the Coupled Model Intercomparison Project (CMIP5) was employed to develop baseline and future climate change scenarios. This comprehensive approach was used for both the Representative Concentration Pathway (RCP) 4.5 and 8.5 scenarios. RCP 4.5 represents a moderate mitigation scenario, while RCP 8.5 signifies a pathway with very high greenhouse gas emissions. This ensemble of models provides a robust framework to examine various possible future climates, thus broadening the understanding of potential climate trajectories and associated risks.

To refine these broad-scale projections, the regional climate model Conformal Cubic Atmospheric Model (CCAM) was utilized to downscale the climate data from a 50km resolution to a more detailed 8km resolution. This procedure enhances the applicability of the model outcomes to the local context, enabling more precise adaptation and mitigation planning. The climate analysis spans two periods: the baseline period (1961 – 1990), which provides a historical context of the climate variations, and the future period (2021 – 2050), offering insights into the likely future climate conditions under different emission scenarios.

3.3.1. Climate Analysis

3.3.1.1. Average Temperatures

The Cape Winelands District Municipality exhibits a diverse climatic profile with average annual temperatures ranging between 12 and 20 °C. Notably, lower averages are found over the higher altitude areas north of Ceres and around De Doorns and Franschhoek. These temperature variations reflect the district's wide geographical and topographical range, from mountainous regions to fertile valleys, contributing to the rich biodiversity and agricultural potential of the area.

Looking into the future, climate projections suggest an impending increase in average annual temperatures across the district. Under a low mitigation, high emissions scenario, these increases could range between 2°C and 3°C. The most substantial temperature increases are anticipated around the towns of Tulbagh, Ceres, and Wolseley. Conversely, the far southeast of the district is projected to experience comparatively smaller increases in temperature. These climate change impacts have significant implications for the area, especially in sectors like agriculture, water supply, and biodiversity, underscoring the urgency for robust climate change adaptation and mitigation strategies.

3.3.1.2. Rainfall

The Cape Winelands District Municipality currently experiences a broad spectrum of average annual rainfall, ranging between 400mm and 1600mm according to GCM-derived estimates. The areas recording higher averages are typically the mountainous regions around the towns of Stellenbosch and Franschhoek. These areas benefit from orographic rainfall, where moist air rises over the mountains and cools, leading to increased precipitation. Conversely, the northern parts of the Witzenberg Local Municipality, extending towards the Northern Cape province, experience lower annual rainfall. This variation reflects the wide climatic diversity within the Cape Winelands District.

Looking to the future, climate change projections indicate a potential shift in this rainfall pattern. Under a low mitigation, high emissions scenario, there could be an average annual rainfall decline of up to 200mm over the western parts of the District. This significant decrease could lead to more arid conditions, affecting local ecosystems, agriculture, and water supplies. However, the future isn't entirely bleak; an increase in rainfall is projected in the northeastern part of the Witzenberg Local Municipality. Understanding these projected changes in rainfall patterns is crucial to formulating effective strategies for climate adaptation and water management in the Cape Winelands District Municipality.

3.3.2. Climate Hazards

A summary of the climate hazards is included below:

3.3.2.1. Drought

Under the current baseline conditions, the Cape Winelands District Municipality sees significant geographical differences in drought tendencies. Central areas of the district are most prone to drought, experiencing dry periods more frequently than other regions. Conversely, the northern and southern parts of the district have lower drought tendencies, benefiting from different climatic and geographic factors that reduce their vulnerability to prolonged periods of dryness. This spatial variability in drought tendencies underscores the complex, localized nature of climate impacts.

However, future climate projections indicate a shift towards increased drought tendencies across most of the district. This heightened risk is expected under a scenario of continued high emissions and low mitigation efforts. Notably, the southwestern area, encompassing Stellenbosch, is projected to maintain drought tendencies similar to the baseline period, suggesting some regional resilience. Regardless, all settlements within the district face a moderate to high risk of increasing droughts in the future. These trends emphasize the urgent need for comprehensive water management and climate adaptation strategies to safeguard the district's water security and the livelihoods of its residents.

3.3.2.2. Heat

The Cape Winelands District Municipality's current climate, defined as the baseline period from 1961 to 1990, experiences a varying number of very hot days annually. Very hot days are those where the maximum temperature exceeds 35°C. Certain regions of the district, particularly the far west and north, experience between 46 to 60 such days each year. These high-temperature days tend to be more prevalent near the settlements of Paarl, Wellington, and Saron, largely due to their geographic and climatic characteristics. The annual average number of these very hot days is a key consideration in climate adaptation strategies, given the health, agricultural, and environmental implications associated with extreme heat.

Looking ahead to the period from 2021 to 2050, projections suggest an increase in the number of very hot days, especially in the northern and southwestern areas of the District Municipality. Moreover, heatwave events, defined as prolonged periods of excessively hot weather, are projected to become more common, particularly towards the east of the District, affecting areas north of Montagu. Such trends suggest that most settlements within the District Municipality should prepare for a higher occurrence of heatwave events in the future. These changes in the thermal regime call for proactive measures, such as heat health warning systems and urban cooling strategies, to mitigate the risks associated with increased temperatures and heatwave events.

3.3.2.3. Wildfire

Fire risk in the Cape Winelands District Municipality is determined by a combination of factors. These include the typical fire hazard for a fire-ecotype, which comprises the likelihood and severity of a fire, and the potential social and economic consequences, which involve possible economic and social losses. This multifaceted approach to assessing fire risk considers both the ecological aspects, such as vegetation type and climatic conditions, and the human dimension, including settlement patterns and economic activities.
All settlements across the District are situated in close proximity to their wildland-urban interfaces, which inherently exposes them to the risk of wildfires. Looking ahead, it's projected that the risk of wildfires could increase in several settlements, including Tulbagh, Ceres,

Wolseley, Paarl, and Stellenbosch. This projected rise in wildfire risk is largely attributed to climate change, with increasing temperatures and decreasing rainfall patterns likely to create conditions more conducive to wildfires. Consequently, these developments necessitate robust wildfire risk management strategies and efforts towards creating fire-resilient communities.

3.3.2.4. Flooding

The flood hazard assessment in the Cape Winelands District Municipality is a comprehensive evaluation that takes into account various relevant factors. These factors include climate patterns, historical flood events, and the specific attributes of water catchments that affect their propensity to generate a flood. The process of flood hazard assessment is crucial for understanding the risk landscape and informing disaster risk reduction strategies. It provides valuable insights into the potential consequences of extreme rainfall events, which are expected to become more frequent and intense due to climate change.

Across the District Municipality, the flood hazard index exhibits significant variation, illustrating the complex interplay of factors contributing to flood risks. Most parts of the District have been categorised as having a low to medium flooding hazard, with a few areas having a very high flooding hazard. Looking ahead, under a Representative Concentration Pathway (RCP) 8.5 scenario, which represents a low mitigation effort and high greenhouse gas emissions, several settlements are projected to face increased flood risk. These include Paarl, Stellenbosch, De Doorns, Touwsrivier, and Montagu. This underscores the need for enhanced flood risk management strategies, particularly in these areas, to ensure community resilience and safeguard economic activities.

3.3.3. Climate Impacts

3.3.3.1. Water Resources

In South Africa, groundwater represents a crucial resource supporting economic development and sustaining water security. Many rural and urban settlements are either fully or partially reliant on groundwater supply. However, the availability and distribution of groundwater are highly influenced by climate variability and change. Hence, groundwater management necessitates a keen understanding of these climatic factors and the strategies to manage them effectively. This becomes even more relevant in the face of climate change, which is projected to have significant impacts on water resources, including groundwater.

In the Cape Winelands District, most towns rely primarily on surface water, with only a few using a combination of surface and groundwater sources. Settlements in the southern areas tend to depend more on surface water, while some rely on both surface and groundwater. Notably, the groundwater potential in the northern areas is considerably lower compared to the south western areas. Looking into the future, groundwater recharge is projected to decrease in the

northern areas, while it is expected to increase in the south western areas. Stellenbosch Local Municipality's settlements face a high risk of groundwater depletion, mainly due to anticipated population growth pressures. Other settlements with a medium risk of groundwater depletion, which rely on groundwater include Wolseley, Tulbagh, and Touwsrivier. This highlights the need for a strategic approach to manage groundwater resources effectively in the face of climate change and other pressures.

Table 3: Current water supply and vulnerability across CWDM.

Local Municipality	Water Demand per Capita (l/p/d)	Water Supply per Capita (l/p/d)	Current Water Supply Vulnerability
Breede Valley	236.55	277.42	0.85
Drakenstein	174.36	268.19	0.65
Langeberg	185.42	341.06	0.54
Stellenbosch	190.63	226.15	0.84
Witzenberg	146.71	144.23	1.02

**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.*

The provided data offers insights into the water demand, supply, and current water supply vulnerability of five local municipalities: Breede Valley, Drakenstein, Langeberg, Stellenbosch, and Witzenberg.

1. Breede Valley: This municipality has a water demand per capita of 236.55 liters per person per day (l/p/d) and a supply of 277.42 l/p/d. With a water supply vulnerability of 0.85, it suggests that the municipality is currently in a relatively stable situation regarding water provision, with a supply surpassing demand. However, the vulnerability figure being close to 1 implies a need for caution and proactive water management strategies to prevent future supply issues, particularly in the face of climate change and potential population growth.
2. Drakenstein: The water demand per capita in Drakenstein is 174.36 l/p/d, and its water supply per capita is significantly higher at 268.19 l/p/d. With a water supply vulnerability index of 0.65, the region seems to be less vulnerable in terms of water supply currently. Nevertheless, water resource management and conservation strategies should be implemented to maintain this favourable position, especially given the unpredictability of climate patterns.
3. Langeberg: Langeberg has a water demand per capita of 185.42 l/p/d and a supply of 341.06 l/p/d, indicating a comfortable supply-demand balance currently. It has the lowest water supply vulnerability index (0.54) among all the municipalities listed, which is a positive indication of its water security status. However, sustainable water management practices should still be prioritized to ensure long-term water security.
4. Stellenbosch: Stellenbosch has a relatively higher water demand per capita at 190.63 l/p/d and a lower supply per capita of 226.15 l/p/d. The water supply vulnerability index is 0.84, indicating a slight risk of water supply issues. These figures suggest a need for increased

focus on water conservation measures, efficiency improvements, and potential infrastructure enhancements.

5. Witzenberg: Witzenberg shows a unique situation where the water demand per capita (146.71 l/p/d) is slightly higher than the water supply per capita (144.23 l/p/d), resulting in a water supply vulnerability index exceeding 1 (1.02). This suggests that the municipality is currently experiencing a slight shortfall in its water supply compared to demand. Immediate actions to balance water demand and supply, enhance water infrastructure, and reduce wastage are crucial in this region.

In conclusion, while most municipalities currently have a supply exceeding demand, there are varying degrees of water supply vulnerability. Measures should be put in place to ensure that these areas maintain or improve their water supply security, particularly in the face of climate change and population growth. Specifically, the Witzenberg municipality needs urgent attention due to its current shortfall in water supply.

3.3.3.2. Sectors

The Agriculture, Forestry, and Fishing (AFF) sector is a major pillar of the Cape Winelands District's economy, with a notable contribution of 10.17% to the local Gross Value Added (GVA), as reported by CoGTA in 2020. This significant share is far above the national average of 2.50% contributed by the agricultural sector to the GVA, emphasizing the crucial role agriculture plays in the district's economic structure. The sector's influence is particularly notable in the Witzenberg, Drakenstein, and Langeberg Local Municipalities, which are significant contributors to the District's economy.

Langeberg is home to the prominent agricultural region known as the KOO Valley. Known for its diverse production of commodities that underpin the district's agricultural sector, it produces a variety of crops including apricots, nectarines, pears, apples, table grapes, and wine grapes. Moreover, this municipality is a significant hub for agro-processing, linking agricultural production to the manufacturing sector and boosting value addition within the district. The growth of the agricultural sector in Langeberg, combined with the wine and tourism industries, is driving economic expansion and providing significant employment opportunities in the area.

Across the district, the AFF sector is the second-largest employer, offering 23% of the total employment opportunities. This highlights the sector's critical role not only in terms of economic contribution but also in securing livelihoods for a substantial part of the local population.

However, the future sustainability and growth of agriculture in the district, including in the key area of Langeberg, are under threat due to climate change. Projections of a generally hotter and drier climate could lead to reduced chill periods necessary for crops such as grapes and stone fruits, increased heat stress, and diminished water availability for irrigation. These changes could affect broiler production costs due to increased cooling needs, and there's also a greater

potential for sunburn damage to crops. These challenges could negatively impact agricultural productivity, and by extension, the district's economy and the livelihoods of those reliant on the sector. It is therefore crucial to implement appropriate adaptation and mitigation strategies to enhance the sector's resilience against these climate-related threats.

3.3.4. Priority Risks and Vulnerabilities

3.3.4.1. Municipal

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

Each Local Municipality in the Cape Winelands District is provided 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 CWDM.

LOCAL MUNICIPALITY	SEVI 1996	SEV 2011	Trend	EcVI 1996	EcVI 2011	Trend	PVI	Trend	EnVI	Trend
Breede Valley	2.08	1.81	↘	4.63	3.43	↘	5.40	N/A	5.11	N/A
Drakenstein	1.72	1.24	↘	3.93	3.25	↘	4.43	N/A	7.26	N/A
Langeberg	3.13	2.10	↘	4.50	2.01	↘	5.80	N/A	4.14	N/A
Stellenbosch	1.95	1.77	↘	2.34	3.91	↗	5.17	N/A	9.21	N/A
Witzenberg	3.04	2.07	↘	4.25	1.79	↘	5.94	N/A	4.44	N/A

Socio-economic vulnerability has decreased (improved) across all Local Municipalities between 1996 and 2011. All Local Municipalities also experienced a downward trend in economic vulnerability except for Stellenbosch Local Municipality. This Local Municipality has the highest economic vulnerability in the District, and the 5th highest in the Western Cape Province. A population growth rate of 2.10 %, high population density and rising unemployment contribute to the economic vulnerability of Stellenbosch region. Moreover, Stellenbosch also has a very high environmental vulnerability, which is the second highest in the province after the city of Cape Town. Ecosystem services has come under severe threat in the Stellenbosch Local Municipality. Soil erosion, water pollution from local industries, wastewater and informal settlements, as well as the spread of alien invasive plants, land development and illegal harvesting of indigenous plants, have impacted on the biodiversity and natural beauty of the area

3.3.4.2. Settlement Vulnerability

The unique set of six (6) indicators listed below highlight the multi-dimensional vulnerabilities of the settlements within the Cape Winelands 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.

Local municipality	Anticipated settlement vulnerability
Breede Valley Local Municipality	• The major settlements in this Local Municipality are Worcester, Rawsonville, De Doorns and Touwsrivier. • The settlements facing the greatest growth pressure are Worcester and De Doorns, which also have a very high environmental vulnerability. • De Doorns and Touwsrivier have very high socio-economic vulnerability. • Touwsrivier also has the greatest regional connectivity vulnerability in the municipality.
Drakenstein Local Municipality	• The major settlements in this Local Municipality are Paarl, Wellington, Gouda and Saron. • Paarl and Wellington are facing the greatest growth pressure in the municipality and have very high service access vulnerability combined with a socio-economically vulnerable population. • Gouda and Saron also have very high socio-economic and economic vulnerability.
Langeberg Local Municipality	• The major settlements in this Local Municipality are Montagu, Bonnievale, McGregor, Robertson and Ashton. • Robertson faces the greatest growth pressure in the municipality. • Bonnievale has very high service access vulnerability and together Bonnievale, McGregor and Montagu are subject to poor regional connectivity.
Stellenbosch Local Municipality	• The major settlements in the Stellenbosch Local Municipality encompass Pniel, Franschhoek, Klapmuts, and Stellenbosch. Other smaller settlements within this area include Langrug, Languedoch, Kylemore, Koelenhof, and Raithby. • Klapmuts, in particular, is emerging as a secondary regional service centre experiencing significant growth. Notably, Distell, one of South Africa's leading producers and marketers of spirits, fine wines, ciders, and ready-to-drinks,

	is planning to relocate its plant to Klapmuts. This planned move, along with industrial developments projected in the local Spatial Development Frameworks (SDFs), is set to boost the economic profile of the area. • Meanwhile, Stellenbosch (Kayamandi), Klapmuts, and Langrug are experiencing the most substantial growth pressure, with high economic and socio-economic vulnerability. Languedoch is facing the highest environmental vulnerability, making it a critical focus area for sustainable development and conservation efforts. As the municipality continues to grow, there will be a need for strategic planning to manage these pressures and vulnerabilities to ensure sustainable and equitable development for all its residents.
Witzenberg Local Municipality	• The primary settlements in the Witzenberg Local Municipality include Prince Alfred Hamlet, Wolseley, Ceres, Tulbagh, and Op-die-Berg. Among these, Ceres (Nduli & Bella Vista), Prince Alfred Hamlet, Tulbagh, and Wolseley are grappling with the highest growth pressure coupled with significant socio-economic vulnerability. All the settlements, including the growing and vulnerable ones, exhibit high environmental vulnerability. • The influx of population and the growth pressure in these areas are partly attributable to the expanding agricultural sector. This sector is labour-intensive, leading to a high demand for seasonal workers. To meet this need, farmers often employ migratory labour from the rural Eastern Cape. However, this situation carries an unintended consequence as a certain percentage of these migratory workers choose to settle permanently in the towns and informal settlements. • This trend is leading to an increased demand for housing and basic services, thereby exacerbating existing backlogs and straining municipal resources. As such, while the agricultural sector's growth is a boon for the local economy, it also poses socio-economic challenges that require concerted and sustainable solutions to ensure balanced development and improved living conditions for all residents.

