MOPANI DISTRICT
MUNICIPALITY

Climate Change Response Strategy

January 2025

To be the food basket of Southern Africa and the tourism destination of choice

EXECUTIVE SUMMARY

The Mopani District Municipality (MDM) Climate Change Response Strategy establishes a structured and proactive approach to address the growing challenges posed by climate change. MDM encompasses diverse geographic and economic landscapes that are increasingly vulnerable to climate-related risks. This strategy presents a comprehensive blueprint for resilience, integrating both adaptation and mitigation measures to promote sustainable development, protect natural resources, and enhance the quality of life for its residents.

The Mopani District Municipality is home to about 1.3 million residents, with a significant portion living in rural areas. The district faces a range of climatic challenges (IPCC, 2022), including extreme weather events, rising temperatures, irregular rainfall, and prolonged droughts., including extreme weather events, rising temperatures, irregular rainfall, and prolonged droughts. These factors exacerbate existing socio-economic vulnerabilities, threaten critical infrastructure, and endanger key sectors such as agriculture, mining, and tourism. In alignment with the National Environmental Management: Climate Change Act (Act No. 22 of 2024) (“Climate Change Act”) and the Local Government: Municipal Systems Act, this strategy fulfills the mandate for municipalities to assess climate risks, establish greenhouse gas inventories, and integrate climate response plans into their Integrated Development Plans (IDPs).

The climate risk profile of MDM underscores the following critical vulnerabilities which require urgent attention (CSIR, 2019):

- ***Increasing Temperatures:*** Projected average annual temperature increases of 2.2–2.5°C by 2050 (IPCC, 2022), leading to more frequent and intense heatwaves.
- ***Irregular Rainfall:*** Spatial variability in rainfall, with potential decreases in some areas and increases in others, heightening the risks of droughts and floods.
- ***Wildfire Risks:*** Greater wildfire likelihood, particularly in the wildland-urban interfaces of Phalaborwa and Hoedspruit.
- ***Flooding Hazards:*** Increased extreme rainfall events, especially in areas such as Tzaneen, Ba-Phalaborwa, and Hoedspruit, with implications for infrastructure and communities.

The socio-economic and environmental vulnerability indices indicate high levels of risk, particularly in rural settlements that lack access to essential services and robust infrastructure. These vulnerabilities are intensified by population growth, resource constraints, and economic disparities.

Mopani District Municipality aspires to become a sustainable, resilient, and low-carbon municipality by 2050. The strategy emphasizes dual objectives of adaptation (building resilience to climate impacts) and mitigation (reducing greenhouse gas emissions). The overarching vision is:

"To create a sustainable, equitable, and climate-resilient district that integrates mitigation and adaptation strategies into all development planning, prioritizes the conservation of natural resources, and fosters partnerships with communities and stakeholders for long-term resilience."

To achieve this vision, the strategy outlines the key objectives below:

- Enhance water security and conservation under changing climatic conditions.
- Protect biodiversity and promote the sustainable use of natural resources.
- Strengthen agricultural resilience to extreme weather events and climate-related risks.
- Improve the adaptive capacity of human settlements, particularly for vulnerable populations.
- Reduce greenhouse gas emissions through energy efficiency, renewable energy adoption, and sustainable practices across sectors.

Adaptation Goals and Programmes

The strategy prioritizes adaptation as a means to safeguard livelihoods and infrastructure against climate impacts. Four core adaptation goals are identified:

1. ***Water Security***
   - Develop comprehensive water resource management plans, incorporating groundwater usage, rainwater harvesting, and wastewater reuse.
   - Implement water conservation and demand management programmes to optimize resource efficiency.
   - Explore alternative water sources and improve infrastructure to withstand drought cycles.
2. ***Biodiversity and Ecosystem Protection***
   - Restore and conserve critical ecosystems such as wetlands and riparian areas to enhance biodiversity and natural flood defenses.
   - Integrate biodiversity considerations into spatial development frameworks and urban planning.
3. ***Agricultural Resilience***
   - Promote sustainable agricultural practices, such as climate-smart farming, drought-tolerant crops, and agroforestry.
   - Enhance support systems for farmers, including early warning systems for pests and extreme weather events.
4. ***Resilient Human Settlements***
   - Upgrade infrastructure in informal settlements to withstand extreme weather conditions.
   - Implement community-based adaptation measures, including education and early warning systems for climate-related hazards.

Mitigation Strategies

To reduce greenhouse gas emissions, the strategy identifies the following priority areas (WRI, 2014):

- ***Energy Sector****:* Promote renewable energy sources, energy-efficient buildings, and the adoption of clean technologies.
- ***Transport****:* Develop sustainable transport systems, including non-motorized transport and low-emission public transport options.
- ***Waste Management****:* Strengthen recycling programmes and waste-to-energy initiatives to minimize landfill emissions.

- ***Agriculture****:* Enhance soil carbon sequestration and reduce emissions from livestock through improved management practices.
- ***Forestry and Ecosystems****:* Implement afforestation and reforestation projects to serve as carbon sinks.

The Greenhouse Gas Inventory for 2020 (LEDET, 2022) indicates that energy (86%) and waste (12%) are the primary sources of emissions, highlighting the need for targeted interventions in these sectors.

Implementation Framework and Enabling Mechanisms

Effective implementation of the strategy relies on:

- **Institutional Arrangements**: Optimising the institutional arrangements within Mopani DM for implementing and mainstreaming climate change.
- **Funding Mechanisms**: Securing financial resources through public-private partnerships, international climate funds, and innovative revenue streams.
- **Stakeholder Engagement**: Promoting collaboration among government agencies, private sector actors, civil society, and local communities.
- **Monitoring and Reporting**: Developing robust metrics to track progress, ensure accountability, and adapt strategies as needed.
- **Capacity Building**: Investing in training and knowledge-sharing to empower municipal staff and stakeholders.

The Mopani District Municipality Climate Change Response Strategy represents a pivotal step toward sustainable and climate-resilient development. By addressing vulnerabilities, leveraging opportunities for mitigation, and fostering community partnerships, MDM aims to build a future that is resilient to climate risks while contributing to global climate goals. The strategy's success hinges on integrated planning, stakeholder collaboration, and sustained commitment from all sectors of society. It is therefore imperative that residents, businesses, and partners collaborate with the Municipality to secure a resilient and prosperous future for the 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
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries & the Environment
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
IRP	Integrated Resource Plan
km	Kilometre
l/p/d	Litres Per Person Per Day
LEDET	Limpopo Department of Economic Development, Environment & Tourism
LM	Local Municipality
MAR	Mean Annual Runoff
MDM	Mopani District Municipality
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

1.1. Background

Mopani District Municipality (MDM) is one of the 5 districts of Limpopo province of South Africa, located in the north-eastern part of the country. It is home to about 1.3 million inhabitants, with the mining and mineral processing sector (including non-metallic mineral and metal products) contributing 35% towards the total GVA of Mopani District (MDM, 2022). Due to the excessive SO_2 emissions in the Ba-Phalaborwa area, the MDM was rated as one of the district municipalities having poor or potentially poor air quality, this was confirmed through the dispersion modelling findings in the Limpopo AQMP (LEDET, 2013). This may have significant impacts on people's health and well-being if the situation remains persistent and not properly managed. It is therefore important that environmental issues are recognised and incorporated into all aspects of decision-making processes in the MDM.

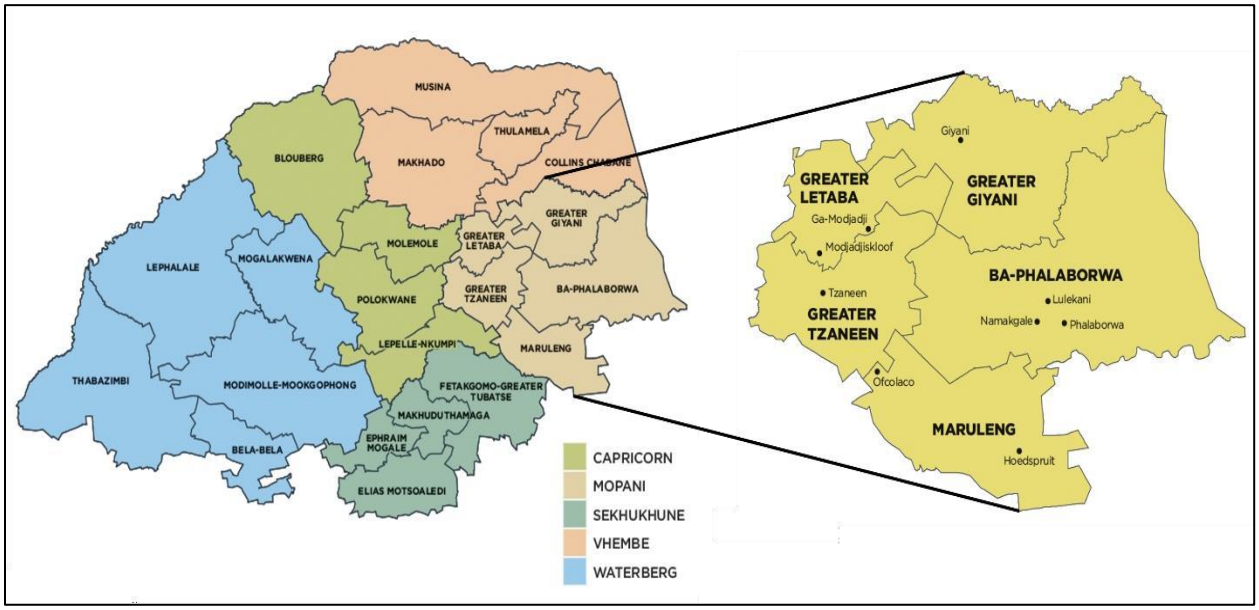

Figure 1: Map depicting the geographical extent of the MDM.

Section 17(1) of the National Environmental Management: Climate Change Act (Act No. 22 of 2024) ("Climate Change Act") (The Presidency, 2024) requires mayors of district municipalities to assess climate change impacts on their areas by conducting a climate change needs and response assessment. This assessment must identify risks, vulnerabilities, and adaptation measures, based on the best available science. In addition to this, municipalities must develop and implement a climate change response plan, incorporating both adaptation and mitigation strategies aligned with local policies, and update it every five years.

A district municipality's climate change response plan must be included as part of the municipality's Integrated Development Plan (IDP), which is adopted according to Section 25 of the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000).

This Climate Change Response Strategy is developed in alignment with the provisions of the Climate Change Act mentioned above. The purpose of the strategy is to:

i. Assess climate change impacts on the Mopani district;
ii. Identify climate change risks and vulnerabilities;
iii. Develop and report the Greenhouse Gas (GHG) inventory for the Municipality;
iv. Conduct a climate change needs and response assessment; and
v. Identify adaptation and mitigation measures based on the vulnerability assessment and greenhouse gas inventory.