4. Climate Change Adaptation Plan

4.1. Cape Winelands District's Strategic Objectives and the Linkage to Climate Change Adaptation

The Cape Winelands District Municipality (CWDM) operates under a guiding credo, "A unified Cape Winelands of excellence for sustainable development," setting a clear and ambitious goal for all its activities and programs. This vision is divided into three strategic objectives, each targeting a different aspect of the overall mission. Firstly, the municipality is dedicated to creating an environment and building partnerships that foster both social and economic development for all communities, with a focus on empowering the underprivileged in the Cape Winelands District. The second strategic goal aims to promote sustainable infrastructure services and a transportation system that enables social and economic opportunities, ensuring the connectivity and growth of the region. Lastly, the CWDM commits to providing effective and efficient financial and strategic support services, bolstering its internal operations and thereby enhancing its ability to serve the Cape Winelands District. These strategic goals align with the municipality's credo, striving to create an inclusive, sustainable, and prosperous future for the region.

Table 6: CWDM's strategic goals and linkage to climate change.

Strategic Objectives	Link to Climate Change
SO1: Creating an environment and forging partnerships that ensure the social and economic development of all communities, including the empowerment of the poor in the Cape Winelands District.	Firstly, the process of creating an environment and forging partnerships that ensure the social and economic development of all communities becomes pivotal in the face of climate change. It's essential to incorporate climate adaptation and mitigation strategies in the developmental plans to safeguard vulnerable communities, especially the impoverished, from adverse climate change impacts. Climate-smart partnerships with various stakeholders, such as research institutions, non-profits, and businesses, can facilitate knowledge sharing, technological innovation, and economic opportunities tailored to the changing climate.
SO2: Promoting sustainable infrastructure services and a transport system which fosters social and economic opportunities.	Secondly, the goal of promoting sustainable infrastructure and transport systems inherently aligns with climate change mitigation and adaptation efforts. Resilient infrastructure, particularly in transport, is key to reducing greenhouse gas emissions and enabling communities to cope with climate-related events such as floods or heatwaves. For instance, developing green spaces, improving public transportation, or promoting renewable energy sources can foster sustainable growth, enhance societal resilience to climate impacts, and provide economic opportunities.
SO3: Providing effective and efficient financial and	Lastly, in relation to providing effective and efficient financial and strategic support services to the CWDM, climate change

strategic support services to the Cape Winelands District Municipality (CWDM).	must be considered as a factor that influences budgeting and strategic planning. Financial resources should be allocated for climate change mitigation and adaptation efforts. Strategies could include investing in climate-resilient infrastructure, supporting sustainable business models, and establishing emergency funds for climate-related disasters. Further, efficient and informed decision-making requires incorporating climate risk assessments in strategic planning, thereby ensuring that the CWDM's actions are proactive rather than reactive to climate change impacts.

4.2. Climate Change Adaptation Vision

In line with the mission of becoming climate resilient, Cape Winelands District Municipality (CWDM) is committed to weaving climate change response principles into all areas of municipal planning, development, and operations. To make a shift towards a climate-resilient district, the CWDM can initiate various actions that correspond with the district's specific climate change forecasts:

- Water resource management: Given the country's water scarcity challenges and the district's projected changes in annual rainfall, 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.
- Ecosystem conservation and green spaces: The protection and restoration of natural ecosystems, like high-priority biomes, wetlands, river ecosystems and riparian areas, are integral to maintaining biodiversity, supporting water resource management, and providing natural buffers against climate-related hazards like wildfires and floods.
- Flood and fire management: Effective strategies for both flood and fire management are essential to mitigate risks associated with heavy rainfall events and wildfires. These strategies include improving stormwater drainage systems, creating floodplains and retention basins, and developing advanced early-warning systems for flooding and fires to protect vulnerable communities and infrastructure.
- Social equity and vulnerable populations: CWDM's efforts need to prioritise the needs of vulnerable populations, such as low-income communities and informal settlements, ensuring that these communities have access to basic services, improved housing conditions, and early-warning systems tailored to their needs.
- Agriculture and food security: Recognising that food security is a significant future climate change-related impact, developing a food security and agricultural policy that considers climate change impacts is crucial. As part of this effort, the Department of Agriculture has implemented the Smart Agri Plan, a strategic climate change adaptation initiative that factors in ecosystem resources and types of produce. The Department's approach to food security is driven by stringent regulation of land development on agricultural land. In their active role,

the Department influences the decision-making process for rezoning, subdivisions, consolidations, and departures. The Local Municipal Planning Tribunals duly consider the Department's formal comments and inputs when deciding on land developments on agricultural land. On a local scale, increasing the resilience of the agricultural sector involves supporting commercial and small-scale farmers, promoting efficient irrigation systems, exploring alternative crop types, and implementing fire and grazing management. These measures aim to sustainably optimise agricultural productivity, thereby ensuring food security in the face of potential climate change impacts.

- Climate-resilient infrastructure and settlements: Climate change considerations are woven into CWDM's infrastructure and settlement design standards and practices to withstand future impacts. This approach aligns with the district's risk profile, which highlights drought, heatwaves, and wildfires as significant threats.

These actions should be pursued with the understanding that the district's climate risks are likely to increase due to climate change. Hence, these actions need to remain adaptable to the evolving risks over time. While these best practices are not exhaustive, they can be enhanced by strategies tailored to the specific needs of CWDM. The key to success is integrating these principles into all aspects of municipal decision-making and operations and actively engaging the community in these initiatives.

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

"A future defined by resilience, environmental conservation, and sustainability. A pledge to safeguard our natural resources, diligently address climate change, and nurture enduring community partnerships. The shared aim to cultivate a thriving and equitable future, ensuring the CWDM continues to benefit all"

With a vision for a future of resilience and sustainability, Cape Winelands District Municipality (CWDM) is dedicated to protecting natural resources, implementing rigorous climate change strategies, and building strong community partnerships. The collective aim is to promote a prosperous and equitable future, guaranteeing the Cape Winelands' richness benefits everyone. In a more concise form, this vision translates to CWDM's commitment to sustainable resilience, emphasizing climate action, resource conservation, and community collaboration. This dedication not only ensures a thriving future for all but also preserves the rich bounty of the Cape Winelands for both residents and visitors.

4.3. Climate Change Goals and Programmes

The process of identifying adaptation actions within the Cape Winelands District Municipality (CWDM) begins with a comprehensive assessment of the local climate change risk profile. This profile has shown that the district faces significant threats from drought, increased temperatures, and more severe storms. Rapid population growth, particularly in the

Stellenbosch and Ceres areas, exacerbates these climate challenges. Stellenbosch municipality, for instance, already holds the highest population density of 232 people/km2 in the district, and the towns experiencing the most significant population growth are under considerable pressure to provide necessary services. This situation increases the vulnerability of larger population groups to climate-related hazards.

Moreover, environmental vulnerability across the district is relatively high. Rapid urbanisation, agricultural expansion, and land-use changes are putting significant pressure on biodiversity, increasing the environment's vulnerability to extreme climate events. Projections of more frequent droughts pose a significant risk to water availability, particularly in the face of anticipated population growth. The district's agriculture, which depends heavily on irrigation for production, is especially vulnerable as water availability for both crop irrigation and human consumption will become more restricted. This limitation is concerning, as more than one-third (40%) of the Western Cape's agricultural exports originate from this region.

Despite predictions of a decrease in annual rainfall, certain parts of the district may experience more extreme rainfall events following droughts. This increase in rainfall intensity and potential flooding could lead to elevated surface runoff, resulting in increased soil erosion, soil loss, degradation, and infrastructure damage, particularly in informal settlements.

Informed by these observations and predictions, specific Adaptation Goals have been developed to guide a contextually relevant approach to adaptation planning. These goals include:

- *To ensure water security for human consumption and irrigation under a changing climate.*
- *To protect biodiversity and improve the sustainable use of natural resources.*
- *To increase the resilience of the agricultural sector to more extreme events such as drought and storms as well as indirect risks such as pests and diseases.*
- *Increase the adaptive capacity of human settlements to climate change and extreme events.*

These Adaptation Goals have informed the development of Strategic Adaptation Priorities, which include:

1. Proactive measures that guarantee adequate water supplies for both human consumption and irrigation purposes. Such measures can involve improving water infrastructure, encouraging water conservation practices, and exploring alternative water sources like rainwater harvesting, groundwater, and wastewater reuse.
2. Protection of biodiversity and promotion of sustainable use of natural resources. This includes enhancing conservation efforts in protected areas, promoting sustainable farming and fishing practices, and raising public awareness about the importance of biodiversity.
3. Increasing the resilience of the agricultural sector. This involves the Department of Agriculture implementing the Smart Agri Plan, which takes into consideration the ecosystem resources required and the types of produce suitable under changing climate conditions. The plan also involves providing support to both commercial and small-scale farmers by

promoting efficient irrigation systems, exploring drought-resistant crop types, and implementing integrated pest and disease management practices.

4. Increasing the adaptive capacity of human settlements. This includes climate-proofing infrastructures, improving access to basic services, incorporating climate change considerations into urban planning and design, and fostering community engagement in mitigation and adaptation strategies.

These Strategic Adaptation Priorities support the identification and categorisation of Adaptation Programmes, each of which has been carefully detailed to provide a breakdown of the key climate actions and support activities necessary to address the impending risks. This sequenced approach ensures the district's response to climate change is both systematic and comprehensive, effectively enhancing its resilience against these climate-related challenges.

The aforementioned list represents the proposed programmes, each meticulously designed to align with the broader climate change goals mentioned above, set to tackle climate-related challenges in a comprehensive and strategic manner in the CWDM:

1. *An integrated approach to water augmentation, use, and management.*
2. *Protect and conserve water through monitoring mechanisms and water conservation through water conservation and water demand management (WCWDM).*
3. *Enhancing water conservation awareness and education for sustainable water management in response to climate change.*
4. *Assessing the feasibility and sustainability of alternative water sources for climate change adaptation.*
5. *Implementing sustainable groundwater use and development strategy.*
6. *Conserve, protect, and restore natural open spaces, ecosystems, and natural resources.*
7. *Enhanced Natural resource management and use of ecosystem services.*
8. *Integrate critical biodiversity areas and ecological support areas into spatial development frameworks.*
9. *Develop and implement conservation and management plan for vulnerable species.*
10. *Water management and conservation strategy.*
11. *Drought and extreme weather resilience programme.*
12. *Integrated pest and disease management programme.*
13. *Integrated fire management for climate resilience.*
14. *Identify and prioritise climate change risks and develop response measures for settlements.*
15. *Climate-smart waste management promotion.*
16. *Community-based adaptation in communities most at risk of climate-related hazards.*
17. *Climate-smart spatial planning for climate-resilient growth and development.*

Each programme corresponds to a specific goal and outcome as outlined in CWDM's strategic development priorities. These programmes, and their implementation, are intended to help the district manage and mitigate the significant risks posed by climate change.

4.4. Climate Change Goal 1: Ensure Water Security Under A Changing Climate.

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

Goal:	• The primary goal is to establish and maintain sustainable water management practices that enhance water security and resilience in the face of climate change in CWDM.
Outcome:	• By implementing this goal, CWDM aims to achieve a secure and robust water management system capable of withstanding climate change impacts. This system will ensure a reliable and resilient supply of water for all users - domestic, industrial, and agricultural, irrespective of climatic fluctuations. The successful outcome of this goal will result in minimized water shortages, lessened vulnerability of the region to droughts and floods, and improved overall community resilience to climate change.
Linkage to CWDM's Strategic Objectives	• SO1 - Creating an environment and forging partnerships that ensure social and economic development of all communities, including the empowerment of the poor in the Cape Winelands District: Establishing water security in the face of climate change contributes to creating an environment conducive to social and economic development. Access to a reliable supply of water is vital to support livelihoods, local businesses, and the well-being of all communities. It can also help empower marginalized groups, as secure access to water is a significant factor in alleviating poverty and supporting socioeconomic development. • SO2 - Promoting sustainable infrastructure services and a transport system which fosters social and economic opportunities: Ensuring water security under a changing climate necessitates the development of robust, resilient, and sustainable water management infrastructure. This aligns directly with the objective of promoting sustainable infrastructure services. Moreover, a reliable water supply is crucial for maintaining the transport system, particularly for tasks such as road maintenance and cleaning. • SO3 - Providing effective and efficient financial and strategic support services to the Cape Winelands District Municipality (CWDM): Water security ties directly to financial and strategic support services, as effective water management involves strategic planning and financial investments. The long-term cost savings from ensuring water security and resilience under a changing climate can contribute to more efficient use of municipal resources. Additionally, strategic actions to mitigate climate change impacts on water supply will enhance overall operational effectiveness of the municipality.

4.4.1. Rationale/Context:

The Cape Winelands District Municipality (CWDM) encompasses three water catchments - the Bergriver, Breede, and Oliphants/Gouritz River Catchments, all of which are currently grappling with insufficient water supply. Climate change exacerbates this challenge, as projections indicate a drying trend in the district, thus escalating the existing water stress. The impacts are further amplified by reduced rainfall, invasive alien species, intensive and poorly managed agricultural activities, and lime production. These factors compound to exert substantial strain on the water supply, affecting both quantity and quality.
Additionally, informal settlements add increased pressure on water infrastructure, with demand surpassing the available resources. A related challenge is the transportation of sewage effluent, which also suffers due to the diminished water availability. Furthermore, the region is witnessing increased pollution of freshwater resources and uncontrolled spread of invasive fish species.

Interestingly, the Breede-Gouritz Water Management Area possesses a high utilisable groundwater exploitable potential (UGEP) of 362.9 million cubic metres per annum, indicating untapped water resources. However, these groundwater reserves could be adversely impacted by the projected changes in the district's hydrological cycle, such as reduced runoff, increased evaporation, and changes in precipitation patterns.

Given that water is the primary medium through which South Africans will feel the impacts of climate change, securing water availability and quality in the face of climatic changes becomes a top strategic priority for the CWDM. It is clear that the challenges posed by climate change, environmental factors, and human activities necessitate a comprehensive strategy for water resource management to safeguard the district's water security, making it a primary concern for climate adaptation initiatives.

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 inaugural programme under CWDM's climate change adaptation plan is titled "Adopt an Integrated Approach to Water Augmentation, Water Use, and Water Management." This programme represents a strategic response to the district's complex and multifaceted water-related challenges in the context of climate change. It embodies a comprehensive and collaborative approach to water resource management. The need for this programme stems from the interconnected climate projections, environmental challenges, and socio-economic factors within CWDM, which influence water availability and quality.

- Water-sensitive urban design (WSUD): Considering the escalating climate extremes, including heightened temperatures and potential for increased flooding, implementing WSUD is vital to enhance the district's resilience. WSUD principles endorse the sustainable use and

management of water in urban design and planning, treating water as an integral part of the urban ecosystem. This approach involves constructing urban landscapes and infrastructures that replicate natural water cycles, managing stormwater, conserving water, and minimizing runoff. WSUD can also help alleviate water pollution issues by filtering runoff before it reaches water bodies, contributing to improved water quality.

- Addressing human resources constraints for effective water management: Adaptation to climate change demands efficient water management, which requires a capable and robust human resources pool. Mitigating any human resources constraints within the district is essential for executing and managing various initiatives under this programme. Training and capacity building in water management, conservation, and climate change adaptation are critical for enhancing the district's capacity to adapt to future climate-related water challenges.
- Review bulk water master plan: Given the ageing and overburdened water networks in CWDM, a review of the Bulk Water Master Plan is a necessary task. This review should factor in the anticipated increase in water demand due to urbanization and population growth, the projections of climate change, and the necessity to ensure water security. Such a review will aid in identifying any necessary upgrades or replacements for ageing infrastructure and plan for potential expansions to meet the increasing demand.
- Developing a water safety plan (WSP): A WSP is a comprehensive risk assessment and risk management approach that covers all steps in the water supply from catchment to consumer. Considering the threats to water quality and availability in CWDM, including pollution and climate change impacts, a WSP will provide a systematic framework for ensuring safe drinking water. This will involve identifying potential risks, implementing control measures, and establishing monitoring systems and management procedures to ensure ongoing water safety.

In conclusion, the rationale behind this first programme is to devise a holistic and future-oriented approach to water management in CWDM, acknowledging and addressing the various challenges and vulnerabilities related to climate change, pollution, and socio-economic factors. The ultimate objective is to secure a sustainable water future for the district, irrespective of the changing climate.

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).	• 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: Asses feasibility of capturing and re-use stormwater. • Educating and engaging stakeholders: Promote awareness of the benefits of WSUD and to 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.	• 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.	• 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. This evaluation will take into account factors like cost, feasibility, and environmental impact for each potential source. • 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 should 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.
Developing a water safety plan (WSP).	• 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

The "*integrated approach to water augmentation, water use, and water management*" programme within the CWDM's climate change adaptation plan seeks to mitigate water consumption and wastage and to ensure the protection of water quality. It aims to secure the sustainability of water resources in the face of climatic changes that might exacerbate water scarcity and pollution. Activities under this programme address key challenges confronting water resources in the Cape Winelands.

- Monitoring and reducing pollution: With significant pollution issues, especially in the Berg and Breede Rivers, rigorous monitoring mechanisms are a necessity. These measures will facilitate regular, reliable data on water quality and enable swift interventions. Moreover, efforts to curtail pollution at its source will be prioritized, whether it emanates from agricultural runoff or residential effluent. This approach is critical in securing water quality, an essential component of water security amidst climate change.

- Water conservation measures: The implications of climate change, such as intensifying drought conditions and more frequent hot days, necessitate improved water conservation. Measures could range from promoting water-efficient technologies and practices to enhancing public awareness about water conservation, to enforcing strict regulations on water use during drought periods.
- Alien invasive species clearing initiatives: Invasive aquatic species, particularly in the Berg and Breede Rivers, consume more water than indigenous species, thereby compromising water security. Strategic clearing of these invasive species, carried out annually between September and April, especially between the R45 and Herman, is essential. This not only boosts the resilience of these areas but also improves their capacity to provide clean, usable water.
- Research into wastewater reuse: Facilitated by the CWDM and implemented by relevant Engineering Departments of B-municipalities, research into the reuse of wastewater is pivotal. B-municipalities will identify towns for inclusion in the research based on economic viability and quantity. The research will also focus on the replenishment of aquifers through the infusion of purified wastewater.
- Assessment of water storage infrastructure: The CWDM will facilitate the evaluation of existing water storage infrastructure, which will be implemented by the Engineering Departments of B-municipalities.
- Promoting 'green' approaches in residential areas: A green approach encourages the sustainable use of resources, including water. Strategies might range from promoting rainwater harvesting and greywater recycling to implementing green infrastructure that manages stormwater and reduces runoff.

Overall, the rationale for this programme arises from the urgent need to conserve water and manage its demand amidst climate change. By focusing on these activities, the programme aims to ensure that the Cape Winelands' water resources are managed sustainably, thereby enhancing the district's adaptability to the predicted impacts of climate change.

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
Implementing monitoring mechanisms and protecting water sources by reducing pollution.	• 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 system. 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 on 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.
Implementing water conservation measures.	• Increase public awareness campaigns: Engagement with the public through campaigns, workshops, and educational programmes that promote water conservation practices. • 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 andin municipal buildings. • Greywater recycling: Promote the use of greywater for irrigation and other non-potable uses to reduce demand on the municipal water supply. • 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.

Alien invasive species clearing initiatives in catchment areas and rivers.	• Stakeholder Collaboration and Equitable Contribution: Considering that catchment areas and rivers, notably those affected by invasive aquatic vegetation, extend beyond the boundaries of CWDM and serve numerous water users, collaboration with all stakeholders is crucial. Equitable contributions from all parties, including the CWDM, B municipalities, Department of Water and Sanitation, LandCare Programme, property/landowners, and water user associations, to manage and enhance water security should be determined and facilitated. • Identification, mapping, and monitoring of invasive species: A thorough survey of invasive species, particularly in the Berg and Breede Rivers and throughout catchment areas, should be carried out in partnership with relevant stakeholders. This step involves the identification, mapping, and continuous monitoring of areas affected by invasive species. Regular clearing efforts should be conducted annually, especially between September and April, with a specific focus on the area between the R45 and Herman. • Removal and control of invasive species: this includes collaborative efforts in the removal and control of invasive species, especially those posing threats to water security. A variety of techniques such as mechanical, chemical, and biological control methods could be employed. Such actions should be supported by all stakeholders, thereby enhancing the district's overall resilience. • Rehabilitation of cleared areas: Post the successful removal of invasive species, the cleared areas need rehabilitation. This can be achieved by restoring indigenous vegetation and implementing erosion control measures, thereby boosting water security in river systems and catchments. • Education and awareness: Along with the practical actions, education and awareness campaigns coordinated with stakeholders are equally important. The goal of these campaigns is to increase understanding of the adverse impacts of invasive species on water security in catchment areas and rivers and to foster responsible behaviour in preventing the spread of such species. • Monitoring and evaluation: In partnership with stakeholders, the effectiveness of invasive species control measures and their impact on water security should be monitored and evaluated. This ensures the long-term sustainability of the project and allows for assessing the contributions and impact of each stakeholder in enhancing water security across the district.
Enforce 'green' approaches in residential areas and developments.	• 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: Enhancing Water Conservation Awareness and Education for Sustainable Water Management in Response to Climate Change

As climate forecasts indicate heightened periods of water stress due to escalating temperatures and decreased rainfall, it's absolutely essential for CWDM to bolster water conservation awareness and education. This programme is targeted at improving the community's comprehension of climate change implications, especially the significance of sustainable water management in mitigating these impacts. The underlying belief is that an enlightened and actively involved community is key to achieving enduring water security in the face of climate change.

Principal actions under this programme are:

- Formulating water conservation education initiatives: These initiatives can be structured to raise community cognizance about the necessity of water conservation and sustainable water management methods. Workshops, community outreach, and public campaigns can serve as mediums to convey information about the perks of water conservation, water-saving techniques, and the long-term effects of these activities on water accessibility and quality.
- Encouraging water conservation in domestic environments: This could encompass offering households practical guidance and tools for minimizing water consumption. For instance, educational resources could be circulated to homeowners about water-efficient appliances, low-flow showerheads and toilets, rainwater harvesting systems, and greywater recycling.
- Motivating businesses to employ water-saving measures: Businesses can be stimulated to decrease their water usage through a blend of advice, support, and incentives. This might encompass workshops for businesses about water-efficient practices, providing recognition or incentives for businesses that effect significant water reductions, and endorsing the adoption of water-efficient technologies in industrial processes.
- Executing research on water conservation: To assure the effectiveness of these efforts and adapt to evolving circumstances, it is vital to carry out consistent research on water conservation. This could involve scrutinizing the impact of existing conservation measures,

recognizing barriers that prevent or impede water conservation, and investigating pioneering approaches and technologies for water conservation.

Through these undertakings, the "*promoting water conservation awareness and education for sustainable water management in response to climate change*" programme aims to cultivate a culture of water conservation amongst residents and businesses in the District, assisting the region in becoming more resilient to the projected impacts of climate change.

Table 10: Programme 3 - Enhancing water conservation awareness and education for sustainable water management in response to climate change.

Programme 3: Enhancing Water Conservation Awareness and Education for Sustainable Water Management in Response to Climate Change.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Developing water conservation education programs. *(The programs can include activities such as workshops, community outreach, and public campaigns to promote the benefits of water conservation and the importance of sustainable water management),*	• Conducting a needs assessment: This involves identifying the target audience, understanding their knowledge level, attitudes, and behaviours related to water conservation, and identifying the gaps that need to be addressed. • Developing educational materials: This involves creating educational materials, such as brochures, pamphlets, posters, and videos that effectively communicate the importance of water conservation and offer practical tips on how to save water. The materials should be designed to appeal to the target audience and be culturally appropriate. • Conducting education and outreach activities: This involves organizing events and activities, such as workshops, seminars, public presentations, and social media campaigns, to promote water conservation and distribute educational materials to the target audience. • Partnering with community organizations: This involves collaborating with community-based organizations, such as schools, churches, and community centres, to disseminate educational materials and raise awareness of water conservation. • Evaluating the effectiveness of the program: This involves collecting data to measure the impact of the education program on knowledge, attitudes, and behaviours related to water conservation. This data can be used to refine the program and make it more effective.
Promoting water conservation in households.	• Developing and distributing educational materials: This involves developing materials such as brochures, posters, and pamphlets that provide tips and guidelines on how to conserve water at home. These materials can be distributed to households, community centres, and other public places to promote water conservation.

	• Providing incentives for water conservation: Providing incentives such as rebates for installing water-efficient devices and appliances can encourage households to adopt water conservation practices. This can include rebates for low-flow toilets, showerheads, and faucets. • Conducting water audits: Water audits involve identifying and fixing leaks, as well as identifying areas where water can be conserved. Households can conduct their own water audits or seek the assistance of trained professionals. • Encouraging the use of rainwater harvesting systems: Rainwater harvesting involves collecting rainwater and using it for non-potable purposes such as watering plants and flushing toilets. This can help households reduce their reliance on potable water for non-potable uses. • Implementing water-efficient landscaping: Water-efficient landscaping involves planting drought-resistant plants and using irrigation systems that deliver water directly to plants' roots. This can reduce the amount of water needed to maintain a garden or lawn. • Providing training and workshops: Providing training and workshops on water conservation can help households learn about the importance of water conservation and how to implement water conservation practices in their daily lives. • Engaging community leaders and stakeholders: Engaging community leaders and stakeholders in promoting water conservation can help to build momentum and increase participation in water conservation efforts.
Encouraging businesses to implement water-saving measures. *(This can include providing support and guidance on water-efficient practices, offering incentives for businesses to reduce water consumption, and promoting the use of water-efficient technologies).*	• Conducting water audits to identify areas where water savings can be made. • Developing and distributing guidance material to help businesses implement water-saving measures. • Providing financial incentives, such as rebates or tax credits, for businesses that implement water-saving measures. • Working with industry associations to promote water conservation practices and encourage member businesses to take action. • Conducting outreach and education programs to raise awareness among businesses about the importance of water conservation and the benefits of implementing water-saving measures. • Providing training and technical assistance to help businesses implement water-saving measures effectively. • Collaborating with large water users, such as industrial facilities, to develop customized water-saving plans and targets.
Conducting research on water conservation.	• Conducting studies on the water usage patterns of different sectors, including households, agriculture, and industry, to

(Research can include investigating the effectiveness of water conservation measures, identifying barriers to water conservation, and exploring innovative approaches to water conservation).	identify areas where water conservation measures can be implemented. • Developing and testing new technologies and practices that promote water conservation, such as efficient irrigation systems, water recycling and reuse, and rainwater harvesting. • Analyzing the economic, social, and environmental impacts of water conservation initiatives, to help decision-makers prioritize and implement effective conservation strategies. • Evaluating the effectiveness of existing water conservation programs, and identifying opportunities for improvement. • Collaborating with other stakeholders, such as government agencies, academic institutions, and non-governmental organizations, to share knowledge and best practices related to water conservation. • Conducting public outreach and education campaigns to promote awareness of the importance of water conservation, and to encourage individuals and organizations to take action to conserve water. • Monitoring and evaluating the implementation and impact of water conservation programs, to ensure that they are achieving their intended goals and objectives.

4.4.4. Programme 4: Assessing Alternative Water Sources

With climate change projections for CWDM indicating elevated temperatures and diminished rainfall, water scarcity may become an increasingly serious concern. The "*Exploring Alternate Water Sources*" programme is conceived to guarantee a dependable and sustainable water supply by identifying, establishing, and utilizing other sources of water. The principle behind this programme is that by lessening dependence on a single water source and diversifying the water supply portfolio, we can enhance resilience to the impacts of climate change.

Primary actions incorporated in this programme are:

- Water resource management planning: This activity entails an in-depth analysis of the water resources in the district, ascertaining the present and future demand, and evaluating how this demand can be catered to by a blend of conventional and alternate water sources. It necessitates planning for the present and future, considering both the volume and quality of the accessible water resources.
- Surveying alternate water sources: Identifying potential alternative sources of water is vital for diversification. These can encompass extraction of groundwater and the reprocessing of treated wastewater. Each of these sources has its advantages and drawbacks, and their feasibility would need to be assessed considering economic, environmental, and social factors.
- Investing in alternate water sources: Once feasible alternative water sources have been pinpointed, the required infrastructure and technology to extract, treat, and distribute these

water sources would be developed. This could involve drilling new boreholes for groundwater extraction and enhancing wastewater treatment facilities to facilitate wastewater reuse.

- Formulating and executing a treated effluent reuse strategy: Wastewater reuse can be a viable alternative water source, especially for non-drinking purposes such as irrigation, industrial processes, and toilet flushing. A comprehensive strategy can deliver guidelines for the treatment, distribution, and utilization of reclaimed water, ensuring its safe and efficient usage.

By executing these activities, the "*Exploring Alternate Water Sources*" programme seeks to augment CWDM's resilience to climate change-induced water scarcity, guaranteeing sustainable water management in the face of altering environmental conditions.

Table 11: Programme 4 - Assessing the feasibility and sustainability of alternative water sources for climate change adaptation.

Programme 4: Assessing the Feasibility and Sustainability of Alternative Water Sources for Climate Change Adaptation.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Water resource management planning.	• 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*	• Feasibility studies: Conduct feasibility studies to identify and assess the viability of various alternative water sources, such as rainwater harvesting, groundwater extraction, and stormwater capture.

alternative water sources, such as desalination, groundwater, and wastewater reuse).	• 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 their water needs and preferences and to get their input on the development of alternative water sources. • 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.
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).*	• 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.
Develop and implement a treated effluent reuse strategy for	• Assessing the feasibility and potential benefits of a treated effluent reuse strategy for the CWDM. • Identifying and prioritising potential sites for treated effluent reuse, including public spaces, industrial sites, and agriculture.

sustainable water management.	• 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 5: Groundwater Management

Groundwater is a crucial resource in the Cape Winelands District Municipality (CWDM), supporting the region's economic development and underpinning water security. This resource is becoming increasingly vulnerable to the impacts of climate change, pollution from industrial, urban, and agricultural activities, and contamination from wastewater treatment facilities. The complexity of managing this resource is increased by South Africa's climate variability, which significantly influences groundwater availability and distribution.

CWDM faces substantial challenges regarding water pollution in river systems and water bodies, notably the Berg and Breede Rivers. The Berg River, one of the most contaminated in the District, is influenced by runoff from agricultural and urban activities from its upper catchments located outside the District's boundaries. These external activities significantly impact the quality of CWDM's surface and groundwater resources.

Internally, urban areas within the District, specifically towns within the B-municipalities, exert substantial pressure on these water resources. Rural areas, where agricultural activities are prevalent, also influence surface and groundwater quality, albeit on a smaller scale. Pollution associated with urbanization contributes to the degradation of groundwater in both rural and urban areas.