This strategy will be incorporated in the IDP of the Municipality for implementation.

1.2. General description of the Mopani District Municipality

1.2.1. Geography and Demographics

The MDM is located within the North-eastern quadrant (Longitudes: 29° 52´E to 31° 52´E and Latitudes: 23° 0´S to 24° 38´S) of the Limpopo Province (South Africa's northernmost province), 70 km and 50 km from Polokwane city. It is bordered in the east by Mozambique, in the north, by Vhembe District Municipality through Thulamela & Makhado municipalities, in the south, by Mpumalanga province through Ehlanzeni District Municipality (Bushbuckridge, ThabaChweu and Greater Tubatse) and, to the west, by Capricorn District Municipality (Molemole, Polokwane & Lepelle-Nkumpi), in the south-west, by Sekhukhune District Municipality (Fetakgomo). The district spans a total area of 20 011 km², inclusive of a portion of the Kruger National Park from Olifants to Tshingwedzi camps or Lepelle to Tshingwedzi rivers.

1.2.2. Topography

The MDM is characterised by mountainous, inaccessible terrain in the western bushveld region, and un-even topography (gentle slopes) in the eastern lowveld region. The mean altitude of the eastern lowveld is about 436 m whilst that of the western bushveld averages 811 m above mean sea level separated by the north-eastern escarpment. On the western end, the highest elevation is higher than 1800 m falling to below 400 m in the river valleys of the eastern end (Figure 2: Topography of the MDM.

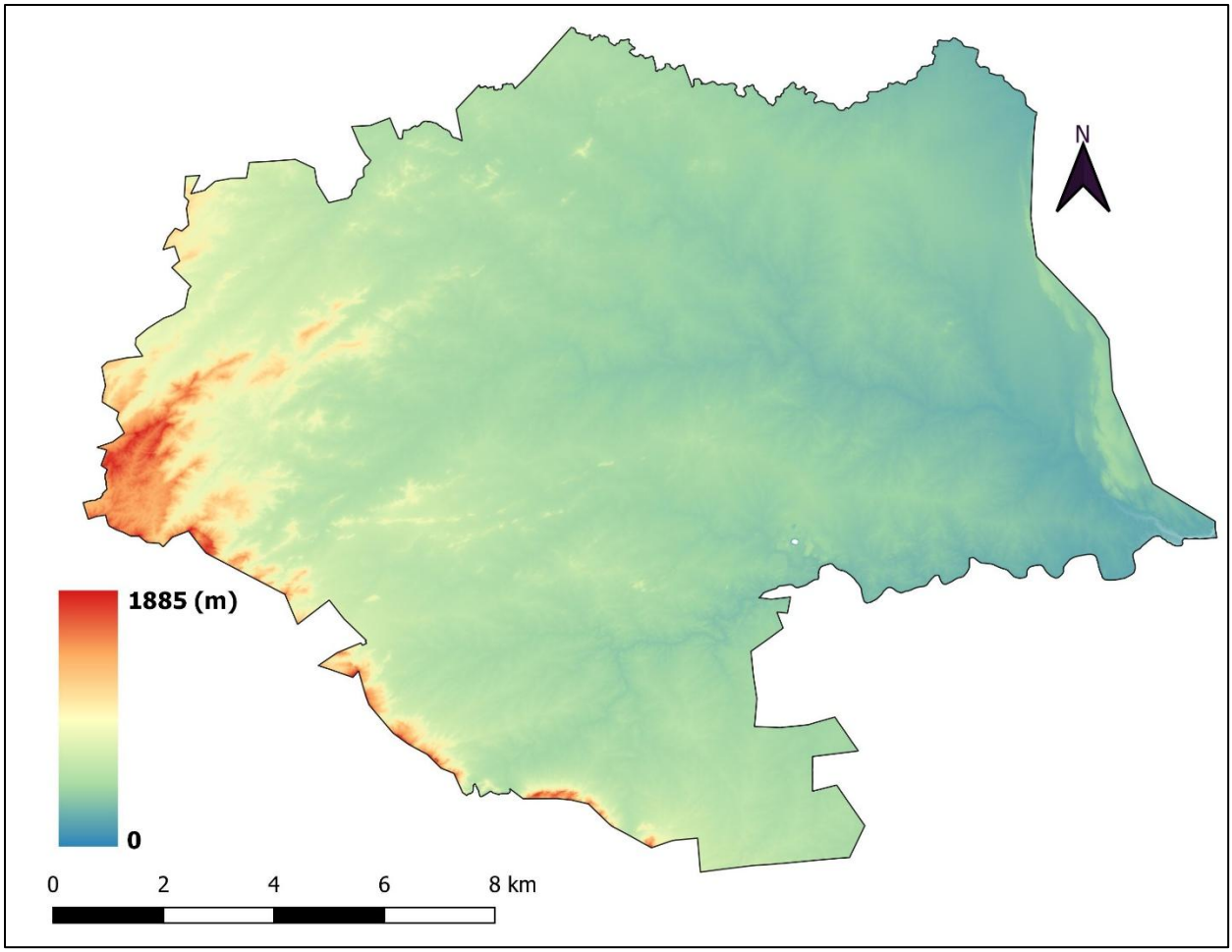

Figure 2: Topography of the MDM.

1.2.3. Land Cover

Forest and cultivated land are the dominant land cover types in the MDM, together, covering over 70% of the total land cover (Figure 3: Landcover map of the MDM
). Most of the cultivated land and residential areas are located in the western half of the district. Grassland land covers a significant portion of the landcover in the north-eastern portion of the MDM. There is a heavy presence of mines and quarries in the Ba-Phalaborwa region. (Mopani District Municipality, 2023)

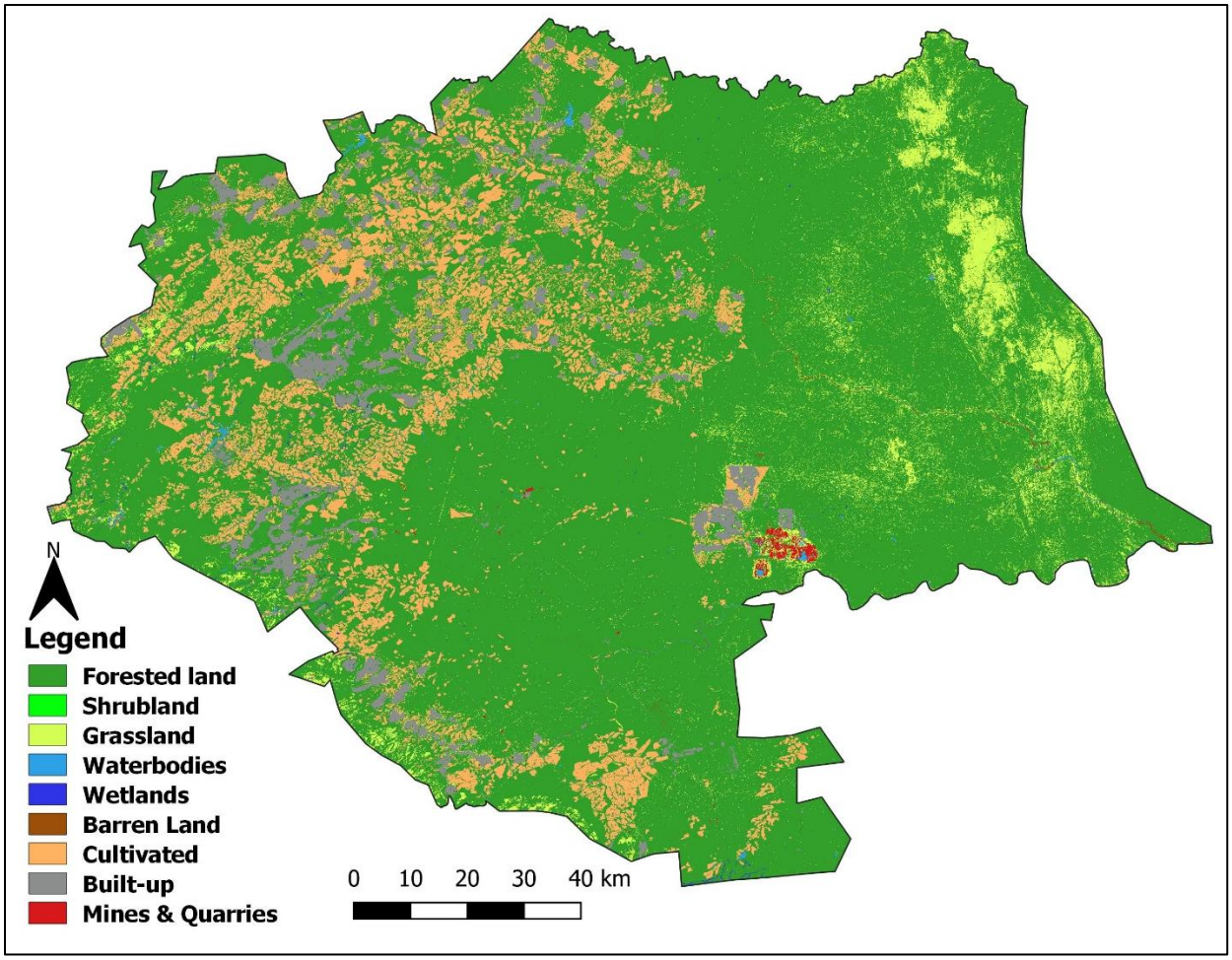

Figure 3: Landcover map of the MDM

1.2.4. Population Distribution

Mopani district has 16 urban areas (towns and townships), 354 villages (rural settlements) and a total of 129 Wards. The reconciled total population of the MDM has increased from 1 159 185 (Census 2016) to 1 372 873 (Census 2022), an 18%% growth over six years (MDM, 2024). Out of the entire district population, 81% reside in rural areas, 14% in urban areas and 5% stay on farms. The population densities vary from one municipality to another, but the average is 23 people/ ha. Indicating that people are sparsely populated with sufficient land around them. However, there is a problem of land shortage for economic development due to the vast land occupied for dwelling purposes, leaving much little for economic growth areas (MDM, 2022).

Table 1 MDM Local Municipalities and the respective populations in each local municipality (MDM, 2024).

Local and District Municipalities	Community Survey 2022 Population
Greater Giyani	316 841
Greater Letaba	261 038
Greater Tzaneen	478 254
Ba-Phalaborwa	188 602
Maruleng	128 137
Mopani	**1 372 873**

1.2.5. Regional Climate and Atmospheric Dispersion Conditions

The MDM has a temperate climate with rainfall predominantly occurring in the summer months (80%) from November to March. On average the MDM receives between 400 mm over the dry Savannah areas and up to 2000 mm of rain per annum over the Great escarpment areas. The temperature ranges from a maximum average of 21°C in the mountainous areas, to 25°C in the dry lowveld areas (MDM, 2022), with north-easterly to south-easterly winds frequently observed (Mopani AQMP, 2015).