Most towns within the District primarily rely on surface water, with only a few utilising a combination of surface and groundwater sources. The groundwater potential in the northern areas of the District is considerably lower compared to the south-western areas. Projections indicate that groundwater recharge is expected to decrease in the northern areas, whilst potentially increasing in the south-western regions due to climate change. This differential distribution of groundwater resources, coupled with anticipated population growth, particularly in Stellenbosch Local Municipality, poses risks of groundwater depletion. Other settlements with medium depletion risks, relying on groundwater, include Wolseley, Tulbagh, and Touwsrivier.

Given these significant challenges, it's not just essential but an urgent priority for the District to implement a sustainable groundwater use and development strategy. Such a strategy will help promote groundwater sustainability, ensuring the continued supply of safe water for the community. Moreover, it will enhance resilience against climate change impacts and play a significant role in improving the overall quality of water resources in the District.

Table 12: Programme 5 - Implementing sustainable groundwater use and development strategy.

Programme 5: 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 CWDM area.	• 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. • 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. • 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. • Engage with local communities, water users, and other stakeholders to understand their needs and concerns related to groundwater resources in the area. • Use the data collected and the models developed to develop a plan for the sustainable management and use of groundwater resources in the CWDM 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.
Establishing sustainable groundwater use policies and guidelines to promote efficient and effective groundwater management.	• 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.

Implementing groundwater monitoring programmes to monitor water levels, water quality, and potential pollution sources, enabling early detection of potential problems and timely intervention.	• 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.
Promoting groundwater conservation and efficiency by encouraging the adoption of water-saving technologies and practices in all sectors.	• 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 demand for groundwater resources.
Developing groundwater recharge and artificial recharge strategies to enhance aquifer recharge rates and improve groundwater storage capacity.	• 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. • 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.
Implementing land-use planning and zoning regulations to	• Conduct a groundwater vulnerability assessment to identify areas where groundwater resources are most at risk from pollution and overuse.

protect groundwater resources 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.
Utilize an information management system for groundwater data to provide accurate and timely information to water users, decision-makers, and the public.	• Conduct a comprehensive inventory of all groundwater monitoring wells in the CWDM area and assessing 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. • 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.

4.5. Climate Change Goal 2: To Protect Biodiversity and Improve Sustainable Use of Natural Resources

Table 13: Climate change goal 2, outcome, linkage to district's strategic development priorities.

Goal:	• Develop and implement strategies that preserve biodiversity, enhance ecosystem resilience, and promote sustainable utilization of natural resources within the Cape Winelands District Municipality (CWDM), ensuring a healthy environment for future generations.
Outcome:	• Enhanced biodiversity, improved ecosystem health, and optimized sustainable use of natural resources are achieved, ensuring a balance between ecological preservation and economic development. This results in greater resilience to climate change impacts, improved livelihoods for communities dependent on these resources, and the conservation of the unique flora and fauna in CWDM.
Linkage to CWDM's Strategic Objectives	• SO1 - Creating an environment and forging partnerships that ensure social and economic development of all communities, including the empowerment of the poor in the Cape Winelands District: The protection of biodiversity and sustainable use of natural resources contribute to a healthy environment, which is fundamental for social and economic development. The sustainable use of natural resources can empower impoverished communities by providing sustainable livelihood options. • SO2 - Promoting sustainable infrastructure services and a transport system which fosters social and economic opportunities: Infrastructure development that considers biodiversity protection and sustainable resource use can lead to ecologically balanced growth. Proper planning can reduce environmental impacts, and eco-friendly transport systems can lower emissions and promote sustainable development. • SO3 - Providing effective and efficient financial and strategic support services to the Cape Winelands District Municipality (CWDM): Strategic investment in biodiversity protection and sustainable resource management can offer long-term economic benefits, including sustainable tourism, job creation in conservation, and maintaining ecosystem services. Proper financial management and planning can ensure resources are effectively allocated towards these goals.

4.5.1. Rationale/Context

Preserving biodiversity and promoting sustainable use of natural resources have emerged as top strategic priorities for the Cape Winelands District Municipality (CWDM) climate adaptation report due to several critical reasons rooted in the unique environmental conditions of the area and the challenges it faces.

- Unique biodiversity: CWDM is situated within one of the world's greatest biodiversity hotspots, the Cape Floristic Region, also known as the Core Cape Sub-Region (CCR). The CCR is home to four distinct biomes - Fynbos, Succulent Karoo, Albany Thicket, and Afro-temperate Forest. It boasts an impressive diversity of plant species, many of which are endemic, found nowhere else on Earth. However, this exceptional biodiversity is highly vulnerable due to its endemic nature and range restriction. Protecting this biodiversity is vital, not just for conservation but also for maintaining the ecosystem's health and resilience.
- Climate change impacts: The effects of climate change, such as extended droughts and extreme rainfall causing flooding, pose significant threats to the region's biodiversity and natural resources. These impacts not only damage the environment but also disrupt the livelihoods of local communities. Developing climate adaptation strategies is crucial to prepare for, respond to, and recover from these climate-induced disturbances.
- Human activities: Rapid urbanization, agricultural expansion, infrastructure developments, and the over-extraction of water sources are increasingly threatening the sustainability of the region's natural resources and causing habitat loss. Around 30% of Fynbos habitat has already been lost, and many plant species are endangered. Thus, it's crucial to promote sustainable practices to prevent further degradation.
- Invasive alien species: Invasive alien species, such as Pinus and Hakea species, are causing significant harm to the region's native flora, especially in the mountainous areas of the CWDM. The control and management of these invasive species are critical for protecting the biodiversity and ensuring the sustainability of natural resources.
- Fire regime changes: Fire plays a pivotal role in the health and maintenance of Fynbos biodiversity. Changes in fire regimes, primarily due to human activities, threaten many native species. Implementing sustainable fire management strategies is a strategic priority to preserve this unique ecosystem.
- Protection of ecosystem services: The loss and degradation of ecosystems, such as wetlands and freshwater ecosystems, undermine the services they provide, including water filtration, carbon storage, and flood control. Integrating ecosystem services into planning and development is a strategic imperative for sustainable regional development.
- Responsibility to future generations: CWDM, given its unique location, has a responsibility to protect the CCR not just for its current inhabitants but for future generations globally. The natural resources in the region hold immense value, much of which is still unknown. Therefore, maintaining biodiversity and promoting sustainable use of resources serve as insurance for future economic and environmental security.

Given these reasons, it is clear that the strategy to "*protect biodiversity and improve sustainable use of natural resources*" is not just a priority, but an urgent requirement for the CWDM to build resilience against climate change and ensure long-term sustainability.

4.5.2. Programme 6: Conserve, Protect and Restore Natural Open Spaces, Ecosystems with Climate Change Adaptation Benefits

As climate patterns evolve within the Cape Winelands District Municipality (CWDM), the program "*conserve, protect and restore natural open spaces, ecosystems with climate change adaptation benefits*" becomes a crucial component for a resilient future. This strategy is especially vital in mitigating substantial risks associated with climate change, such as droughts, heatwaves, wildfires, and flooding, that threaten CWDM's unique ecosystems, natural resources, and open spaces. The program gives priority to the preservation, protection, and restoration of these spaces to maximize their natural climate resilience capabilities.

The initial action under this program is to assess CWDM's diverse natural resources and ensure conservation, protection, and restoration of natural open spaces and ecosystems. This involves continual monitoring and scientific evaluations of the conditions and health of the Cape Winelands Biosphere Reserve (CWBR), a 322,030 ha region designated by UNESCO, as well as other significant habitats, rivers, and wetlands within the district. The assessment will pinpoint crucial biodiversity areas needing urgent protection and establish environmental corridors vital for species adaptation and migration.

The second action leverages the climate adaptation benefits inherent in these open spaces. This involves strategic management to amplify their carbon sequestration capacity and their resilience against extreme weather events. Initiatives could encompass reforestation, the creation of urban green spaces, and the restoration of wetlands and riparian zones in the core and buffer zones of the CWBR. These areas not only sequester carbon but also regulate water flow and reduce flood risk.

The final key action involves implementing mitigation strategies against climate change and severe weather impacts, particularly in climate-risk zones. Given CWDM's susceptibility to droughts, heatwaves, wildfires, and flooding, these strategies will be tailored to address the unique challenges of each climate risk zone. For instance, in wildfire-prone areas, actions might include vegetation management to lower fuel loads, establishing firebreaks, and controlled burns. In flood-prone zones, restoration of wetlands and implementing sustainable land management practices could be crucial.

At its core, the program acknowledges the intrinsic value of natural open spaces and ecosystems in climate change adaptation, recognizing them not just as victims of climate shifts, but as active participants in climate resilience. The program activities will synergistically protect the district's natural wealth, including the UNESCO-designated CWBR, to ensure its ongoing role in climate change mitigation and adaptation. This reflects the central mission of the CWBR, which is to promote biodiversity, sustainable development, and education, to establish the Cape Winelands as an area of excellence for the harmonious coexistence of people, culture, and nature.

Table 14: Programme 6 - Conserve, protect and restore natural open spaces, ecosystems and natural resources.

Programme 6: 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.	• Performing a detailed inventory of natural resources, including land, water, and biological assets, within the CWBR and other notable ecosystems in the CWDM, to identify high conservation value areas and zones of concern. • Regularly monitoring and scientifically assessing the current health and conditions of these open spaces and ecosystems to determine any threats or vulnerabilities they may face due to climate change. • Designing conservation plans and management strategies for areas of high conservation value. These strategies must be integrated into municipal spatial plans and enforced through appropriate legislation, policy, and land use management to ensure protection. • Implementing restoration measures for degraded natural habitats and ecosystems, such as wetlands and riparian zones within the CWBR and the wider CWDM area. This is crucial to enhance their functionality and resilience against climate change impacts. • Establishing and effectively managing protected areas to ensure the conservation of vital natural resources and ecosystems, with a specific focus on the core and buffer zones of the CWBR and the biodiversity corridors that play a critical role in species adaptation and migration.
Harnessing the potential of open spaces to absorb and mitigate the impacts of climate change.	• 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.

4.5.3. Programme 7: Enhanced Natural Resource Management

Amid the swiftly evolving climate dynamics within the CWDM, the strategic initiative, "*enhanced natural resource management,*" becomes an essential component of a resilient and sustainable future. This initiative addresses the immediate need for judicious management of the region's natural resources, such as water and soil, and aims to fortify institutional and community capacities to sustainably manage these assets amidst climate change.

The first significant action under this initiative concentrates on maintaining water resource quality, which is fundamental to the district's sustainability trajectory. Water, vital to ecosystems, human health, and socio-economic development, becomes even more critical given the projected climate changes like potential increases in extreme rainfall events and drought. Thus, the monitoring, protection, and enhancement of water quality is paramount. Actions could encompass regular water quality testing, watershed management planning, and implementation of strategies to mitigate water pollution from agricultural runoff and urban waste within the Cape Winelands Biosphere Reserve (CWBR) and beyond.

The second action involves monitoring and mitigating soil erosion, an environmental threat with implications not only for the health and productivity of ecosystems but also for water quality. Soil erosion can cause siltation of rivers and dams within CWDM, potentially harming aquatic life and disrupting water supply. The holistic approach to preventing soil erosion necessitates regular monitoring of erosion hotspots, land-use planning incorporating erosion risk, and the enactment of soil conservation measures, such as sustainable agricultural practices.

The third essential action involves offering training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines. This action is crucial for ensuring compliance with these rules and building capacity within the municipality and wider community to manage natural resources sustainably and adaptively. Training modules could cover subjects such as biodiversity conservation, watershed management, soil conservation, and climate change adaptation, empowering participants with the skills to understand and apply regulations and guidelines effectively.

Finally, the establishment of a District Environmental Management Forum (DEMF) constitutes the fourth critical activity of this initiative. The DEMF will operate as a platform for improved collaboration and coordination between various sectors, organisations, and agencies involved in natural resource management. The DEMF could facilitate knowledge and resource sharing, strategy and plan harmonisation, and resolution of conflicts over resource use.

Through these interconnected actions, the "*Enhanced Natural Resource Management*" initiative underscores the crucial role of responsible natural resource management in navigating CWDM's climate future. It seeks to empower the district and its communities to protect and enhance their natural resources, not just as an end in itself, but as a means to secure the district's resilience and sustainability amidst climate change.

Table 15: Programme 7 - Enhanced natural resource management and use of ecosystem services.

Programme 7: Enhanced Natural Resource Management and Use of Ecosystem Services	
ACTIONS	ACTIVITIES
Ensuring the quality of water resources is critical to the sustainable development of CWDM, as they play a vital role in maintaining the health of ecosystems, human health, and socio-economic development.	• 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.
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. (*Preventing soil erosion requires a multifaceted approach that involves monitoring, planning, and implementing strategies that protect natural resources).*	• 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.
Provide training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines. *(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*	• 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

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).	
Establish a District Municipal Environmental Management Forum (DEMF) to enhance collaboration and coordination between Sectoral Departments, Conversation Organisation and agencies related to natural resource management.	• 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.

4.5.4. Programme 8: Integration of Critical Biodiversity Areas and Ecological Support Areas and Ecosystem Services into SDFs

The programme, "*Integration of Ecological Support Areas and Ecosystem Services into SDFs*," underscores the critical importance of recognising the inherent and functional value of natural spaces and ecosystems in the planning and development agenda of the CWDM. The climate change projections discussed earlier further heighten the necessity of this initiative. Here's how each of these key actions might function within the context of this programme:

- Ensuring critical biodiversity and ecological support areas are integrated into municipal spatial plans at all scales: This action necessitates identifying those areas within CWDM that are particularly significant for biodiversity and ecosystem services. For instance, the Cape Winelands Biosphere Reserve (CWBR) is a primary example. This and other ecologically vital areas should be incorporated into the municipal and B-Municipality spatial planning processes to ensure their preservation and sustainable use. With the impending risks of

droughts, heatwaves, and flooding, the conservation of these areas could also provide valuable climate change mitigation and adaptation benefits.

- Identifying and mapping natural open spaces, ecosystems, and natural resources, and integrating inventories in Spatial Development Frameworks and the open space framework: This involves conducting a comprehensive assessment of the municipality's natural assets, which should encompass not only areas of significant biodiversity like the CWBR but also other open spaces, ecosystems, and natural resources. These findings should then be woven into CWDM's and B-Municipality Spatial Development Frameworks and Open Space Framework, providing a blueprint for sustainable development that respects and upholds the value of these natural resources.
- Identifying undeveloped open space with potential for green infrastructure: This action is about recognising those undeveloped areas within the municipality that hold potential for the development of green infrastructure. Given the projected increase in heatwaves, such spaces can provide vital climate adaptation benefits, such as heat mitigation, increased stormwater management, and provision of habitats for biodiversity, contributing to the overall resilience of the municipality.
- Assessing the value of open spaces and ecosystem services: This action speaks to the need to quantify and appreciate the ecological, economic, and socio-cultural value offered by the district's open spaces and the services its ecosystems provide. Recognising the tangible and intangible benefits these spaces offer can strengthen the case for their protection and management, particularly in light of the escalating impacts of climate change.

Table 16: Programme 8 - Integrate critical biodiversity areas and ecological support areas into spatial development frameworks.

Programme 8: Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Frameworks.	
ACTIONS	KEY ACTIVITIES
Ensuring critical biodiversity and ecological support areas are integrated into municipal spatial plans at all scales. *(This involves identifying areas of high ecological value and ensuring that they are given due consideration in the municipality's spatial planning activities).*	• 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. • 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.
Identifying and mapping natural open spaces, ecosystems, and natural resources, and integrating inventories in Spatial Development Frameworks and the open space framework.	• 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 Spatial Development Frameworks, open space frameworks, 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.
Identifying undeveloped open space with potential for green infrastructure.	• 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 undeveloped open spaces with potential for green infrastructure. • 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.

Assessing the value of open spaces and ecosystem services	• 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.

4.5.5. Programme 9: Develop and Implement Conservation and Management Plan For Vulnerable Species

The programme "*Develop and Implement Conservation and Management Plan For Vulnerable Species*" for the Cape Winelands District Municipality (CWDM) is a strategic initiative aimed at protecting and preserving the region's unique biodiversity, particularly the species that are most at risk from environmental changes and human activities. The programme will involve a range of activities designed to promote species conservation and enhance the resilience of these vulnerable species.

Table 17: Programme 9 - Develop and implement a conservation and management plan for vulnerable species.

Programme 9: Develop and Implement Conservation and Management Plan For Vulnerable Species.	
ACTIONS	KEY ACTIVITIES
Develop and implement a conservation and management plan for vulnerable species.	• Conduct a thorough assessment of vulnerable and endangered species within the municipality. • Identify and prioritize species in need of protection and management based on their level of vulnerability, ecological importance, and cultural significance. • Develop and implement conservation and management plans that include strategies to protect and restore habitats, manage threats, and monitor populations. • Partner with local organizations, experts, and communities to implement conservation and management plans and ensure their long-term sustainability. • Provide education and outreach to raise awareness of the importance of protecting vulnerable species and their habitats and engage the public in conservation efforts. • Integrate conservation and management plans into municipal policies and planning documents, and ensure that they are

	regularly reviewed and updated to reflect changing ecological conditions and new information.

4.6. Climate Change Goal 3: To Increase the Resilience of the Agricultural Sector to More Extreme Events such as Drought and Storms as well as Indirect Risks such as Pests and Diseases.

Table 18: Climate change goal 3, outcome, linkage to district's strategic development priorities.

Goal:	• Develop and execute strategies to strengthen the agricultural sector's resilience against severe climatic events, including droughts and storms, as well as indirect risks such as pests and diseases within the Cape Winelands District Municipality (CWDM).
Outcome:	• A more resilient agricultural sector that can adapt to and effectively manage the impacts of severe weather events, pests, and diseases. This enhances food security, protects farmers' livelihoods, and ensures sustained agricultural productivity within CWDM.
Linkage to CWDM's Strategic Objectives	• SO1 - Creating an environment and forging partnerships that ensure social and economic development of all communities, including the empowerment of the poor in the Cape Winelands District: Resilience in the agricultural sector promotes economic stability by protecting the livelihoods of those working in agriculture, including vulnerable communities. Partnerships with stakeholders can foster knowledge exchange and support for farmers. • SO2 - Promoting sustainable infrastructure services and a transport system which fosters social and economic opportunities: Sustainable infrastructure, such as irrigation and early warning systems, can increase the resilience of the agricultural sector. A resilient transport system ensures the supply chain's continuity, enabling farmers to deliver their products under extreme weather conditions. • SO3 - Providing effective and efficient financial and strategic support services to the Cape Winelands District Municipality (CWDM): Through strategic financial planning and support, the municipality can fund projects and initiatives that enhance agricultural resilience, including infrastructure development, farmer education programs, and insurance schemes.

4.6.1. Rationale/Context

The strategic priority "*to increase resilience of the agricultural sector to more extreme events such as drought and storms as well as indirect risks such as pests and diseases*" is crucial for the Cape Winelands District Municipality (CWDM) given the anticipated impacts of climate change on the region's robust agricultural sector.

The CWDM boasts a high agricultural potential, attributed to its diverse commodities including deciduous fruits, table grapes, wine grapes, wheat, milk, and vegetables, and notably contributes 10.17% to the local Gross Value Added (GVA), significantly higher than the national average.

Furthermore, the sector plays a substantial role in providing employment opportunities, making up 23% of the overall employment in the district.

However, climate projections indicate a hotter and drier future for the district. This is expected to reduce the necessary chill periods required by certain crops, like grapes and stone fruits, and increase heat stress and water scarcity. This changing climate also raises the likelihood of more extreme events, such as drought and storms, and indirect risks, such as pests and diseases, all of which pose serious threats to the productivity and sustainability of the agricultural sector. The Department of Agriculture has been proactive in addressing these challenges through the implementation of the Smart Agri Plan. This climate change adaptation plan takes into consideration the ecosystem resources required and the types of produce suitable under changing climate conditions. An integral part of this approach is ensuring food security, which is driven by stringent regulation of land development on agricultural land. The Department plays an active role in the decision-making process for rezonings, subdivisions, consolidations, and departures. These decisions, influenced by the Department's formal comments and inputs, are considered by Local Municipal Planning Tribunals in their determinations on land developments on agricultural land.

To increase the resilience of the agricultural sector further, it is essential to provide support to both commercial and small-scale farmers. This can be achieved by promoting efficient irrigation systems, exploring drought-resistant crop types, and implementing integrated pest and disease management practices. Additionally, knowledge sharing initiatives and capacity-building programs can equip farmers with necessary skills and techniques to cope with climate-related challenges. The potential impacts of climate change are multi-faceted, potentially leading to smaller fruits, changes in pest and disease levels, insufficient groundwater recharge, and even challenges related to irrigation water quality. Furthermore, the shift in climate conditions could affect the agricultural sector's contribution to the economy and the livelihoods of those reliant on it.

Given the importance of the agricultural sector to the district's economy and its vulnerability to the projected climate changes, the strategic priority to increase resilience becomes paramount. This is about more than just safeguarding an industry – it is about ensuring the sustainability of livelihoods, the continuity of economic contribution, and the health of the local environment in the face of climate change. Effective adaptation and mitigation measures, such as the implementation of conservation agriculture, the cultivation of drought-resistant crops, and exploration of 'green' market opportunities, could play a vital role in increasing the sector's resilience. It is essential to leverage the resources provided by projects like SmartAgri and to engage experts for comprehensive and informed planning to ensure the sector's resilience against the inevitable impacts of climate change.

This strategic priority recognises the intricacy of the relationship between climate change and agriculture, aiming to equip the CWDM to navigate these complexities and continue to thrive in an increasingly uncertain climate future."

4.6.2. Programme 10: Water Management and Conservation Strategy

The "*water management and conservation strategy*" programme for Cape Winelands District Municipality (CWDM) acknowledges the central role that water plays in the agricultural sector and seeks to ensure the sustainable and efficient use of this vital resource, particularly in the context of climate change. The initiative is framed around three key actions: developing and implementing efficient irrigation methods, promoting rainwater harvesting and storage, and enhancing soil management practices to optimize water retention. Here are the specific activities under each of these actions:

- Develop and implement efficient irrigation methods: Agriculture is a major consumer of water in CWDM, with irrigation representing a significant portion of that use. This action aims to introduce and promote the use of efficient irrigation technologies and practices. These could include precision agriculture technologies like drip irrigation and micro-sprinklers, which deliver water directly to the plant roots, reducing evaporation losses. Other practices might involve scheduling irrigation based on soil moisture data or evapotranspiration rates to minimize water waste. Training and support will be provided to farmers to facilitate the adoption of these efficient irrigation methods.
- Promote rainwater harvesting and storage: Given the predicted increase in weather variability and the potential for longer dry periods, it is vital to make the most of the rainfall when it does occur. This action will promote the implementation of rainwater harvesting systems at the farm level, including the installation of appropriate catchment and storage infrastructure. Such systems can capture and store rainwater for use during dry periods, helping to reduce reliance on groundwater and surface water sources. This measure will be accompanied by initiatives to ensure that water quality is maintained in storage, and that health and safety standards are met.
- Enhance soil management practices to optimize water retention: Healthy soils with good structure and high organic matter content can hold more water, making crops more resilient to dry spells and reducing the need for irrigation. This action will promote soil management practices that improve soil health and increase water holding capacity. These practices could include cover cropping, organic amendments (such as compost or manure), reduced tillage, and crop rotation. These practices not only enhance soil water retention but also improve soil fertility and can sequester carbon, contributing to climate change mitigation.

In conclusion, the "*water management and conservation strategy*" programme aims to promote water efficiency and conservation in CWDM's agricultural sector. Through these actions, the programme will contribute to the resilience of the agricultural sector to climate change, safeguard water resources for future generations, and support the overall sustainability of farming in the region.

Table 19: Programme 10 - Water management and conservation strategy.

Programme 10: Water Management and Conservation Strategy.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Develop and implement efficient irrigation methods.	• Conduct a region-wide survey to assess current irrigation practices and identify areas for improvement. • Establish guidelines and best practices for efficient irrigation, including drip irrigation, sprinkler irrigation, and other water-conserving irrigation techniques. • Organize training workshops for farmers to learn about these efficient irrigation methods and how to implement them. • Develop a grant or subsidy program to assist farmers with the costs of installing and maintaining more efficient irrigation systems. • Implement a monitoring system to assess the effectiveness of the new irrigation methods and to provide ongoing feedback for improvements.
Promote rainwater harvesting and storage.	• Develop an educational campaign to promote the benefits and methods of rainwater harvesting among farmers. • Provide technical guidance on designing and installing rainwater harvesting systems, including rooftop systems, rainwater collection barrels, and larger reservoirs. • Offer financial incentives, such as grants, subsidies, or low-interest loans, to support the installation of rainwater harvesting systems. • Partner with local construction firms to ensure the availability of skilled labour for building these systems. • Establish regulations to encourage rainwater harvesting and ensure that systems are installed and used safely.
Enhance soil management practices to optimize water retention.	• Provide farmers with training on soil management practices that improve water retention, such as cover cropping, mulching, and composting. • Promote the use of organic matter additions to the soil to improve soil structure and water-holding capacity. • Develop a soil testing program to help farmers understand the composition and water-holding capacity of their soils, and provide personalized advice on improving soil health. • Offer incentives for farmers to adopt these improved soil management practices, such as financial assistance or recognition programs for best practices. • Establish a soil health monitoring program to track improvements over time and inform future strategies.

4.6.3. Programme 11: Drought and Extreme Weather Resilience Programme

The "*drought and extreme weather resilience programme*" is an essential strategic initiative for the Cape Winelands District Municipality (CWDM) to tackle the ongoing climate change crisis. As extreme weather events like droughts and storms become increasingly frequent and severe, it's imperative that the district develops a comprehensive approach to protect its agricultural sector, the economy, and the livelihoods of its residents. The programme entails three key actions - diversifying crop and livestock systems, developing infrastructure resilience to withstand extreme weather, and improving early warning systems for extreme weather events.

- Diversify crop and livestock systems: The aim of this action is to decrease the vulnerability of the agricultural sector to climate change by encouraging diversity in crop and livestock production. Key activities could include researching drought-resistant crop and livestock varieties suitable for local conditions, offering educational programs and workshops on the benefits and methods of diversification, and creating incentives like subsidies or grants to encourage farmers to diversify. A digital platform could also be set up to facilitate knowledge and experience exchange among farmers about diversification strategies. The impact of these measures on farm productivity and resilience to extreme weather events would then be monitored and assessed.
- Develop infrastructure resilience to withstand extreme weather: This action focuses on strengthening the physical infrastructure used in agriculture to better withstand extreme weather events. An assessment of existing infrastructure would identify vulnerabilities, leading to the development of guidelines for designing and constructing storm-resistant infrastructure. Training workshops for farmers and local construction firms would ensure these guidelines are understood and applied. A financial assistance programme would support farmers in making necessary upgrades, and a monitoring system would track the effectiveness of these changes.
- Improve early warning systems for extreme weather events: Effective early warning systems can save lives, protect property, and enhance economic stability. This action aims to improve early warning systems by collaborating with meteorological services and climate scientists to develop a system specific to extreme weather events in CWDM. A rapid communication network could be set up to disseminate warnings to farmers, who would receive regular training on how to interpret these warnings and take necessary precautions. The effectiveness of the early warning system would be regularly monitored and improved based on feedback from farmers.

In conclusion, the "*drought and extreme weather resilience programme*" serves to enhance the resilience and adaptability of the agricultural sector in CWDM, by taking proactive measures to protect it from the negative impacts of climate change. Implementing such a comprehensive strategy would be a significant step in safeguarding CWDM's agricultural sector and its economy from the growing threat of climate change.

Table 20: Programme 11 - Drought and extreme weather resilience programme.

Programme 11: Drought and Extreme Weather Resilience Programme.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Diversify crop and livestock systems.	• Conduct research to identify drought-resistant crop and livestock varieties suitable for local conditions. • Develop and implement educational programs and workshops for farmers about the benefits and methods of diversifying crop and livestock systems. • Set up a subsidy or grant program to incentivize farmers to diversify their crop and livestock systems. • Create an online platform to facilitate the exchange of knowledge and experiences among farmers about diversification strategies. • Monitor and assess the impact of diversification on farm productivity and resilience to extreme weather events.
Develop infrastructure resilience to withstand extreme weather.	• Carry out an assessment of existing agricultural infrastructure to identify areas of vulnerability to extreme weather events. • Develop guidelines for storm-resistant infrastructure design and construction. • Organize training workshops for farmers and local construction firms on these guidelines. • Establish a financial assistance program to help farmers upgrade their infrastructure to withstand extreme weather events. • Set up a monitoring system to track the effectiveness of the upgraded infrastructure in withstanding extreme weather events.
Improve early warning systems for extreme weather events.	• Explore the possibility to collaborate with meteorological services such as SAWS and climate scientists to develop an early warning system for extreme weather events. • Partner with local weather monitoring systems equipped with state-of-the-art technology for accurate forecasting. • Create a communication network (via SMS, email, mobile apps) to rapidly disseminate early warnings to farmers. • Conduct regular training sessions for farmers on how to interpret early warnings and take necessary precautions. • Monitor the effectiveness of the early warning system and make necessary improvements based on feedback from farmers.

4.6.4. Programme 12: Integrated Pest and Disease Management Programme

The "*integrated pest and disease management programme*" is a critical initiative designed to enhance the resilience of Cape Winelands District Municipality's (CWDM) agricultural sector against the escalating threat of pests and diseases, which are expected to worsen with climate change. The programme proposes three key actions: enhancing pest and disease monitoring systems, fostering the use of integrated pest management (IPM) strategies, and researching changing pest and disease trends in response to climate change.

To enhance pest and disease monitoring systems, CWDM could develop a network of monitoring stations across the district. This network would work in tandem with advanced pest and disease detection technologies and methodologies, developed through collaboration with research institutions. Farmers would be trained to identify early signs of infestations or outbreaks, contributing to a centralized, digital reporting system designed for real-time data collection and analysis. A prompt notification system would ensure that both farmers and agricultural agencies are quickly alerted about potential outbreaks, enabling timely responses to mitigate damage.

In order to foster the use of integrated pest management (IPM) strategies, CWDM could develop and disseminate best-practice guidelines that emphasize prevention and environmentally friendly control measures. Farmers would be educated about IPM techniques, such as crop rotation, biological control, habitat manipulation, and judicious use of pesticides, through workshops and training sessions. Incentives, like subsidies, grants, or recognition could be offered to farmers adopting these strategies. Moreover, the establishment of IPM demonstration farms would provide practical examples of how these strategies can be effectively implemented. Feedback from ongoing research and farmers would be used to regularly update and refine these strategies.

In light of the potential impact of climate change on pest and disease trends, it's crucial that the CWDM invest in researching changing pest and disease trends in response to climate change. Collaboration with academic and research institutions would provide insights into how local pest and disease patterns may evolve. Investment in predictive modeling would facilitate anticipation of potential future threats under different climate scenarios. Regular communication of these findings to farmers and agricultural extension services would keep them informed, while also assisting in refining IPM strategies and guidelines. Finally, contingency plans for potential new threats identified through this research would be developed, ensuring the district is prepared for all eventualities.

Table 21: Programme 12 - Integrated pest and disease management programme.

Programme 12: Integrated Pest and Disease Management Programme.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Enhance pest and disease monitoring systems.	• Develop a network of pest and disease monitoring stations across the Cape Winelands District. • Collaborate with research institutions to develop advanced pest and disease detection technologies and methodologies. • Train farmers in identifying early signs of pest infestations and disease outbreaks. • Establish a centralized, digital reporting system to facilitate real-time data collection and analysis. • Implement a notification system to promptly alert farmers and agricultural agencies about potential outbreaks.