2. POLICY CONTEXT

2.1. National Policy Context

South Africa's institutional policy and legislative framework make provision for climate change at all levels of government, with local governments increasingly identified as the primary drivers of both climate change adaptation and mitigation. For instance, there exist various national policy and legislative mechanisms that promote, necessitate, guide, and/or regulate climate change adaptation and mitigation 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 Act (Act 22 of 2024), the 2011 National Climate Change Response White Paper, and 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), climate change adaptation and mitigation, 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 from both anthropogenic and natural threats, including the impacts of climate change. This also includes considering the current and future costs of providing infrastructure and social services in certain areas. Uninformed municipal investments may lead to an increase in the exposure of people and valuable assets to extreme climate hazards. The Climate Change Act sets out requirements for every district intergovernmental forum to serve as a Municipal Forum on climate change that coordinates climate response actions and activities, covering both adaptation and mitigation strategies, in its respective municipality. It also requires every municipality to report on their climate change response needs and draft resultant climate change response assessments and implementation plans.

In 2015, the United Nations' Paris Agreement was signed by the majority of the world's countries, including South Africa. The Paris Agreement outlines how signatories should approach climate change adaptation and commits signatories to reduce their greenhouse gas (GHG) emissions to limit the rise in average global temperature to less than 2°C (ideally below 1.5°C) above pre-industrial levels (UN, 2015). As a signatory to the Paris Agreement, South Africa must submit regular reports, called Nationally Determined Contributions (NDCs), that outline how its GHG emissions will be reduced in response to climate change. These reports include national targets to reduce GHG emissions. Achieving these targets requires the support of all spheres of government, with local governments playing a crucial role in both mitigation and adaptation efforts.

Furthermore, the National Climate Change Response White Paper identifies local governments as critical role players that can contribute towards effective climate change adaptation and mitigation through their various functions, including human settlement planning; urban development; municipal infrastructure and services provision; water and energy demand management; and local disaster response, among others. South Africa has also adopted a National Climate Change Adaptation Strategy (NCCAS), as required by the Paris Agreement. Implementing the NCCAS requires the support of all spheres of government, including municipalities, which are expected to incorporate both adaptation and mitigation strategies into their planning and development processes. The National Climate Change Adaptation Strategy outlines several actions targeted at municipalities, including the development and implementation of adaptation strategies, vulnerability reduction programmes for communities most at risk of the impacts of climate change, the development of municipal early warning systems, and the integration of climate change into municipal integrated development plans (IDPs) and relevant sector plans. In parallel, the strategy emphasizes the importance of promoting low-carbon development pathways, including energy efficiency and renewable energy adoption, as part of municipal climate change mitigation efforts.

In line with South Africa's commitment to climate change mitigation, the Integrated Resource Plan (IRP) plays a pivotal role in shaping the country's energy future. The IRP outlines the country's

energy mix and the transition to a low-carbon economy by emphasizing renewable energy sources, reducing dependence on fossil fuels, and promoting energy efficiency across sectors (DMRE, 2023). This plan aligns with the country's commitments under the Paris Agreement by supporting the reduction of GHG emissions, particularly from the energy sector, which is a significant contributor to South Africa's overall emissions. The IRP sets clear targets for expanding renewable energy capacity and phasing out coal-fired power generation, positioning South Africa to meet its climate mitigation goals and support sustainable economic development.

The table that follows presents a summary of both international and national policy instruments relevant to climate change. 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, 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), the Amended Disaster Management Act, and the Integrated Resource Plan (IRP) are discussed. Each of these policy instruments plays a crucial role in shaping climate change response strategies, establishing frameworks for low-carbon, climate-resilient economies, and ensuring environmental sustainability while promoting socio-economic development.

Table 2: International and national policy context.

International	
United Nations Framework Convention on Climate Change (UNFCCC)	The UNFCCC is the primary multilateral global treaty governing actions to combat climate change through adaptation and mitigation efforts.
International Carbon Action Partnership (ICAP)	The ICAP is an international forum for governments and public authorities that have implemented or are planning to implement carbon trading systems (ETS).
United Nations Sustainable Development Goals (SDGs)	The SDGs are a universal call to action consisting of 17 goals to end poverty, protect the planet and improve the lives and prospects of everyone globally.

Sendai Framework for Disaster Risk Reduction	This framework aims to substantially reduce disaster risk and losses in lives, livelihoods and health in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years.
Nationally Determined Contribution (NDC)	The Paris Agreement requests each Country to outline and communicate their post-2020 climate actions, known as their NDCs. NDCs embody efforts by each Country to reduce national emissions and adapt to the impacts of climate change.
Convention on Biological Diversity	The Convention on Biological Diversity is an international treaty designed to promote biodiversity conservation and ensure the equitable sharing of genetic resources.
Paris Agreement (2015)	A legally binding international treaty under the UNFCCC that commits countries to limit global temperature rise to below 2°C above pre-industrial levels, with an aim to limit it to 1.5°C, promoting both adaptation and mitigation efforts.
Guideline on Mainstreaming Climate Responsiveness and Resilience into Urban Planning	The Guideline provides process-related guidance and recommendations on how to go about integrating climate responsiveness and resilience (CR&R) into planning.
National	
Climate Change Act (2024)	The Climate Change Act is a Specific Environmental Act (SEMA). It 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 Development Plan Chapter 5: "Transition to Low-Carbon Economy"	The NDP aims to eliminate poverty and reduce inequality by 2030. According to the Plan, South Africa can realise these goals by drawing on the energies of its people, growing an inclusive economy, building capabilities, enhancing the state's capacity, and promoting leadership and partnerships throughout society. Chapter 5 of the NDP outlines' ensuring environmental sustainability and an equitable transition to a low-carbon economy.
National Climate Change Response White Paper (2011)	This paper outlines South Africa's strategy to address climate change, focusing on both climate change adaptation and mitigation at the national and local government levels.
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 efficiently manage 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.
Integrated Resource Plan (IRP) 2023	The IRP is a national energy policy that outlines the future energy mix for South Africa, emphasizing renewable energy sources, the phasing out of coal, and aligning the energy sector with national climate change mitigation targets.

Spatial Planning and Land Use Management Act (SPLUMA) (2013)	The SPLUMA requires municipalities to integrate climate change considerations into spatial planning and land use management, ensuring sustainable development and resilience to climate impacts.
Disaster Management Act (2002)	The Disaster Management Act of 2002 provides for an integrated and coordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery, including climate-related disasters.

2.1.1. 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 MDM 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:

i. Robust policies, programmes and actions for climate change adaptation.
ii. Appropriate processes and mechanisms for coordinating climate change adaptation.
iii. Accurate weather forecasting, reliable seasonal predictions, climate projections and effective early warning systems for extreme weather and other climate-related events.
iv. Capacity development, education, and awareness programmes for climate change adaptation.
v. Resources and capacity to deliver climate change adaptation.
vi. Climate change adaptation is fully integrated into development planning.
vii. New technologies/knowledge developed for use in climate change adaptation and other cost-effective opportunities optimized.
viii. Systems, resources, communities, and sectors are less vulnerable to climate change impacts.
ix. Reduction in non-climate pressures and threats to human and natural systems.
x. 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.

2.1.2. National Climate Change Mitigation Strategy

South Africa is committed to contributing to global efforts to mitigate greenhouse gas (GHG) emissions, in alignment with its moral and legal obligations under the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the Paris Agreement, and the Climate Change Act (Act 22 of 2024). As part of its commitment under the Paris Agreement, South Africa has pledged to reduce its GHG emissions to keep the global temperature rise well below 2°C, ideally limiting it to 1.5°C, above pre-industrial levels (UN, 2015).

The country aims to significantly reduce its emissions over the coming decades. The successful achievement of these targets for South Africa's Nationally Determined Contributions (NDCs) depends on the support of developed countries in terms of finance, capacity-building, technology development, and technology transfer to developing nations, as outlined in Article 4.7 of the UNFCCC. With the necessary international support, South Africa plans to peak its GHG emissions by 2025, after which emissions are expected to plateau for approximately a decade and then decline in absolute terms. These efforts are aligned with South Africa's long-term low-emission development strategy, which envisions a transition to a net-zero emissions economy by 2050.

The Climate Change Act (Act 22 of 2024) provides the national legal framework for addressing climate change, ensuring that mitigation efforts are coordinated across all sectors and levels of government. This Act mandates the setting of clear emissions reduction targets, the establishment of carbon budgets, and the formulation of sectoral mitigation plans, which are essential to achieving the targets set by the Paris Agreement.

As indicated in the National Climate Change Response White Paper (NCCRWP), the country's overall mitigation strategy incorporates several key components:

i. **Setting Performance Benchmarks**: The National GHG Emissions Trajectory Range serves as a reference point for measuring the collective results of all mitigation actions. This trajectory is based on projections for emission reductions through to 2050, in line with the Paris Agreement targets. These benchmarks will guide South Africa's progress toward a net-zero emissions future.
ii. **Sectoral Mitigation Contributions**: South Africa has identified sector-specific emission reduction targets. Within two years of the publication of the policy, clear emission reduction outcomes will be defined for each sector and sub-sector, based on an in-depth evaluation of mitigation potential, technological solutions, and the associated costs and benefits. These targets will be cascaded down to individual companies or entities within relevant sectors.

iii. **Carbon Budgets for Key Sectors**: A carbon budget approach has been adopted for major GHG-emitting sectors. Initial carbon budgets will be finalized within two years of the policy's publication, with updates based on monitoring and evaluation results, new scientific evidence, and technological advancements. A mechanism will also be developed to translate these carbon budgets into company-level emission reduction outcomes for significant emitters, starting from the highest emission thresholds.

iv. **Mitigation Plans**: As part of their commitment, companies and economic sectors will be required to prepare and submit mitigation plans that outline their strategies for achieving their emission reduction targets. These plans will include details on how they will contribute to South Africa's long-term climate change mitigation goals.

v. **Diversified Mitigation Approaches**: A mix of mitigation strategies, policies, and actions will be deployed to achieve emission reduction goals while optimizing job creation and sustainable development. These actions will be tailored to the specific needs of each sector, sub-sector, and organization, ensuring that the best solutions are employed based on sectoral characteristics and local conditions.

vi. **Market-Based Approaches**: South Africa will implement economic instruments such as carbon pricing, incentives, and the possible use of emissions offset and trading mechanisms to support emissions reductions. These market-driven mechanisms will help to incentivize the transition to a low-carbon economy.

vii. **Monitoring and Evaluation**: A national Greenhouse Gas Inventory and Monitoring and Evaluation System will be established to collect accurate, up-to-date emissions data. This system will facilitate the tracking of progress towards meeting emission reduction targets and will support the analysis of the effectiveness of mitigation actions. The information gathered will be crucial for reporting under the Paris Agreement and to guide further policy adjustments.