Foster use of integrated pest management (IPM) strategies.	• Develop and disseminate best-practice guidelines for IPM, emphasizing prevention and the use of environmentally friendly control measures. • Conduct workshops and training sessions to educate farmers about IPM techniques, such as crop rotation, biological control, habitat manipulation, and judicious use of pesticides. • Offer incentives (e.g., subsidies, grants, recognition) to farmers adopting IPM strategies. • Establish IPM demonstration farms to provide practical examples of how these strategies can be effectively implemented. • Regularly update and refine IPM strategies based on ongoing research and farmer feedback.
Research changing pest and disease trends in response to climate change.	• Collaborate with academic and research institutions to study how climate change affects local pest and disease patterns. • Invest in predictive modelling to anticipate potential future pest and disease threats under different climate scenarios. • Communicate research findings regularly to farmers and agricultural extension services to inform their pest and disease management practices. • Integrate research outcomes into the revision and enhancement of IPM strategies and guidelines. • Develop contingency plans for potential new pest or disease threats identified through this research.

4.7. Climate Change Goal 4: Increase the Adaptive Capacity of Human Settlements to Climate Change and Extreme Events.

Table 22: Climate change goal 4, outcome, linkage to district's strategic development priorities.

Goal:	• Develop and implement robust adaptation strategies to enhance the resilience and adaptive capacity of human settlements to climate change and extreme weather events within the Cape Winelands District Municipality (CWDM).
Outcome:	• Climate-resilient human settlements that can withstand and recover from the impacts of climate change and extreme weather events, safeguarding the well-being of residents and ensuring the continuity of social and economic activities within the CWDM.
Linkage to CWDM's Strategic Objectives	• SO1: Creating an environment and forging partnerships that ensure the social and economic development of all communities, including the empowerment of the poor in the Cape Winelands District: Increasing the adaptive capacity of human settlements contributes to the social and economic well-being of all communities by protecting homes, community infrastructure, and economic activities from the impacts of climate change. • SO2: Promoting sustainable infrastructure services and a transport system which fosters social and economic opportunities: Creating climate-resilient infrastructure and transport systems in human settlements ensures continued accessibility and safety, particularly during extreme weather events, thereby fostering social and economic opportunities. • SO3: Providing effective and efficient financial and strategic support services to the Cape Winelands District Municipality (CWDM): By providing financial and strategic support for the development and implementation of adaptation strategies, the CWDM can ensure that human settlements are equipped to adapt to climate change and extreme weather events.

4.7.1. Rationale/Context

"*Increasing the adaptive capacity of human settlements to climate change and extreme events*" is a strategic priority for Cape Winelands District Municipality (CWDM) primarily due to the disproportionate impact of climate change on the region's vulnerable populations. The poor and disadvantaged, including smallholder farmers, peri-urban farmers, new farmers, and farm workers, especially women, who often shoulder familial responsibilities, face significant risks from climate change. These groups, with limited resources and choices, are most susceptible to climate extremes such as heat stress, waterborne and vector-borne diseases, fire risks, and decreased productivity worsened by food insecurity, hunger, and malnutrition. Additionally, climate change can exacerbate existing health challenges like HIV and TB among these populations.

The repercussions of climate change, such as decreased agricultural production, can lead to increased unemployment and significant socio-economic distress, which in turn, can catalyze urban-rural migration. As climate change is expected to hit subsistence farmers and small-scale farmers hardest, an influx of these populations into cities can strain urban infrastructure and basic services. While it is essential to introduce measures to help these communities adapt and sustain their reliance on natural resources, it is equally important for local governments to prepare for the inevitable urbanization and prioritize mitigating the economic impacts of climate change.

Moreover, it's worth noting that adaptation to climate change has social limits, shaped by ethics, knowledge, risk perception, and cultural aspects. These social limits, however, are not constant and can be influenced through education and community-based initiatives. These initiatives can empower individuals, help them perceive climate change risks accurately, and encourage the adoption of adaptive behaviours. Therefore, CWDM must prioritize increasing the adaptive capacity of its human settlements to safeguard its population, stabilize its economy, and maintain social harmony amidst the mounting challenges posed by climate change and extreme events.

4.7.2. Programme 13: Integrated Fire Management for Climate Resilience

The "*integrated fire management for climate resilience*" programme holds significant importance for Cape Winelands District Municipality (CWDM), given its present condition and future forecasts of increased wildfire risks. Certain settlements within the district, such as Stellenbosch, Paarl, and Wellington, are strategically located at the wildland-urban interface, making them particularly susceptible to wildfires. Climate change-induced temperature rise is expected to exacerbate this threat level in some areas.

This programme is dedicated to methodically mitigating the risks and effects of wildfires through a series of targeted activities. Initially, a "comprehensive evaluation of fire hazards" will be conducted, which will encompass the assessment of fire-prone ecotypes, wildfire probabilities, potential severity, and socio-economic implications. This step will facilitate the identification of high-risk areas and guide strategic planning.

Subsequently, the "strategic fire deterrence roadmap" will set out preventive measures and actions to mitigate wildfire risks. this could involve actions such as maintaining firebreaks, managing flammable vegetation, and endorsing safe land-use practices. an integral part of this programme is "community engagement and fire safety education", aimed at promoting awareness about fire risks, preventive steps, and the necessary actions during a wildfire.

To track wildfires, an "advanced fire detection and monitoring infrastructure" will be put in place, possibly incorporating remote sensing technologies and early warning systems. In the event of a fire outbreak, an "emergency preparedness and response strategy" will ensure rapid and

effective containment and rescue operations. Post-wildfire, the action of "post-fire restoration and ecosystem rehabilitation" will focus on restoring the ecosystem and rehabilitating impacted areas. Concurrently, "policy and by-law development" will create regulations that bolster wildfire management and climate resilience.

Table 23: Programme 13 - Integrated fire management for climate resilience.

Programme 13: Integrated Fire Management for Climate Resilience.	
ACTIONS	POSSIBLE KEY ACTIVITIES
A comprehensive evaluation of fire hazards.	• 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 behavior 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.
Strategic fire prevention roadmap.	• 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.
Community engagement and fire safety education.	• 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 trainings: Organize practical fire safety training sessions, including demonstrations on how to use firefighting equipment, evacuation drills, and basic firefighting skills. • 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.
Advanced fire detection and monitoring infrastructure.	• 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. • Data integration and analysis: Integrate data from different monitoring sources and use advanced analytics to identify patterns, predict fire behavior, 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.

Emergency preparedness and response strategy.	• 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 neighboring 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 lessons learned from previous fire incidents, changes in the community or environment, and advancements in technology.
Post-fire restoration and ecosystem rehabilitation.	• 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 for 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.
Policy and by-law development.	• 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. • 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.
Innovation and research in fire management techniques.	• 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. • 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.
Inter-organizational collaboration and strategic partnerships.	• 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. • 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.
Empowering Fire Management	• Training programs: Organize training programs for municipal staff, community members, and other stakeholders to enhance

Capacities and Efficient Resource Allocation.	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.

4.7.2 Programme 14: Identify and Prioritise Climate Change Risks and Develop Response Measures for Settlements.

The "*identify and prioritise climate change risks and develop response measures for settlements*" programme is crucial for addressing the climate change challenges faced by Cape Winelands District Municipality (CWDM). The district is prone to a variety of natural, technological, and environmental hazards, including severe storms, droughts, fires in informal settlements, and veld fires.

Under this programme, a key action includes conducting a vulnerability assessment to pinpoint the populations and areas most susceptible to the effects of climate change. This understanding

is critical in a region consistently threatened by various hazards, as it assists in determining priority areas for interventions and creating effective, targeted climate adaptation strategies. Another key component of this programme is the development and implementation of an early warning system. Given CWDM's exposure to severe climate events, a robust early warning system is crucial to preparing communities for imminent hazards, allowing for a timely response that can minimise the impact.

To ensure long-term climate resilience, this programme emphasises the importance of fostering partnerships with local stakeholders, such as community groups and NGOs. These collaborations serve to build local capacity, empowering communities to better handle climate change-related challenges - a critical need in a region frequently exposed to an array of environmental threats.

Finally, the programme integrates climate change considerations into land use planning and zoning regulations. In an area so vulnerable to environmental hazards, it's vital to adopt planning practices that account for potential climate impacts. These measures ensure the long-term resilience of human settlements, thereby reducing their vulnerability to the escalating effects of climate change.

Table 24: Programme 14 - Identify and prioritise climate change risks and develop response measures for settlements.

Programme 14: 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.	• Analysing climate data to determine the frequency and severity of extreme weather events. • Assessing the vulnerability of infrastructure to flooding and wildfire. • Mapping areas with high concentrations of vulnerable populations.
Developing and implementing an early warning system to help communities prepare for and respond to climate change risks.	• 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.
Establishing partnerships with local stakeholders, such as community	• 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.

groups and NGOs, to build local capacity for climate change adaptation and resilience.	• Collaborating with local NGOs to implement small-scale adaptation measures, such as rainwater harvesting and urban agriculture.
Developing and implementing land use planning and zoning regulations that take into account the potential impacts of climate change.	• 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.

4.7.3 Programme 15: Climate-Smart Waste Management Promotion

The *"climate-smart waste management promotion*" programme within the Cape Winelands District Municipality (CWDM) is essential for mitigating climate change impacts and managing the area's waste-related challenges more effectively. At present, the district faces challenges related to inconsistent waste collection, largely due to inadequate waste management infrastructure, such as compactor trucks. The issue of illegal dumping exacerbates these problems, underlining the importance of robust waste management strategies.

The District Integrated Waste Management Plan, an initiative launched by the CWDM, is aimed at aligning with the goals of the National Waste Management Strategy. These objectives include encouraging waste minimisation, reuse, recycling, and recovery, ensuring efficient waste services, and boosting the waste sector's contribution to the green economy, among others. However, these ambitions have been hindered by insufficient funding and a lack of adequately trained personnel, necessitating a creative approach to waste management.

Under this programme, several key actions are planned:

- "Waste minimisation and recycling innovation" is a crucial step towards sustainable waste management. The district will advocate for innovative methods of reducing waste production and maximising waste recycling, in harmony with the National Waste Management Strategy's objectives. This might involve new technologies or methodologies to cut down waste or convert it into usable products, thereby reducing the environmental footprint of the area's waste.
- "Staff training and capacity building" is vital considering the current limitations of inadequately trained personnel. This initiative will provide municipal staff with the necessary skills and knowledge to manage waste proficiently and effectively, helping to overcome the staffing deficits that have previously impeded progress.
- "Improved waste collection and transportation" seeks to address the current issues related to inconsistent waste collection. This will entail optimising waste collection schedules,

enhancing waste collection vehicles, and refining waste transportation processes, all to make waste collection more efficient and thorough.

- "Public awareness and illegal dumping reduction" will concentrate on educating the public about the significance of appropriate waste disposal and the environmental and health impacts of illegal dumping. This initiative is intended to foster responsible waste disposal practices among residents and aid in reducing the incidence of illegal dumping, thus safeguarding the health of the community and the local environment.

Table 25: Programme 15 - Climate-smart waste management promotion.

Programme 15: Climate-Smart Waste Management Promotion	
ACTIONS	KEY ACTIVITIES
Waste minimization and recycling innovation.	• Conduct a feasibility study to identify innovative waste processing technologies that could be implemented within the municipality. • Develop recycling programs that incentivize households and businesses to recycle more, such as offering discounts or rebates based on the amount of waste recycled. • Establish dedicated recycling centres across the municipality to facilitate easier access for residents and businesses. • Monitor and evaluate the impact of these innovations on waste reduction and recycling rates, adjusting the program as necessary for maximum effectiveness.
Staff training and capacity building.	• Identify key areas of knowledge and skills required for effective waste management, such as waste collection, separation, and processing procedures. • Develop and implement a comprehensive training program for waste management staff, covering these key areas. • Provide ongoing support and resources for staff to continue learning and improving their skills. • Regularly review and update the training program to ensure it remains relevant and effective.
Improved waste collection and transportation.	• Carry out an assessment of the existing waste collection and transportation infrastructure to identify areas for improvement. • Develop a plan for upgrading this infrastructure, such as purchasing new, more efficient compactor trucks. • Implement the plan, monitor its effectiveness, and make necessary adjustments over time. • Conduct routine maintenance on the infrastructure to ensure it remains in good condition and operates efficiently.
Public awareness and illegal dumping reduction.	• Develop a public awareness campaign to educate residents about the importance of responsible waste disposal and the dangers of illegal dumping.

	• Organize community clean-up events in areas affected by illegal dumping to foster a sense of community pride and responsibility. • Work with law enforcement to increase patrols in areas known for illegal dumping and impose penalties for those caught in the act. • Monitor and evaluate the impact of these activities on rates of illegal dumping, adjusting the strategy as necessary to achieve maximum effectiveness.

4.7.3. Programme 16: Community-Based Adaptation in Communities Most at Risk of Climate-Related Hazards

The "*community-based adaptation in communities most at risk of climate-related hazards*" programme is vital in fostering resilience and mitigating the effects of climate change in CWDM. This programme recognises that local communities, often the first to experience the impacts of climate change, require adaptation measures that are customised and geographically relevant. The initiative underscores the empowerment of local communities and the utilisation of their knowledge in crafting and executing climate adaptation strategies.

Key actions under this programme encompass:

- Carrying out detailed community-based risk and vulnerability assessments in communities to identify risk sources and develop suitable adaptation measures: This action involves an in-depth evaluation of specific climate risks that local communities encounter. By identifying these risks at a detailed level, the district can design adaptation measures that are precise, focused, and effective.
- Establishing and executing community-based adaptation measures to minimise risks and enhance resilience: This involves local departments such as the Department of Agriculture, Land Reform and Rural Development (DALRRD) playing a vital role in endorsing climate-smart agricultural practices, boosting food security, and constructing community resilience. The aim is to decrease climate-related risks and fortify the communities' ability to endure and recover from adverse climate impacts.
- Providing training and education to build community capacity and promote sustainability: Through training and education, the programme intends to arm community members with the knowledge and skills needed to adapt to climate change. This can help advocate sustainable practices at the local level, cultivating a more resilient community.
- Comprehensive community engagement and public awareness initiative on climate change: This initiative is structured to heighten awareness about climate change and involve the community in tackling it. By engaging local organisations, schools, and community groups, the programme ensures that the awareness campaign is inclusive, accessible, and pertinent to all community members.

By centring on community-level adaptation, the programme plays an essential role in reducing the vulnerability of both human and natural systems to climate change and extreme events within the CWDM.

Table 26: Programme 16 - Community-based adaptation in communities most at risk of climate-related hazards.

Programme 16: 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.	• 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.	• 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 stakeholder (such as Provincial and 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.
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. By engaging local organisations, schools, and community groups, the programme will ensure that the campaign is inclusive, accessible, and relevant to all members of the community.*	• Organising community events to enhance climate change awareness and its impacts. • Designing and distributing educational materials on climate change, both physically (like pamphlets and brochures) and digitally, using an online and social media presence to boost outreach and engagement. • Implementing training and education programmes for community members through workshops and seminars. • Holding public meetings and forums to discuss climate change, gather community input, and feedback. • Partnering with local organisations and community groups to ensure the campaign's relevance and accessibility. • Developing a comprehensive public awareness campaign tailored to the diverse needs of the municipality, including vulnerable populations. • Conducting community engagement and outreach activities to raise awareness of climate change impacts and teach communities about mitigation and adaptation strategies. • Providing capacity-building sessions for local leaders and stakeholders on topics such as sustainable energy practices and eco-friendly behaviors. • Utilising various media channels, including social media, print, radio, and television, to disseminate key messages and updates on climate change initiatives. • Fostering collaborations with educational institutions and other stakeholders to expand the campaign's reach. • Establishing feedback mechanisms to assess campaign effectiveness and identify improvement areas. • Using community feedback to refine the campaign and ensure it responds to their needs and concerns. • Building a network of community ambassadors to keep the climate change conversation alive and promote sustainable practices. • Developing partnerships with industry, research institutions, and government agencies to support the development and implementation of CCS technology.

4.7.4. Programme 17: Climate-Resilient Spatial Planning

The "*climate-resilient spatial planning*" programme is a critical component in the CWDM's initiative to mitigate and adapt to the impacts of climate change. It recognises that conventional methods of spatial planning may be insufficient in the wake of climate change, which presents fresh and developing challenges. The programme aims to weave climate change considerations into spatial planning, nurturing resilience, and guaranteeing the district's urban and rural spaces are better equipped for the future.

Key actions under this programme include:

- Ensure that spatial planning frameworks consider a long-term view of climate hazards and incorporate natural infrastructure: This action seeks to integrate an understanding of future climate hazards into spatial planning and acknowledges the essential role of natural infrastructure in climate adaptation, such as utilising wetlands for flood regulation.
- Develop local-level climate-resilient planning mechanisms - precinct plans: At the local level, these plans will guide development designed to resist climate impacts and ensure the endurance and sustainability of CWDM's communities.
- Ensure collaborative strategic planning that incorporates all relevant departments: Recognising that climate change will impact all sectors of the district, this action fosters cross-departmental collaboration to ensure unified and comprehensive planning.
- Create mechanisms to strengthen public participation in planning and decision-making processes: Public involvement ensures plans mirror local needs and knowledge, enhancing the effectiveness and acceptance of climate-resilient plans.
- Resilient urban and rural area design and development to minimise the risk and impact of climate change on urban areas: This involves designing urban and rural areas with climate resilience in mind, such as planning urban green spaces to mitigate heatwaves and floods.
- Identify climate risk zones and hotspots that affect vulnerable district infrastructure and assets: By pinpointing these risk zones, the district can prioritise where resilience needs to be built most urgently, and where infrastructure upgrades or changes may be necessary.

By integrating climate change resilience into spatial planning, the CWDM can reduce the vulnerability of its human and natural systems to climate change and extreme events, thereby enhancing the long-term sustainability of its communities.

Table 27: Programme 17 - Climate-smart spatial planning for climate-resilient growth and development.

Programme 17: Climate-Smart Spatial Planning For Climate-Resilient Growth and Development.	
ACTIONS	POSSIBLE KEY ACTIVITIES
Ensure that spatial planning frameworks consider a long-term	• Conduct a review of current spatial planning frameworks, • Identify climate hazards and vulnerable areas in the municipality,

view of climate hazards and incorporate natural infrastructure.	• Develop guidelines for climate-resilient spatial planning, • Identify natural infrastructure assets that can be incorporated into spatial planning frameworks.
Develop local-level climate-resilient planning mechanisms - Precinct Plans.	• Conduct vulnerability assessments to identify areas at risk of climate hazards. • Develop climate-resilient precinct plans that incorporate the needs and concerns of the community. • Ensure that the precinct plans are adaptable to the impacts of climate change.
Ensure collaborative strategic planning that incorporates all relevant departments (in both strategic planning and project implementation).	• Identify relevant departments and stakeholders. • Establish a coordination mechanism for collaborative strategic planning. • Develop guidelines for collaboration and coordination in strategic planning and project implementation. • Conduct regular reviews and assessments of the collaboration mechanism to ensure its effectiveness.
Create mechanisms to strengthen public participation in planning and decision-making processes.	• Ensure that the public has access to information about spatial planning frameworks and other climate change response initiatives. • Ensure that public feedback is incorporated into the decision-making process.
Resilient urban and township design and development to minimise the risk and impact of climate change on urban areas.	• Promoting innovative urban and township planning and design, which takes advantage of opportunities provided by the natural infrastructure and economic growth-management strategies. • Identifying ecological corridors or climate change corridors within the District Spatial Development Framework (SDF) is also an important aspect of innovative urban and township design and development. • Conducting comprehensive research on climate change and its potential impacts on urban areas, including projections of temperature increases, extreme weather events, and sea level rise. • Developing guidelines in collaboration with reliant government departments, for innovative urban and township design that take into account climate change risks, including those related to flooding, extreme heat, and drought. • Establishing partnerships and networks with key stakeholders in urban planning and design, including government agencies, non-governmental organisations and academic institutions, to promote knowledge sharing and collaboration. • Encouraging the use of green infrastructure in urban design, such as green roofs, permeable pavements, and rain gardens, to help manage stormwater and reduce the urban heat island effect.

To identify climate risk zones and hotspots that affect vulnerable municipal infrastructure and assets, CWDM could undertake various activities.	• Conducting vulnerability assessments for critical infrastructure and assets. • Analysing historical climate data to identify areas that have been particularly vulnerable in the past. • Developing climate models to assess future risks and understand the potential impacts of climate change. • Mapping vulnerable infrastructure and assets to understand where they are located in relation to climate risk zones and hotspots. • Identifying risks and prioritising action based on the level of vulnerability and potential impact of climate change on infrastructure and assets. • Developing and implementing strategies to manage risks and protect infrastructure and assets from climate change impacts.

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: Ensure water security under a changing climate.								
Adaptation Programme 1: Integrated Approach to Water Augmentation, Use and Management.								
Water Sensitive Urban Design (WSUD)	Drought/ Heat Stress	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 Effective Water Management	Drought/ Heat Stress	Water and Sanitation	Year 0-2: Complete needs assessment, assign funds implement WRM KPIs	Low	Advocate for and secure funding for a dedicated water resources	Recruit a qualified water resources manager.	Maintain	High

			Year 3-5: Recruit water resource manager and establish partnerships.		manager position			
Review Bulk Water Master Plan	Drought/ Stress	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		High
Developing a Water Safety Plan (WSP)	Drought/ Heat Stress	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 improvement.	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 mechanisms and protecting water sources by reducing pollution.	Drought/ Heat Stress	Water and Sanitation	Year 0 – 2: Develop monitoring schedule, establish buffer zone and integrate in spatial frameworks	Medium	Implement a regular water quality monitoring schedule, create and manage municipal buffer zones and develop by-laws	Implement	Implement	High

			Year 3-5: Implement by-laws		to regulate effluent discharge.			
Implementing water conservation measures.	Drought/ Heat Stress	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: Mapp alien invasive hotspots. Continue current operation and campaigns. Source funds. Year 3-5: Scale alien invasive clearing and establish green economy initiatives. Year 6-10: Self-sustaining operations in key areas.	Medium	Identify, map and control areas containing alien invasive species.	Scale	Scale	

Enforce 'Green' Approaches in Residential Areas and Developments.	Drought/ Heat Stress	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 incentive programme.	Low	Developing and implement guidelines and standards for sustainable residential and commercial development	Incentive programme. Enforcement	Enforcement.	
Adaptation Programme 3: Enhancing Water Conservation Awareness and Education for Sustainable Water Management in Response to Climate Change								
Developing Water Conservation Education Programs.	Drought/ Heat Stress	Water and Sanitation	Year 0-2: Developing and distributing educational materials. Year 3-5: Conducting education and outreach activities.	Low	Developing and distributing educational materials.	Conducting education and outreach activities	Maintain and evaluate.	High
Promoting Water Conservation in Households.	Drought/ Heat Stress	Water and Sanitation	Year 0-2: Providing incentives for water conservation and encouraging the use of rainwater harvesting systems. Year 3-5:	Medium	Providing incentives for water conservation and encouraging the use of rainwater harvesting systems.	Implement water-efficient landscaping.	Maintain	High

			Implement water-efficient landscaping.					
Encouraging Businesses To Implement Water-Saving Measures.	Drought/ Heat Stress	Water and Sanitation	Year 0-2: Developing and distributing guidance material to help businesses implement water-saving measures. Year 2-5: Working with industry associations to promote water conservation practices and encourage member businesses to take action.	Low	Developing and distributing guidance material to help businesses implement water-saving measures.	Working with industry associations to promote water conservation practices and encourage member businesses to take action.	Maintain.	High
Conducting Research On Water Conservation	Drought/ Heat Stress	Water and Sanitation	Year 0-2: Developing and testing new technologies and practices that promote water conservation, such as efficient irrigation systems, water	Medium	Developing and testing new technologies and practices that promote water conservation, such as efficient irrigation systems, water recycling and	Implement	Implement	High

			recycling and reuse, and rainwater harvesting. Year 3-5: Implement		reuse, and rainwater harvesting.			
Adaptation Programme 4: 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. Integrated drought management plan developed.	Medium	Conduct a water resource assessment, develop a drought management plan and develop and implement water conservation strategies.	Implement	Implement	Medium
Investigating alternative water resources	Drought	Water and Sanitation	Year 0-2: Completion of feasibility studies Year 3-5: Pilot project implemented.	Medium	Year 0-2: Conduct a feasibility study to identify alternate water sources, and undertake hydrological assessments to determine water availability and potential yield of alternative water sources. Year 3-5: Implement	Implement alternative water sources.	Maintain.	High

Investing in alternative water resources	Drought	Water and Sanitation	Year 3 – 5: Pilot Projects Year 6 – 10: Scaling	High	Pilot projects.	Implement	Implement	
Develop and Implement a Treated Effluent Reuse Strategy For Sustainable Water Management.	Drought	Water and Sanitation	Year 0-2: Develop Strategy and Resources. Year 3 – 5: Implement	Medium	Developing a comprehensive treated effluent reuse plan, including infrastructure and system requirements, stakeholder engagement, and potential risks and mitigation strategies.	Implement	Implement	
Adaptation Programme 5: Implementing Sustainable Groundwater Use and Development Strategy								
Conducting Groundwater Resource Assessments to Establish the Availability and Quality of Groundwater in the DM area.	Drought	Water and Sanitation	Year 0-2: Completion of a 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 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 Programmes to Monitor Water Levels, Water Quality, and Potential Pollution Sources, Enabling Early Detection of Potential Problems and Timely Intervention.	Drought	Water and Sanitation	Year 0 – 2: Establish partnerships with irrigation boards and large water users.	Medium	Establish Partnerships	Install and maintain a network of groundwater monitoring wells and equipment to collect data on groundwater levels, water quality, and potential pollution sources.		High
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 speres 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 Enhance Aquifer Recharge Rates and Improve Groundwater Storage Capacity.	Drought	Water and Sanitation	Year 0-2: Feasibility and recharge sites established. Year 3-5: Recharge	Medium	Conduct studies to identify suitable sites for groundwater recharge, including areas with high	Implement	Maintain	Medium

			infrastructure established		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/ Planning and Economic Development	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 a system.	Low	Develop and update a database and web-based portal for storing and accessing groundwater data, including water levels, quality, and other relevant information.			
Climate Change Goal: Ecosystem Conservation.								
Programme 6: Conserve, Protect and Restore Natural Open Spaces, Ecosystems and Natural Resources.								
Assessing natural resources and ensuring that natural open spaces, ecosystems, and resources are conserved, protected and restored.	Flooding/Drought / Wildfires	Environmental Management	Year 0-2: Identify high ecological value areas	Medium	Develop conservation plans and management strategies for high	Integrate into SDF	Review.	Medium

			Year 3 – 5: Integrate into SDF on review.		conservation 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 project.	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 Ecosystem Based Adaptation Plan. Year 3-5: Resource Plan and Implement	Medium	EBA Plan	Implement	Implement	High
Adaptation Programme 7: Enhanced Natural Resource Management								
Ensuring the quality of water resources.	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, in water bodies.	Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals, in water bodies.	Conducting regular water quality monitoring to track the levels of various pollutants, including pathogens, nutrients, and chemicals, in water bodies.	High
Monitoring and preventing soil erosion is crucial to ensure the long-term health and productivity of natural ecosystems, as well as to maintain the	Flooding	Environmental Health	Year 0-2: Erosion Risk Assessment Year 3-5: Develop and implement	Medium	Conduct a soil erosion risk assessment on municipal land.	Implement control plans for high priority areas.	Review and maintain.	High

quality of water resources.			erosion control plans for high-risk areas.					
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 Municipal Environmental Management Forum (MEMF) to enhance collaboration and coordination between Sectoral Departments, Conversation Organisation and agencies related to natural resource management.	Flooding/ Drought/ Fire/ Heat Stress	Environmental Management	Year 0-2: Establish forum with terms of reference	Low	Conduct regular meetings. Track progress and performance.	Conduct regular meetings. Track progress and performance. Review Terms of Reference.	Conduct regular meetings. Track progress and performance. Review Terms of Reference.	Medium
Adaptation Programme 8: Integration of Ecological Support Areas and Ecosystem Services into SDFs.								
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	Low	Integrate critical biodiversity and ecological support areas into the municipal spatial plans.	Implement municipal spatial plans.	Implement municipal spatial plans.	High

			Year					
Identifying and mapping natural open spaces, ecosystems, and natural resources, and integrating inventories in the Spatial Development Framework and the open space framework.	Drought/ Flooding/ Heat Stress	Environmental Management	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 space framework.	Integrate and implement the mapped inventory information from the SDF.	Monitor.	High
Identifying undeveloped open space with potential for green infrastructure.	Flooding	Environmental Management	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 9: Develop and Implement Conservation and Management Plan For Vulnerable Species								
Develop and implement a conservation and management plan for vulnerable species	Environment		0-2 years: Conduct a thorough assessment of vulnerable and endangered species within the municipality; Provide	Low-High	Conduct a thorough assessment of vulnerable and endangered species within the municipality; Provide education and	Identify and prioritize species; Develop initial conservation and management plans.	Fully implement conservation and management plans; Regular review and update of plans; Build partnerships	Low-High

			education and outreach to raise awareness. 3-5 years: Identify and prioritize species; Develop initial conservation and management plans. 6-10 years: Fully implement conservation and management plans; Regular review and update of plans; Build partnerships for long-term sustainability.		outreach to raise awareness.		for long-term sustainability.	
Climate Change Goal 3: To Increase Resilience of the Agricultural Sector to More Extreme Events such as Drought and Storms as well as Indirect Risks such as Pests and Diseases.								
Adaptation Programme 10: Water Management and Conservation Strategy								
Develop and Implement Efficient Irrigation Methods	All risks		0-2 years: Conduct a region-wide survey to assess current irrigation practices; Establish guidelines and best practices		0-2 years: Conduct a region-wide survey to assess current irrigation practices; Establish guidelines and best practices	3-5 years: Develop a grant or subsidy program to assist farmers with installing and maintaining more efficient irrigation systems; Begin	6-10 years: Continue monitoring and providing feedback for improvements; Assess the overall impact of the initiative on water	Medium

			for efficient irrigation; Organize training workshops for farmers. 3-5 years: Develop a grant or subsidy program to assist farmers with installing and maintaining more efficient irrigation systems; Begin implementing a monitoring system. 6-10 years: Continue monitoring and providing feedback for improvements; Assess the overall impact of the initiative on water conservation and adjust strategies as necessary.		for efficient irrigation; Organize training workshops for farmers.	implementing a monitoring system.	conservation and adjust strategies as necessary.	
Promote Rainwater Harvesting and Storage	All hazards		0-2 years: Develop an educational	Medium	0-2 years: Develop an educational	3-5 years: Begin offering financial	6-10 years: Continue to promote,	Medium

			campaign; Provide technical guidance on designing and installing systems; Establish regulations. 3-5 years: Begin offering financial incentives; Initiate partnerships with local construction firms. 6-10 years: Continue to promote, support, and regulate rainwater harvesting; Evaluate program effectiveness and make necessary adjustments.		campaign; Provide technical guidance on designing and installing systems; Establish regulations.	incentives; Initiate partnerships with local construction firms.	support, and regulate rainwater harvesting; Evaluate program effectiveness and make necessary adjustments.	
Enhance Soil Management Practices to Optimize Water Retention	Drought, Flooding, Environmental Health		Immediate implementation with ongoing activities; soil testing and	Medium to High	Majority of farmers trained and adopting new practices	all farmers with access to soil testing services and participating in		High

			monitoring programs fully operational within 3-5 years		within the first 2 years,	the monitoring program within 5 years		
Adaptation 11: Drought and Extreme Weather Resilience Programme								
Diversify Crop and Livestock Systems	Drought, Heat Stress, Environmental Health.			High	Completion of research within the first 2 years, and	Majority of farmers educated and adopting diversification practices within 5 years,	Noticeable increase in farm productivity and resilience within 10 years.	High
Develop Infrastructure Resilience to Withstand Extreme Weather	Flooding, Heat Stress, Wildfires, Drought.		Infrastructure assessment and guidelines development in the first 2 years, training workshops and financial assistance program in years 3-5, and ongoing monitoring system setup and adjustments from years 6-10.	Medium to High	Complete assessment of all agricultural infrastructure in 2 years,	Training of farmers and local construction firms by year 5,	Majority of vulnerable infrastructure upgraded in 10 years.	High
Improve Early Warning Systems for Extreme Weather Events	Flooding, Heat Stress, Wildfires, Drought.		Collaboration and creation of the warning system and communication network within the first 2 years, training	Medium	Establishment of early warning system and communication network by year 2,.	full training of farmers by year 5,	continuous improvement of the system's effectiveness throughout the 10-year period	High

			sessions throughout years 3-5, and continuous monitoring and improvement of the system from years 6-10.					
Adaptation Programme 12: Integrated Pest and Disease Management Programme								
Enhance Pest and Disease Monitoring Systems	Environment Health		Monitoring network development and collaboration with research institutions in the first 2 years, establishment of reporting and notification systems and farmer training in years 3-5, continuous monitoring, improvement, and training throughout years 6-10.	High	Functional monitoring network and collaboration with institutions by year 2, ,	fully trained farmers and functioning reporting and notification systems by year 5	continuous updates and improvements throughout the 10-year period.	High
Foster Use of Integrated Pest Management (IPM) Strategies	Environment health		Development and dissemination of IPM guidelines, organization of workshops and training sessions in the	Medium	Completion of guidelines and initial trainings by year 2,	fully functional demonstration farms and implementation of incentives by year 5,	continuous refinement and training throughout the 10-year period.	High

			first 2 years, establishment of demonstration farms and offering of incentives in years 3-5, continuous updates, refinement, and training throughout years 6-10.					
Research Changing Pest and Disease Trends in Response to Climate Change	Environment Health		Collaboration with institutions and initial research in the first 2 years, development of predictive models and communication of initial findings in years 3-5, continuous integration of findings into IPM strategies and contingency plans throughout years 6-10.	High	Establishment of collaborations and completion of initial research by year 2, ,	functional predictive models and communication strategy by year 5	continuous integration of new research into existing strategies and the development of robust contingency plans by year 10.	High
Climate Change Goal 4: To Reduce The Vulnerability and Exposure of Human and Natural Systems to Climate Change and Extreme Events.								
Adaptation Programme 13: Integrated Fire Management for Climate Resilience								
Comprehensive Evaluation of Fire Hazards	Fire	Disaster Management	Year 0-2:	Low	Hazard identification			High