In addition, South Afria's plays a critical role in the country's transition to a low-carbon energy future. The IRP outlines the country's energy mix and the transition from fossil fuels to renewable energy, with an emphasis on reducing carbon emissions from the energy sector, which is the largest emitter in South Africa. The IRP targets a significant increase in renewable energy capacity by 2030, aligning with both national and international climate goals.

These strategies, outlined in the National Climate Change Response White Paper, supported by the Climate Change Act, and guided by the Paris Agreement, will enable South Africa to meet its climate change mitigation objectives and contribute effectively to global climate action. Through these measures, South Africa aims to achieve a net-zero emissions future by 2050, consistent with its long-term climate commitments and sustainable development goals.

2.2. Local Policy Context

As the impacts of climate change are experienced at the local scale, local governments have a responsibility to respond to the climate crisis and to implement measures across all relevant sectors. There are a number of policies in place at the local level that assist with guiding the implementation of climate change and disaster management measures.

The Mopani District has a Climate Change Vulnerability Assessment and Response plan that was developed in 2016 through the Local Government Climate Change Support (LGCCS) program, with support from the Department of Environmental Affairs (DEA) and the Deutsche Gesellschaft für Internationale (GIZ). As outlined in the Climate Change Vulnerability Assessment and Response Plan, Mopani District Municipality acknowledges that climate change poses a threat to the environment, its residents, and future development. Actions are required to reduce carbon emissions (mitigation), and prepare for the changes that are projected to take place (adaptation) in the District.

The outcomes of the vulnerability assessment indicated the following vulnerabilities to be experienced by the District:

- Change in grain production;
- Increased risks to livestock (cattle and pigs);
- Loss of grasslands;
- Increased occupational health problems;
- Loss of industrial productivity;
- Increased isolation of rural communities;
- Decreased income from tourism; and
- Less water is available for irrigation and drinking.

The areas that were noted as imperative to respond to climate change included:

- Agriculture;
- Biodiversity and environment;
- Human health,
- Human settlements; and
- Water.

In addition to the Climate Change Vulnerability Assessment and Response Plan, the Municipality also has the following plans:

- ***Disaster Management Plan:*** The plan has been developed in order to provide key officials, role players and departments in the Mopani District Municipality with a general guideline for the expected initial response to an emergency and an overview of their responsibilities during an emergency or disaster. This plan serves to confirm the arrangements in the Mopani Disaster Management approach to effectively prevent disasters from occurring and to lessen the impact of those hazards that cannot be avoided.
- ***Environmental Management Framework (EMF):*** is being funded for the Letaba and Olifant Catchments area, which also covers MDM. The EMF will provide necessary guidance for environmental considerations in Municipal Planning processes to promote sustainable development that caters the needs for current and future generations in MDM. The DFFE has also deployed an official to provide technical advice on environmental management issues, ensure proper planning and implementation of its EPWP projects funded under its Environmental Protection and Implementation Programme (EPIP).

- ***Air Quality Management Plan (AQMP):*** The AQMP outlines the current state of the air quality of the municipality.This includes ambient air quality information from the monitoring network in the district as well as an emission inventory which covers various emission sources. Furthermore, the plan presents an emission reduction strategy for various emission sources. Implementation of this strategy will contribute greatly to reducing GHG emission and mitigating the effects of climate change.
- ***Integrated Waste Management Plan (IWMP):*** The IWMP outlines the state of waste management in the Municipality. The plan seeks to ensure that there is integrationa dn optimization of general waste in order to maximize efficiency and minimize associated environmental impacts. It discusses the types of waste generated, landfill sites that exist in the Municipality and further presents for proper managmeemnt of waste. The plan forms an integral part in ensuring that GHG emissions from the waste sector is minimized.
- ***Integrated Development Plan (IDP):*** Mopani District Municipality has an IDP which outlines the development plans for the Municipality for a five year period. The plan describes the various services that are rendered by the different directorates of the Municipality and lists proposed projects for the period. Environmental management issues, including climate change, are also covered in the plan. This presents an opportunity for climate change projects to be funded and implemented.

At the provincial level, Limpopo has adopted a number of important policy documents that set out the province's response to climate change. These include:

- The ***Limpopo Provincial Climate Change Response Strategy 2022*** includes adaptation and mitigation strategies for each of the key sectors in Limpopo and documents the GHG emissions data for the province for 2020.
- The ***Limpopo Green Economy Plan (2013)*** focuses on local production, the efficient use of energy and water, and the care of natural and other resources.
- The ***Vulnerability Assessment for Limpopo Province (2015)*** highlights climate change risks and vulnerability within different sectors in the province.
- The ***Limpopo Provincial Air Quality Management Plan (2013)*** looks at the health impacts and monitoring of greenhouse gas emissions in the province and sets air quality management goals.
- The ***Limpopo Environmental Outlook Report (2016)*** provides an overview of projected climate change hazards and impacts.
- The ***Provincial Integrated Waste Management Plan*** *for Limpopo Province: 2020–2025* (2020) identifies climate change mitigation opportunities through proactive waste management.
- The ***Limpopo Development Plan 2015-2019 (2015)*** is the provincial response to South Africa's *National Development Plan.* It commits Limpopo to the National Development Plan's targets including ensuring that the "transition to an environmentally sustainable, climate-change resilient, low-carbon economy and just society will be well under way" by 2030.
- The ***Green Economy Plan*** is being updated for the period 2020 to 2030. A draft has not yet been published for public comment.

2.3. District Municipality Responsibilities

In South Africa, district municipalities play a significant role in both climate change adaptation and mitigation. While the specific powers and functions related to climate change may vary slightly between municipalities, several established responsibilities are typically associated with district municipalities that contribute to the country's overall climate change mitigation and adaptation efforts:

1. **Climate Change Planning:** Section 17 of the Climate Change Act (Act 22 of 2024) mandates district municipalities with the responsibility of developing and implementing climate change response strategies at the local level, which include both adaptation and mitigation. These strategies are required to assess the vulnerability of the district to climate change impacts while also identifying opportunities for reducing greenhouse gas emissions. As part of this, district municipalities must outline mitigation strategies for sectors such as energy, transportation, and waste management, and present a GHG inventory to track emissions reductions. This ensures that climate risks are minimized and local resilience is enhanced while contributing to the national climate change mitigation goals.
2. **Establishing Municipal Forums on Climate Change:** District municipalities are responsible for establishing and coordinating Municipal Forums on Climate Change within their district. According to Section 9 of the Climate Change Act, every district intergovernmental forum, established under section 24 of the Intergovernmental Relations Framework Act, also functions as a Municipal Forum on Climate Change. Sections 25 and 27 of the Intergovernmental Relations Framework Act apply to this Municipal Forum on Climate Change. The Municipal Forum is responsible for coordinating climate change response actions for activities within the operational control of the relevant municipality, in line with the provisions of the Act. It must also report these actions to the relevant Provincial Forum on Climate Change.
3. **Infrastructure Development:** District municipalities play a key role in planning and coordinating the development of infrastructure, ensuring that it is both climate-resilient and aligned with climate change mitigation goals. Infrastructure development must consider future climate risks and incorporate low-carbon technologies. For example, constructing climate-resilient roads, bridges, and drainage systems can not only help communities adapt to extreme weather events but can also reduce the carbon footprint by integrating sustainable materials and energy-efficient designs that support mitigation objectives.
4. **Natural Resource Management:** Effective management of natural resources is a critical part of climate change mitigation and adaptation. District municipalities are responsible for conserving and protecting ecosystems, such as wetlands, and forests, which play vital roles in carbon sequestration and act as natural buffers against climate impacts like flooding and erosion. By promoting the sustainable use of natural resources, municipalities can reduce emissions and enhance climate resilience, supporting both mitigation and adaptation strategies.
5. **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.

6. **Stakeholder Engagement:** District municipalities facilitate stakeholder engagement processes to raise awareness about climate change, engaging local communities, NGOs, businesses, and other stakeholders in decision-making processes. By involving local actors in climate change adaptation and mitigation actions, municipalities can encourage the adoption of low-carbon technologies, promote sustainable agricultural practices, and foster a culture of sustainability. Collaboration with local organizations also helps in implementing mitigation and adaptation projects that are tailored to the specific needs and resources of the district.
7. **Capacity Building and Training:** District municipalities are responsible for building local capacity and providing training on climate change to local government officials, communities, and stakeholders. These training initiatives help enhance the knowledge and skills needed to implement climate-resilient practices, reduce emissions, and adopt sustainable technologies. By building local capacity, municipalities ensure that climate actions are effectively executed and that there is a shared understanding of both adaptation and mitigation needs.
8. **Monitoring and Evaluation:** District municipalities play a key role in monitoring and evaluating the progress of both climate change adaptation and mitigation initiatives. They are tasked with collecting data, measuring key performance indicators, and assessing the effectiveness of implemented strategies in reducing emissions and enhancing resilience. This monitoring process ensures that mitigation actions are on track and that climate change policies at the local level are achieving the desired outcomes, informing future actions and adjustments to the overall climate change framework.

It is important to note that while district municipalities have a range of powers and functions related to climate change, 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. Power and Functions of the District Municipality

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

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

a) Integrated development planning for the district municipality as a whole, including a framework for integrated development plans of all municipalities in the area of the district municipality.
b) Potable water supply systems.

c) Provision of environmental management services mandated by the NEMA and SEMAs (i.e. air quality management, waste management, climate change, biodiversity, etc.).
d) Bulk supply of electricity that affects a significant proportion of municipalities in the district.
e) Domestic waste-water and sewage disposal systems.
f) 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.
g) Municipal health services.
h) Disaster Management services
i) Provision of the water and sanitation services
j) Municipal roads which form an integral part of a road transport system for the area of the district municipality as a whole.
k) Regulation of passenger transport services.
l) Municipal airports serving the area of the district municipality as a whole.
m) 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.
n) The establishment, conduct and control of fresh produce markets and abattoirs serving the area of a major proportion of the municipalities in the district.
o) The establishment, conduct and control of cemeteries and crematoria serving the [district as a whole] area of a major proportion of municipalities in the district.
p) Promotion of local tourism for the area of the district municipality.
q) Municipal public works relating to any of the above functions or any other functions assigned to the district municipality.
r) The receipt, allocation and, if applicable, the distribution of grants made to the district municipality.
s) The imposition and collection of taxes, levies and duties as related to the above functions or as may be assigned to the district municipality in terms of national legislation.