			Hazard identification and risk mapping		and risk mapping			
Fire Prevention Roadmap	Fire	Disaster Management	Year 0-2: Identify firebreaks, develop community fire plans and install fire detection systems. Year 3-5: Implement	Medium	Identify firebreaks, develop community fire plans and install fire detection systems.	Implement	Implement	High
Community Engagement and Fire Safety Education	Fire	Disaster Management	Year 0-2: Hold community workshops and seminars and distribute educational materials.	Low	Hold community workshops and seminars and distribute educational materials.	Hold community workshops and seminars and distribute educational materials.	Hold community workshops and seminars and distribute educational materials.	
Advancing Fire Detection and Monitoring Infrastructure	Fire	Disaster Management	0-2 years: Assess infrastructure required for advanced fire detection and monitoring.	Medium	Assess infrastructure required for advanced fire detection and monitoring.	Install infrastructure.	Maintain	
Emergency Preparedness and Response Strategy	Fire	Disaster Management	0-2 years: Develop an emergency response plan.	Medium	Develop an emergency response plan.	Implement	Implement	
Post-fire Restoration and Ecosystem Rehabilitation	Fire	Disaster Management	0-2 years: Damage assessment and implementation of restoration	Medium	Damage assessment and implementation of restoration measures	Damage assessment and implementation of restoration measures	Damage assessment and implementation of restoration	

			measures including erosion control, revegetation and wildlife management		including erosion control, revegetation and wildlife management	including erosion control, revegetation and wildlife management	measures including erosion control, revegetation and wildlife management	
Policy and By-law Development	Fire	Disaster Management						
Adaptation Programme 14: 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 change impacts.	All	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 change.	Develop and implement climate-resilient infrastructure.	Implement and maintain.	Medium
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.	
Developing and implementing land use planning and zoning regulations that take into	All	Urban Planning	Year 0-2: Develop land use and zoning regulations	Medium	Developing land use and zoning regulations to ensure that	Implement land use and zoning regulations	Implement	

account the potential impacts of climate change.			Year 3-5: Implement		settlements are built in safe and sustainable locations.			
Programme 15: 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	
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.	
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 adaptation strategies.	Design, implement and monitor adaptation measures.	Implement and monitor adaptation measures.	
Comprehensive Community Engagement	All	Environmental Management	Year 0-2: Climate change	Low	Raise climate change	Implement training and	Continue awareness	

and Public Awareness Initiative on Climate Change.			awareness raising. Year 3-5: Implement training and education programmes		awareness for communities.	education programmes for community members.	raising, developing partnerships and capacity building.	
Adaptation Programme 16: 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.	
Resilient urban and township design and development to minimise the risk and impact of climate change on urban areas.	All	Urban Planning	Year 0-2: Develop guidelines. Year 3-5: Implement guidelines.	Medium	Developing guidelines in collaboration with reliant government departments, for innovative urban and township design that take into account climate change risks.	Implement guidelines.	Implement guidelines.	
To identify climate risk zones and hotspots that affect vulnerable municipal infrastructure and assets.	All	Urban Planning	Year 0-2: Develop strategies to manage risks and protect infrastructure and assets from climate change impacts. 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.	

5.1. Enabling Mechanisms for Implementation

5.1.1. Institutional Arrangements

For Cape Winelands District Municipality (CWDM), formulating a Climate Change Response Strategy is a substantial stride towards mitigating the impacts of climate change. The success of this strategy rests upon the seamless coordination of institutional arrangements within the municipality. Aligning such efforts is crucial at the local level and it's equally important to echo national climate change initiatives, echoing South Africa's pledge to combat climate change under the Paris Agreement and the United Nations Framework Convention on Climate Change.

To kick off, the municipality should contemplate carrying out an exhaustive evaluation of the Climate Change Response Strategy, pinpointing specific climate mitigation measures for execution. These actions should be in harmony with the aims outlined in South Africa's National Climate Change Response Policy (NCCRP) and the National Development Plan (2012), documents that envisage a climate-resilient, low-carbon society. Reflecting these national strategies, CWDM initiated its Climate Change Response Plan. This plan, focusing on sectors such as Agriculture, Biodiversity, Environment, Human Health, Human Settlement, and Water, embodies a comprehensive vulnerability risk assessment, expressing the municipality's dedication to its residents and the environment.
With the definite identification of climate actions, the municipality can delegate roles and responsibilities to the relevant departments, harnessing their particular expertise, resources, and capacities. This assignment should factor in not only the lead role but also the supporting roles other departments can fulfil. Conversations with departmental heads can confirm agreement on these roles, shed light on possible challenges, and provide wisdom on effective tactics. These roles and responsibilities should be registered in the Climate Change Response Strategy, ensuring transparency for stakeholders and promoting a joint effort towards the strategic objectives.

Furthermore, meshing the Climate Change Response Strategy with the specific plans and policies of each department is crucial. For example, the Integrated Development Plan, Spatial Development Framework, and Local Economic Development Strategy of the Department of Economic Development and Strategic Services could integrate specific targets and actions related to climate change. In summary, ideal institutional arrangements for addressing climate change in CWDM require a clear distribution of duties across departments and alignment of the Climate Change Response Strategy with each department's individual plans and policies. This harmonious collaboration of efforts allows for a thorough and integrated approach to climate change mitigation, consistent tracking and reporting of progress, and ensures the District's alignment with the broader national climate change response vision.

5.1.2. Governance Considerations

In the framework of CWDM, it is suggested that every department within the municipality be delegated clear responsibilities concerning climate change. These responsibilities should be paired with key performance indicators (KPIs) that supervise and assess progress towards defined climate goals. This can be achieved by aligning existing plans and strategies with climate change targets and subsequently tracking progress towards these targets using dedicated KPIs.

The Department of Economic Development and Strategic Services could match their critical plans—such as the Integrated Development Plan (IDP), Spatial Development Framework, and Local Economic Development Strategy—with climate change goals. This alignment can act as a powerful catalyst in guiding the region towards a climate-resilient future. Furthermore, the department can establish and monitor KPIs tailored to these climate change objectives. These KPIs could span a range of parameters, from measuring the number of local businesses adopting sustainable practices to tracking the volume of renewable energy harnessed within the municipality.

The municipality should be prepared to face and manage natural disasters—such as floods and wildfires—that are expected to increase in frequency and severity due to climate change. By merging climate change objectives with existing plans and strategies, and monitoring progress through KPIs, municipalities can ensure that climate change responses are integrated into all aspects of municipal operations.

This comprehensive integration will serve as a solid guarantee of the municipality's progression towards a sustainable future. It will also confirm the municipality's readiness to navigate the challenges and impacts linked with climate change, thereby protecting its communities and natural resources.

5.1.3. Information Management

Building a culture that prioritizes risk mitigation is a key aspect of the effective implementation of the climate change response plan within the CWDM. This requires empowering all stakeholders—including officials, policymakers, and residents—through holistic education, extensive training, and strong public awareness campaigns, all supported by scientific research. This strategic approach will deepen the understanding of the consequences of climate change and the necessary responses, fostering a shared sense of responsibility and stewardship among all stakeholders.

To achieve this goal, CWDM could undertake the following measures: ▪

- Firstly, the municipality can develop and carry out a comprehensive educational and training programme focused on climate change and its effects on the municipality. Targeting officials, policymakers, and residents will ensure a universally accepted understanding of climate change and underscore the urgency of responsive action. ▪
- Secondly, the Municipality can leverage scientific research and data to guide the creation of educational and training content, making sure that stakeholders are informed with the most precise and up-to-date information. This can also help identify key risk areas and zones requiring immediate action. ▪
- Thirdly, CWDM can organise public awareness initiatives centered around climate change and its impacts. These initiatives could be communicated through various mediums, including social media, community workshops, and public gatherings. These campaigns aim to heighten public understanding of climate change, stress the need for action, and provide practical guidance on individual steps to mitigate the impact. ▪
- Fourthly, the municipality can foster active participation in climate change mitigation and adaptation efforts by residents, civil society organisations, and the private sector. This could involve providing platforms for engagement and collaboration, forming partnerships with relevant stakeholders to develop and implement shared initiatives, and offering resources and support to individuals and organisations that are proactively responding to climate change.

Lastly, CWDM can foster partnerships with academic institutions and research organisations to ensure sustained access to the latest research and expertise in the field of climate change. This will ensure that the municipality stays informed about the most recent developments in the field and can utilize the latest knowledge and tools to inform its decision-making and strategies.
By promoting a culture of risk mitigation and equipping all stakeholders, CWDM can create an environment conducive for the successful implementation of the climate change response plan, ultimately contributing to the building of a more resilient and sustainable municipality. This will require sustained commitment and effort, as well as continuous engagement with stakeholders to ensure their needs and perspectives are considered in climate change policies and initiatives.

5.1.4. Funding Mechanisms

Climate change poses an escalating challenge for local municipalities in South Africa, necessitating substantial funding allocations to mount an effective response. Several funding mechanisms are available to propel these climate change response initiatives, ranging from national and international grants to public-private partnerships and municipal budgets. Nonetheless, municipalities might grapple with issues such as insufficient funding, capacity constraints for effective fund management, and limited access to funding resources.

One such mechanism is the Municipal Infrastructure Grant (MIG), offering fiscal support to municipalities for the development of fundamental infrastructure, including water, sanitation, and solid waste management. The MIG can also be utilized to fund climate change response projects tethered to these infrastructure needs. However, the MIG's limited scope could present challenges for municipalities striving to finance all necessary climate change initiatives solely via this conduit.

An alternate source of funding available to municipalities is the Green Fund, a national financial mechanism proffering financing for environmentally responsible initiatives. Projects aligned with renewable energy, energy efficiency, climate change adaptation, and mitigation can tap into the Green Fund. Yet, the fund's finite resources and substantial competition from other municipalities and organizations make it a challenging source to access.

Municipalities can also seek funding from international entities such as the Global Environment Facility (GEF) and the Green Climate Fund (GCF). These institutions extend financing to climate change response programmes in developing nations. However, satisfying the stringent eligibility criteria to access these funds can be demanding for municipalities. Public-Private Partnerships (PPPs) offer an additional route to financing climate change response initiatives. These partnerships represent collaborative efforts between the public and private sectors to fund and execute infrastructure projects. PPPs can furnish municipalities with alternative funding sources and the advantage of private sector expertise in project management and implementation. Nevertheless, municipalities must ensure equitable terms within the partnership and a shared commitment towards the project's objectives.

Municipalities may confront several challenges in sourcing funding for climate change response initiatives. The lack of in-house technical expertise to develop and implement climate change projects can be a formidable barrier to accessing funds from entities like the Green Fund, which typically demand comprehensive project proposals and technical competence.

Furthermore, the limited resources earmarked for climate change response in municipalities already experiencing financial constraints can pose a significant challenge. In many South African municipalities, financing climate change response initiatives might be deprioritized against other basic service delivery needs, making resource allocation to climate change response programs challenging.

To surmount these hurdles, municipalities should emphasize building internal technical capacities and forging partnerships with private sector organizations to unlock additional funding sources. Municipalities should also explore novel financing mechanisms, such as green bonds and crowdfunding, which have proven successful in other jurisdictions.

In conclusion, while funding mechanisms exist for South African local municipalities to finance climate change response initiatives, municipalities must navigate a complex labyrinth of funding sources and ensure they possess the technical proficiency and capacity to develop and implement successful projects. By investigating innovative financing mechanisms and building partnerships with private sector organizations, municipalities can marshal the resources required to create more resilient and sustainable communities.

5.2. Recommendations for mainstreaming

Mainstreaming climate adaptation within the CWDM necessitates a multifaceted approach that considers the current institutional structures, processes, and instruments within the district. The aim should be to integrate climate-responsive strategies into all aspects of the municipality's work, thereby transforming it from an isolated concern into a standard operational consideration.

1. Opportunities for mainstreaming: There are several opportunities for mainstreaming within CWDM. The District Development Model (DDM), for instance, offers an integrated platform for planning and delivery across different governmental spheres, thereby providing an excellent base for embedding climate adaptation into existing strategies. The DDM's joint "One Plan" approach can be tailored to include climate adaptation considerations.
2. Leveraging existing decision-making structures: Existing decision-making structures, such as the Project Management Unit (PMU), can be instrumental in driving climate adaptation. The PMU's framework for assessing and approving projects could be revised to incorporate climate responsiveness/adaptation/sustainability, thereby ensuring all new initiatives are climate-friendly.
3. Targeting planning instruments for mainstreaming: Key planning instruments like the Integrated Development Plan (IDP), Spatial Development Frameworks, and Local Economic Development Strategy could be utilized for mainstreaming climate adaptation. These documents can be updated to include climate evidence and adaptation actions.

Here are some specific mainstreaming recommendations:

- Key performance indicators (KPIs): All departments should include climate response/adaptation/sustainability outcomes in their KPIs, enabling progress towards climate goals to be tracked and measured.
- Raising awareness: Conducting awareness training with entities such as the Project Management Unit, Strategic Procurement, Councillors, and other relevant groups can facilitate mainstreaming. By enhancing their understanding of climate change and the need for adaptation, these groups can integrate climate considerations more effectively into their operations.
- Policy and plan updates: Existing policies and plans should be revised to incorporate the climate risk profile and adaptation actions. This may involve integrating climate change considerations into land use plans, infrastructure development strategies, and emergency management plans.
- Funding: CWDM should investigate existing and new revenue streams to support climate adaptation/response initiatives. This may include applying for grants from government agencies, engaging in public-private partnerships, and integrating climate adaptation into budget planning processes.

- Capacity-building: Ongoing training and capacity building of officials across all departments is essential to enhance their understanding of climate change and their ability to incorporate climate considerations into their roles.
- Establishing networks or partnerships: CWDM should consider establishing networks or partnerships with civil society organisations, the private sector, the government, and other relevant entities to strengthen climate adaptation efforts.

At the heart of these strategies is the DDM, which can act as the backbone of these efforts. Adopting a "*One District, One Plan, One Budget*" approach, CWDM can ensure all development initiatives within 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 seamlessly with the goal of mainstreaming climate adaptation.
In conclusion, mainstreaming climate adaptation in CWDM calls for a comprehensive, integrated approach that leverages existing structures and processes, builds capacity, and involves all stakeholders. By taking these steps, CWDM can ensure a more sustainable and resilient future for its residents and the environment.

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