3. CLIMATE CHANGE RESPONSE STRATEGY DEVELOPMENT PROCESS

The Adaptation Plan for this Climate Change Response Strategy, as well as the accompanying Climate Risk Profile report, were developed by the Council for Scientific and Industrial Research (CSIR) specifically for Mopani District Municipality (MDM) 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 district municipalities (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 are guided along a value-chain towards the implementation of climate change response and adaptation plans in municipalities (See Figure 4 below). Thus, in fulfillment 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.

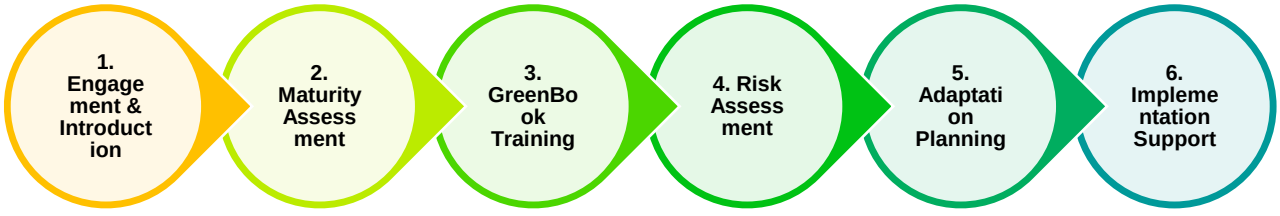

Figure 4: The value-chain towards the implementation of climate change response and adaptation in municipalities

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.

The mitigation plan for the strategy was developed by the MDM, based on the greenhouse gas emission (GHG) inventory which was conducted for the Limpopo Climate Change Response Strategy & Implementation Plan (LEDET, 2022). The GHG inventory informed the proposed mitigation strategies which are based on best practices.

3.1. Municipal Context

The Mopani District's economy is primarily driven by mining and agriculture. Mining, which focuses on copper and phosphate, accounts for 35% of the district's GVA but contributes only 13% to local employment. Agriculture, especially the production of sub-tropical fruits, contributes 4% to GVA and 17% to employment, with Greater Giyani and Greater Tzaneen being key areas for primary agriculture. The tourism sector, centered around Kruger National Park and Gastronomy Route 71, adds further economic value, particularly in areas like Maruleng and Ba-Phalaborwa. Despite its reliance on just a few large firms, the district's economy is bolstered by these key sectors. (MDM, 2024)

In the Mopani district, people are employed across various sectors, including agriculture, industry, mining, trade, government, transport, tourism, manufacturing, construction, and energy. According to the 2011 Census by Statssa, the government sector is the largest employer in the district, followed by agriculture as the second biggest employer. However, when examining individual towns, the mining industry in Ba-Phalaborwa employs 19.5% of the population, making it the second-largest employer. Greater Tzaneen municipality has the highest employment rate at 42%, but also faces the highest unemployment rate in the district, with 41% of the population unemployed. (MDM, 2024)

The MDM experiences spatially distinct climatic conditions which are also influenced by the extensive topographic variation. This variance in topography and climate dictates vegetation and land use. The area boasts exceptional biodiversity such as the indigenous Afromontane forests, wetlands, the critically endangered Woodbush Granite Grasslands, as well as endangered species such as Modjadji cycads, Cape Parrot, Pel's Fishing Owl, etc. There are several biodiversity hotspots and conservation areas, as well as numerous game farms and privately owned protected areas, which greatly contribute to tourism opportunities. The area is however also faced with environmental risks and threats that lead to environmental degradation.

3.2. Key Risks

The greatest risks faced across the MDM are drought and increased temperatures, combined with population growth pressure in some areas. The towns that are seeing significant population growth are already experiencing service access pressure, and larger groups of people will become vulnerable and exposed to climate-related hazards. Physical vulnerability is relatively high across the entire District, indicating that infrastructure such as roads and housing, and accessibility could be poor, making the built-environment and its population, vulnerable to extreme events.

The generally drier and hotter climate over most parts of the District will also lead to an increased risk of wildfire. The increase in wildfires raises the threat of fire to all heritage resources, natural and built, as well as posing health risks to populations from exposure to smoke and ash pollution. Additionally, certain parts of the District could experience more extreme rainfall events that could lead to flooding. An increase in the intensity of rainfall and flooding could lead to increased surface runoff, resulting in increased soil erosion and soil loss and degradation.

4. SUMMARY OF CLIMATE RISK PROFILE

In line with global trends, Mopani DM 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 municipality 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 Mopani DM, and the priority risks and climate impacts which provide the basis for the identification of suitable climate change adaptation actions.

4.1. Overview of Baseline and Future Climate Risk

Mopani DM's baseline climate risk refers to the current level of risk posed by climate change and its impacts, and future climate risk refers to the projected level of risk that is expected to occur. An ensemble of 6 CMIP5 GCMs was used in the development of baseline and future climate change scenarios, for both the RCP 4.5 and 8.5 scenarios. The regional climate model (CCAM) was utilised in the downscaling from 50km resolution to 8km resolution. The periods that will be covered in the climate analysis are the baseline (1961 – 1990) and the future (2021 – 2050) periods.

4.1.1. Climate Analysis

4.1.1.1. Average temperatures

The District Municipality experiences current average annual temperatures of between 20 and 24 °C, with higher averages found along in the east towards Mozambique within the municipality of Ba-Phalaborwa. The projections show average annual temperature increases of between 2.2°C and 2.5°C across the district by 2050, under a RCP8.5 scenario. Projected increases in temperature into the future are uniform across the District Municipality.

4.1.1.2. Rainfall

The District Municipality experiences a current average annual rainfall of between 450mm in the eastern part of the District Municipality and more than 1200mm, over the higher-lying areas in the western parts of Greater Tzaneen. The projections show a change in average annual rainfall change of between 50mm less and 130mm more across the District Municipality by 2050. Projections indicate that decreases in rainfall are expected in Ba-Phalaborwa and Maruleng areas, while increases are expected in the rest of the municipality.

4.1.2. Climate Hazards

A summary of the climate hazards is included below:

4.1.2.1. Drought

Under baseline (current) conditions the north-eastern part of the District Municipality is exposed to higher drought tendencies than the central and western areas. In the future drought tendencies are projected to decrease over the eastern parts and increase over the western areas.

4.1.2.2. Heat

Annual average number of very hot days, which is defined as the number of days when the maximum temperature exceeds 35°C GCM grid point for the baseline (current) period of 1961–1990, and the projected change for the period 2021–2050. At the baseline climate conditions, there are approximately 60 very hot days experienced in the eastern areas east of the District Municipality. Heatwave events are however more likely to take place towards the east of the District Municipality, affecting Greater Tzaneen and Greater Letaba. The number of very hot days is projected to increase in the areas that are already more likely to experience extreme heat, especially over the central parts of the district. Some of the settlements that would be most exposed to heat stress in the future in the District Municipality include Giyani, Tzaneen, Hoedspruit and Phalaborwa.

3.1.2.3. Wildfire

Fire risk is determined by combining the typical fire hazard for a fire-ecotype (i.e., likelihood, fire severity) and the social and economic consequences (i.e., the potential for economic and social

losses). Settlements which are likely to experience wildfires on their wildland-urban interface include Phalaborwa, Modjadjiskloof, Gravelotte and Hoedspruit. It is projected that of these settlements, Phalaborwa, Hoedspruit and Gravelotte could see an increased risk of wildfire in the future.

3.1.2.4. Flooding

The flood hazard assessment combines information on the climate, observed floods, and the characteristics of water catchments that make them more or less likely to produce a flood. Most parts of the District Municipality have a medium flooding hazard, with pockets of medium to very high flooding hazard. Some areas in the central District and far south west have a very low flood hazard. Most parts of the District Municipality will experience slight increases in the number of extreme rainfall days. Settlements such as Tzaneen, Ba-Phalaborwa and Hoedspruit are expected to be at an increased risk of flooding in the future.

4.1.3. Climate Impacts

4.1.3.1. Water Resources

In South Africa, groundwater plays a key strategic role in supporting economic development and sustaining water security in several rural and urban settlements that are either entirely or partially dependent on groundwater supply. Groundwater is, however, a natural resource whose availability and distribution are highly influenced by climate variability and change. In the Mopani District, most of the larger settlements are surface water-dependent, while some also use a combination of surface and groundwater. Groundwater-dependent settlements may be most at risk of groundwater depletion based on decreasing groundwater aquifer recharge potential and significant increases in population growth pressure by 2050. Groundwater recharge potential is high in the west of the District Municipality, especially in the higher rainfall mountain areas of Greater Tzaneen municipality, and lower towards the central parts of Ba-Phalaborwa.

Table 3: Current water supply and vulnerability across Mopani District Municipality

Local Municipality	Water Demand per Capita (l/p/d)	Water Supply per Capita (l/p/d)	Current Water Supply Vulnerability
Ba-Phalaborwa	162.74	430.37	0.38
Greater Giyani	229.68	212.46	1.08
Greater Letaba	71.82	38.36	1.87
Greater Tzaneen	108.36	125.09	0.87
Maruleng	161.32	128.91	1.25

Sourced from: Council for Scientific and Industrial Research (CSIR)

4.1.3.2. Sectors

The Agricultural, Forestry and Fisheries sector contributes 3.2% to the local GVA of the Mopani District Municipality. The Limpopo province stands as the leading grower of citrus in South Africa, producing 42% of the total national citrus output. The main commodities are citrus, beef cattle

and vegetables. The Tzaneen and Letsitele regions support citrus, avocados, mangoes and bananas, while the Mooketsi area is the biggest producer of tomatoes in Limpopo and South Africa. Climate projections show a generally hotter and wetter climate in the future. Hot and moist conditions could lead to an increase in the spread of diseases and parasites across both crops and livestock. Overall, a hotter and wetter climate may result in an increased rate of photosynthesis, but an increase in the occurrence of parasites and diseases could also result.

4.1.4. Priority Risks and Vulnerabilities

4.1.4.1. Municipal

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

Each municipality in the Mopani District, as per Table 3 below, is provided with a score out of 10 for each of the vulnerability indices. A score higher than 5 indicates an above-national average and a score lower than 5 indicates a below-national average for vulnerability. Scores are provided for both 1996 and 2011, where a lower score in 2011 compared to 1996 indicates an improvement and a higher score indicates worsening vulnerability. Trend data is only available for Socio-Economic Vulnerability and Economic Vulnerability.

Table 4: Vulnerability indicators across Mopani District Municipality

LOCAL MUNICIPALITY	SEVI 1996	SEV 2011	Trend	EcVI 1996	EcVI 2011	Trend	PVI	Trend	EnVI	Trend
Ba-Phalaborwa	4.37	3.83	↘	7.54	10.0	↗	4.52	N/A	4.48	N/A
Greater Giyani	5.82	5.95	↗	4.34	6.46	↗	6.09	N/A	3.03	N/A
Greater Letaba	5.77	5.78	↗	4.98	7.06	↗	5.60	N/A	3.96	N/A
Greater Tzaneen	5.06	5.04	↘	5.67	8.14	↗	6.19	N/A	6.64	N/A
Maruleng	5.66	5.54	↘	7.92	9.89	↗	4.79	N/A	4.97	N/A

Socio-economic vulnerability has increased (worsened) in the Local Municipalities of Greater Giyani and Greater Letaba while economic vulnerability has increased across all local municipalities between 1996 and 2011. Ba-Phalaborwa Local Municipality has the highest economic vulnerability in the District and the highest in the Province as well. It has experienced the most significant population growth (14.90 %) of all Local Municipalities (MDM, 2022). The mining sector is the largest within Mopani District Municipality accounting for 35 % of the total GVA, with mining concentrated in the Ba-Phalaborwa region. The sector that contributes the second most to the GVA of the Mopani District Municipality is the community services sector at 20 %, followed by the finance and trade sectors at 13%. In 2019, 628 941 people were living in poverty, using the upper poverty line definition, across Mopani District Municipality - this is higher than the 674 588 in 2009.

4.1.4.2. Settlement

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

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

The table below presents anticipated settlement vulnerability in Mopani DM.

Table 5: Anticipated Settlement Vulnerability

Local municipality	Anticipated settlement vulnerability
Ba-Phalaborwa	• The town of Phalaborwa and the nearby Namakgale/ Lulekani towns and surrounding villages constitute the major population concentration areas in Ba-Phalaborwa. • The settlements of Namakgale and Gravelotte have been identified as District growth points in the area. • Gravelotte is facing significant growth pressure as well as very high service access vulnerability. • Namakgale has very high environmental vulnerability and significant economic pressures. • Nondweni has poor regional connectivity and high environmental and socio-economic pressures.
Greater Giyani	• Giyani as its only town. • Smaller settlements include Xawela, Ntsanwisi and KaNkuri. Xawela has extremely hight environmental, economic and regional connectivity vulnerability. • A large number of the sparsely located settlements are traditional villages.
Greater Letaba	• Greater Letaba Local Municipality is primarily rural/ non-urban in nature. • Major settlements are Modjadjiskloof, Ga-Kgapane and Senwamokgope. • Both the towns of Modjadjiskloof and Senwamokgope face extremely high growth pressure. • Senwamokgope also has very high regional connectivity vulnerability combined with a socio-economically vulnerable population.

Local municipality	Anticipated settlement vulnerability
Greater Tzaneen	• Major settlements include Tzaneen, Nkowankowa, Lenyenye, Letsitele, and Haenertsburg. • Tzaneen is the economic hub of the municipality and experiences very high growth pressures. • Traditional rural villages make up around 81 % of this municipality. These villages experience very high socio-economic and economic vulnerability. • Haenertsburg has the highest regional connectivity vulnerability.
Maruleng	• The major settlements in this municipality are Hoedspruit, Kampersrus and Madeira. • Hoedspruit experiences the highest growth pressures. • Madeira has very low access to services. • Traditional rural villages make up around 87 % of this municipality. These villages experience very high socio-economic, economic and environmental vulnerability.

5. MOPANI DISTRICT GREENHOUSE GAS EMISSIONS INVENTORY

5.1. Inventory Parameters

The greenhouse gas (GHG) inventory for Mopani District Municipslity was derived from the Limpopo Greenhouse Gas Emissions Inventory reported in the Limpopo Climate Change Response Strategy & Implementation Plan (LEDET, 2022). The basis year for the inventory is 2020. It uses the *Greenhouse Gas Protocol - Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities* which was developed by the World Resources Institute (WRI, 2014)

For the purposes of this inventory, the Scope 1 and Scope 2 GHG emissions presented in Table 5 below were considered.

Table 6: Emissions sources by scope included in the inventory

Scope 1	Scope 2	Scope 3
Solid Fuel Combustion	Net Electricity	None
Liquid Fuel Combustion		
Wastewater Treatment		
Solid Waste Disposal		
Enteric Fermentation (Livestock)		

To standardise reporting, the source data (such as fuel sales) was multiplied by an emissions factor to convert all data to gigagrams of carbon dioxide equivalent (Gg CO_2e). GHG emission factors were sourced primarily from the IPCC emission factor database (IPCC 2021).

5.2. Inventory Results

5.2.1. Summary Results

In line with the National GHG Inventory Report South Africa 2020 (DFFE, 2022), summary results for Mopani's Greenhouse Gas (GHG) Emissions Inventory are presented below (without Forestry and Other Land Use (FOLU)).

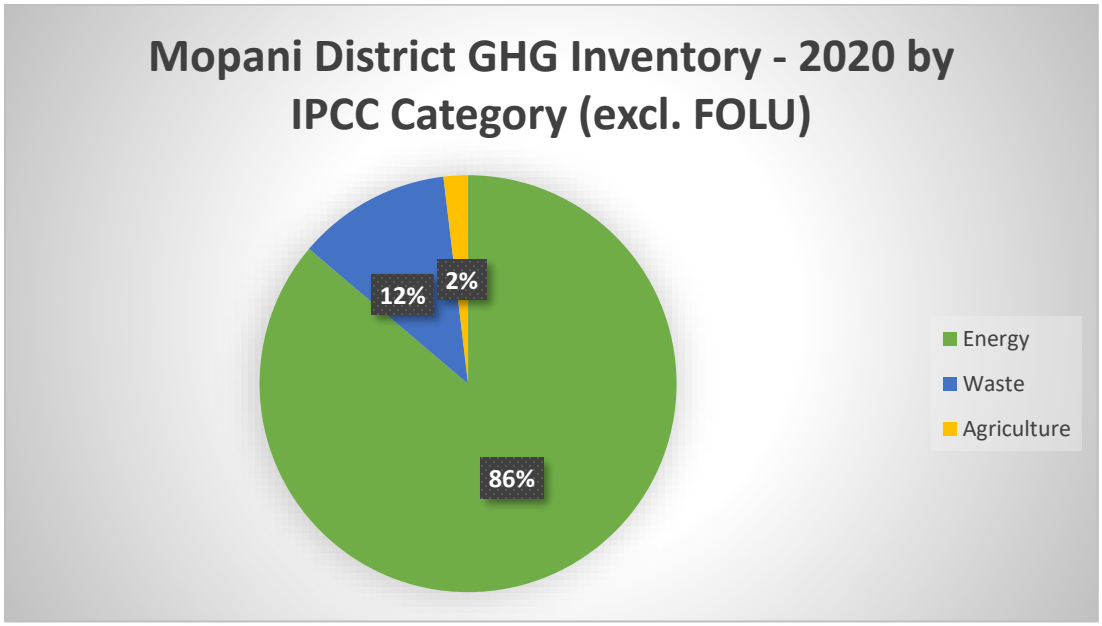

Figure 5 and Table 7: Mopani Greenhouse Gas Emissions Inventory – 2020 by IPCC Category (excluding FOLU)summarise the total GHG emissions excluding FOLU for Mopani for the year 2020. It is evident from this data that the energy category is by far the largest contributor to the GHG emissions profile of the district. The data also show that the total GHG emissions for the district (excluding FOLU) for 2020 were estimated to be 5 250.70 gigagrams of carbon dioxide equivalent (Gg CO2e). By comparison, the estimated total emissions for Limpopo (excluding FOLU) in the Limpopo Climate Change Response Strategy & Implementation Plan (LEDET, 2022) were 48 776.17 Gg CO2e. This means that in 2020, Mopani district accounted for 11% of Limpopo's GHG emissions.

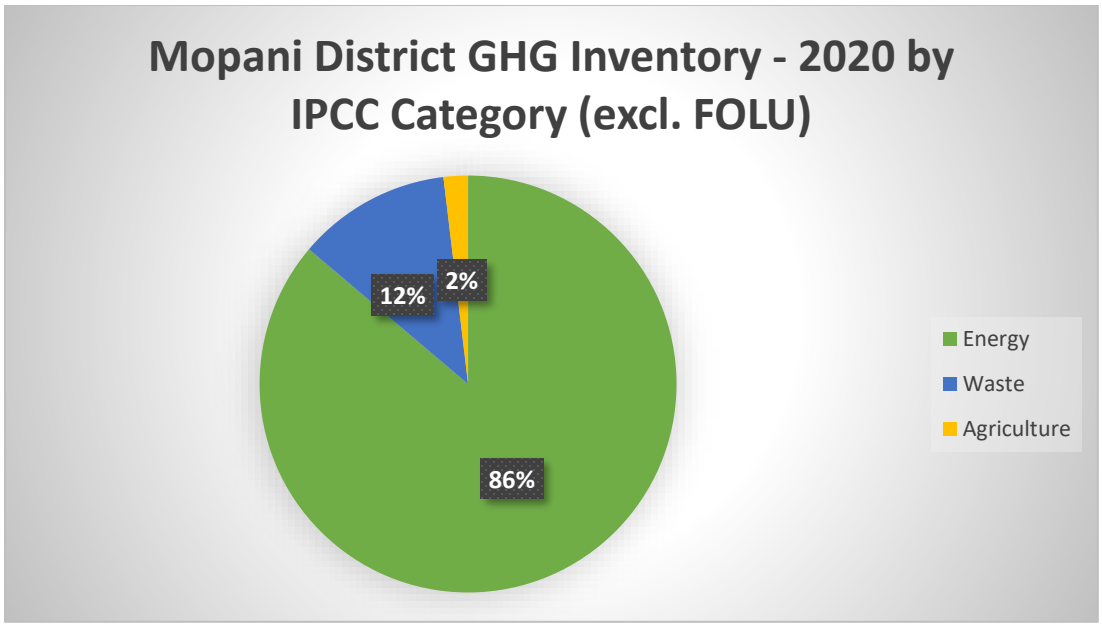

Figure 5: Mopani District Greenhouse Gas Emissions Inventory – 2020 by IPCC Category (excluding FOLU)

Table 7: Mopani Greenhouse Gas Emissions Inventory – 2020 by IPCC Category (excluding FOLU)

Source	Gg CO2e
Energy	4 525.51
IPPU	-
Waste	625.93
Agriculture	99.25
Grand Total	**5 250.70**

It is also possible to summarise Mopani's GHG emissions (excluding FOLU) for 2020 at a sector level where energy is separated into its different source categories. Figure 6 and Table 8: Mopani District Greenhouse Gas Emissions Inventory – 2020 by Sub-Sector (excluding FOLU) show this sub-categorisation of the energy sector and highlight the dominance of electricity sales in the overall GHG emissions profile for the district.

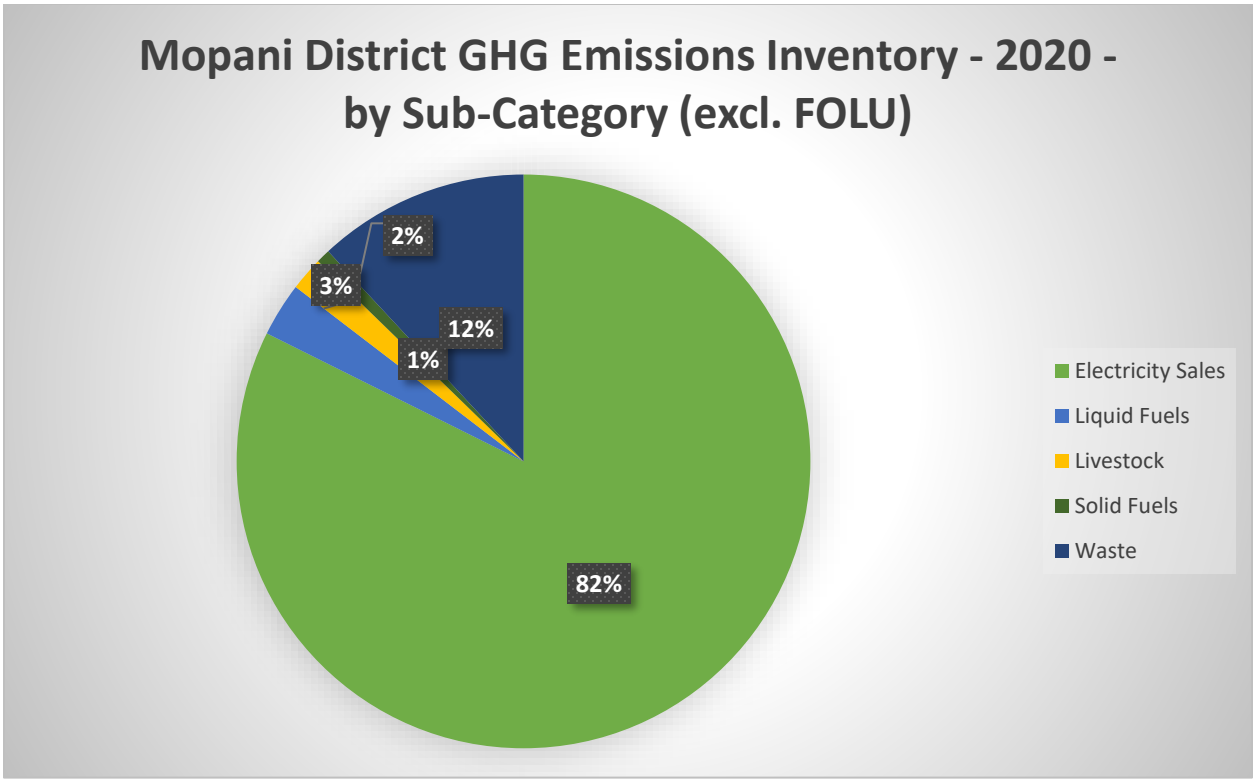

Figure 6: Mopani District Greenhouse Gas Emissions Inventory – 2020 by Sub-Sector (excluding FOLU)

Table 8: Mopani District Greenhouse Gas Emissions Inventory – 2020 by Sub-Sector (excluding FOLU)

Source	Sum of GgCO2e
Electricity (Net Generation)	-
Electricity Sales	4 324.68
IPPU	-
Liquid Fuels	159.40
Livestock	99.25
Solid Fuels	41.44
Waste	625.93
Grand Total	**5 250.70**

5.2.2. Solid Fuels

Solid fuel data was collected from the South African Greenhouse Gas Emissions Reporting System (SAGERS) (DFFE 2019). These data therefore only include solid fuels from industrial and commercial processes that need to report through the SAGERS (DFFE 2019). The data does not include residential or small-scale commercial solid fuels such as coal used at a household level. The available solid fuel data is summarised in Figure 7 and Table 9: Mopani District Greenhouse

Gas Emissions Inventory – 2020 – Solid Fuels (excluding Electricity Generation) by type of use (excluding energy generation). This data shows that non-metallic minerals and the non-ferrous metals industries account for a large portion of the solid fuels GHG emissions in Mopani.

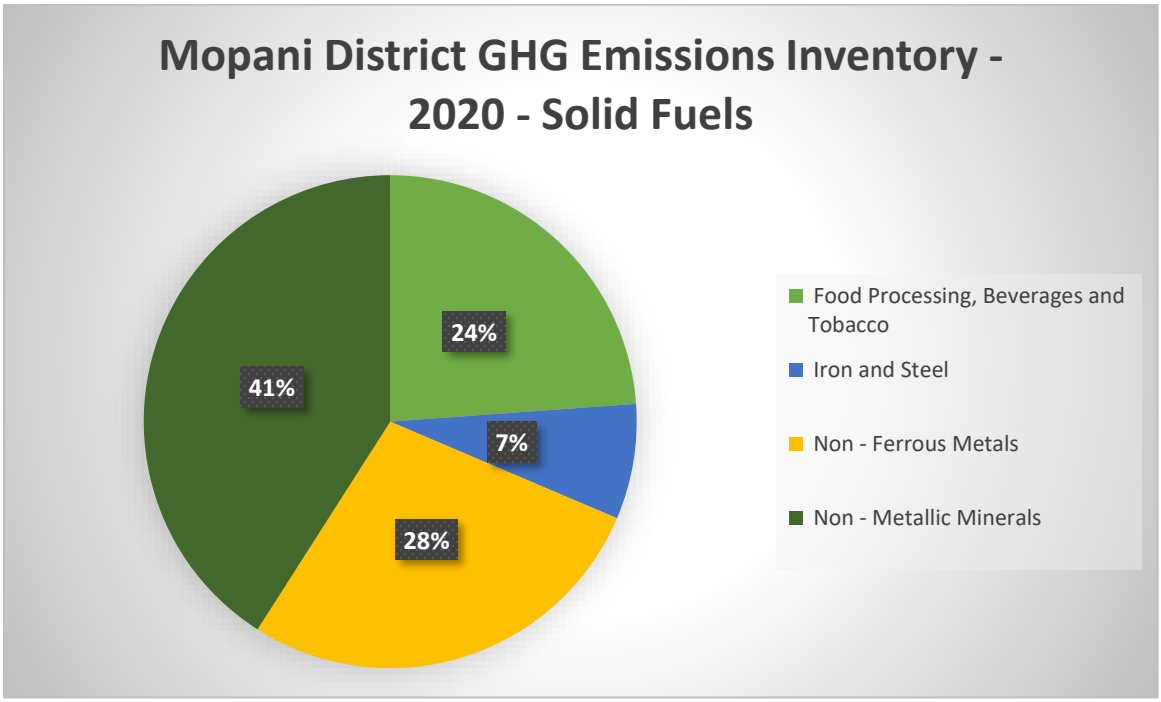

Figure 7: Mopani District Greenhouse Gas Emissions Inventory - 2020 - Solid Fuels (excluding Electricity Generation)

Table 9: Mopani District Greenhouse Gas Emissions Inventory – 2020 – Solid Fuels (excluding Electricity Generation)

Source	Sum of GgCO2e
Solid fuel transformation	-
Food Processing, Beverages and Tobacco	9.88
Iron and Steel	3.13
Mining (excluding fuels) and Quarrying	-
Non - Ferrous Metals	11.45
Non - Metallic Minerals	16.97
Non - specified Industry	-
Grand Total	**41.44**

5.2.3. Liquid Fuels

A summary of GHG emissions from fuel sale data for Mopani is provided in Figure 8 and Table 10: Mopani District Greenhouse Gas Emissions Inventory – 2020 – Liquid Fuels. This data shows that petrol and diesel are by far the dominant sources of GHG emissions from liquid fuels. It is important to note that the data from liquid fuels was provided at a magisterial district level (DMRE 2021). These magisterial district boundaries were aligned with the current district municipal boundaries using a proportional spatial allocation between the two datasets.

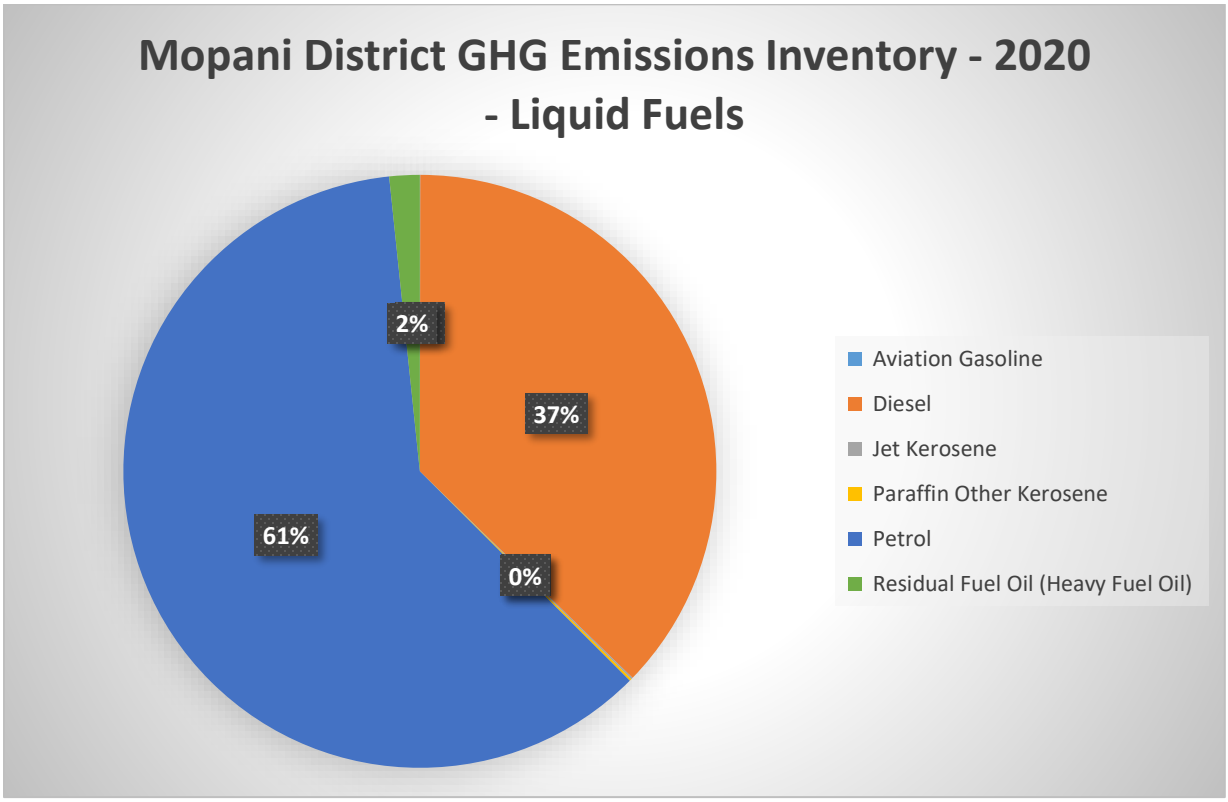

Figure 8: Mopani District Greenhouse Gas Emissions Inventory – 2020 – Liquid Fuels

Table 10: Mopani District Greenhouse Gas Emissions Inventory – 2020 – Liquid Fuels

Row Labels	Sum of GgCO2e
Aviation Gasoline	0.04
Diesel	59.36
Jet Kerosene	0.14
Liquefied Petroleum Gases	-
Paraffin Other Kerosene	0.19
Petrol	97.03
Residual Fuel Oil (Heavy Fuel Oil)	2.63
Grand Total	**159.40**

5.2.4. Waste

A summary of the GHG emissions from solid waste and wastewater is provided in Figure 9 and Table 11: Limpopo Province Greenhouse Gas Emissions Inventory – 2020 – Waste.

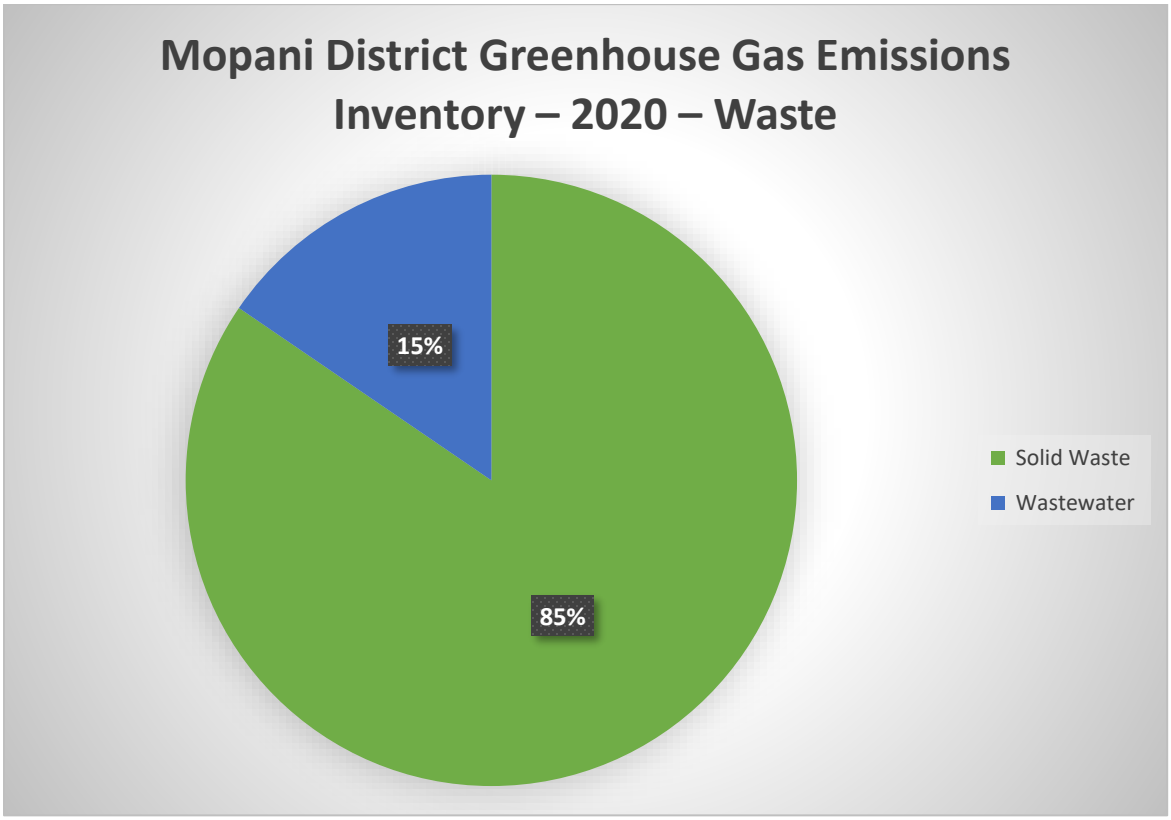

Figure 9: Limpopo Province Greenhouse Gas Emissions Inventory – 2020 – Waste

Table 11: Limpopo Province Greenhouse Gas Emissions Inventory – 2020 – Waste

Source	Sum of $GgCO_2e$
Solid Waste	529.14
Wastewater	96.79
Total	**625.93**

5.2.5. Agriculture

Under agriculture, only enteric fermentation was included in the inventory and for enteric fermentation, only commercial livestock data was available. Livestock data for Limpopo was provided through the Census of Commercial Agriculture, 2017 (Statistics SA 2020). No assumptions were made regarding the change in livestock numbers from 2017 to 2020. The GHG emissions from these livestock data are summarised in Figure 10 and Table 12: Mopani

Greenhouse Gas Emissions Inventory – 2020 – Livestock. As expected, the bulk of GHG emissions from commercial livestock in Mopani comes from cattle.

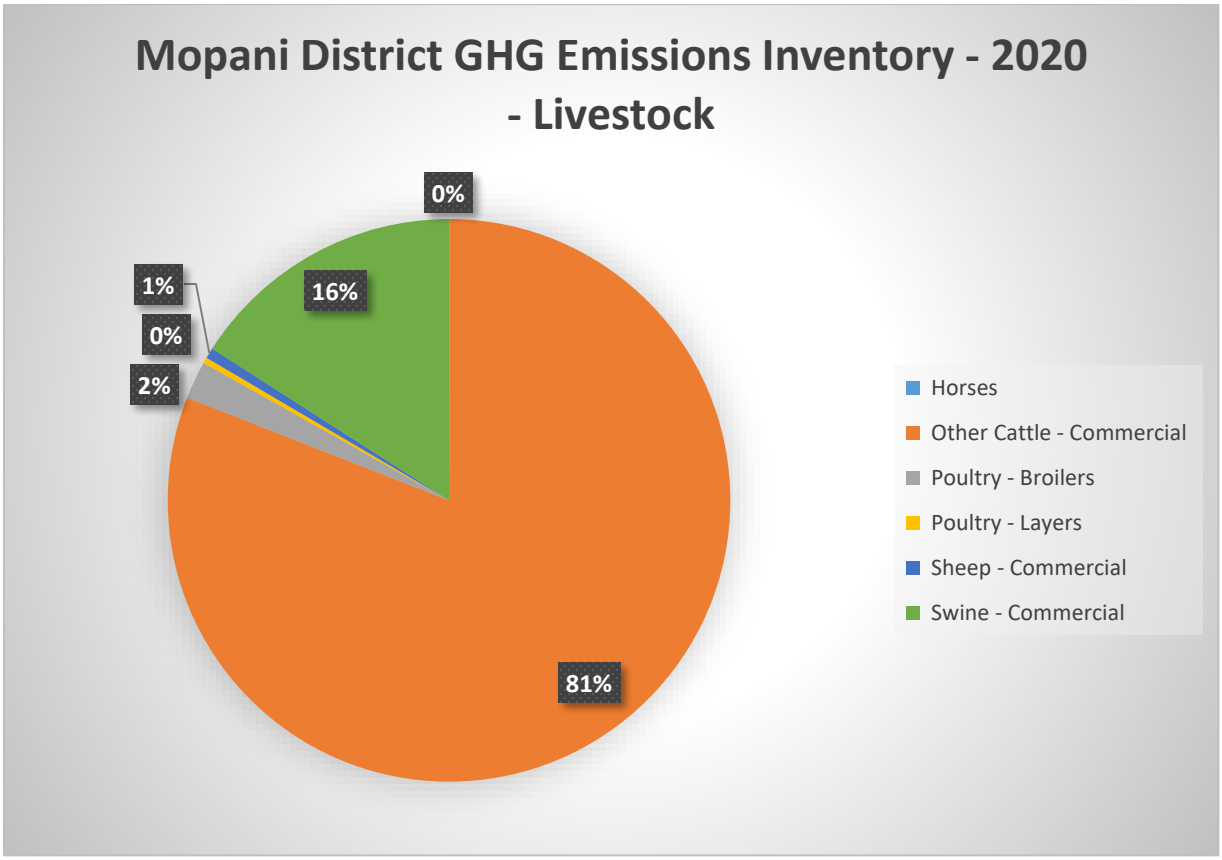

Figure 10: Mopani Greenhouse Gas Emissions Inventory – 2020 – Livestock

Table 12: Mopani Greenhouse Gas Emissions Inventory – 2020 – Livestock

Row Labels	Sum of GgCO2e
Horses	0.04
Other Cattle - Commercial	80.30
Poultry - Broilers	2.16
Poultry - Layers	0.33
Sheep - Commercial	0.61
Swine - Commercial	15.81
Grand Total	**99.25**

6. CLIMATE CHANGE RESPONSE

6.1. Comprehensive Approach to 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.

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 has proposed a point of reference for establishing an overarching approach to climate change response in the Mopani DM 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.

6.2. Climate Change Response Vision

For the Mopani District Municipality (DM), achieving climate change resilience means incorporating both climate change mitigation and adaptation principles into all aspects of municipal planning, development, and operations.

In the context of the Municipality, several practices can contribute to the transition towards a climate-resilient and low-carbon district:

- **Climate-Resilient and Low-Carbon Infrastructure**: The municipality could adopt design standards and practices that not only enhance resilience to climate impacts, such as flooding, droughts, and extreme heat, but also reduce greenhouse gas emissions. This includes promoting energy-efficient buildings, low-carbon transport solutions, and the use of renewable energy sources in infrastructure development.
- **Biodiversity and Natural Resource Conservation**: Protecting and enhancing the district's rich biodiversity and natural resources plays a critical role in both adaptation and mitigation. These resources provide vital ecosystem services, such as carbon sequestration, water regulation, and flood prevention. Efforts to conserve and restore ecosystems, including wetlands, forests, and grasslands, will contribute to both reducing emissions and building resilience to climate impacts.
- **Water Conservation and Efficiency**: Given that drought is a key climate risk for the municipality, water conservation and efficiency are crucial in addressing both adaptation and mitigation needs. Efficient water management practices, such as rainwater harvesting, wastewater reuse, and improved irrigation systems, help to conserve water resources, reduce energy use, and increase the municipality's capacity to manage water scarcity.
- **Climate-Resilient and Sustainable Agriculture**: The agricultural sector, vital to the Mopani DM, must adapt to climate impacts such as changing rainfall patterns and rising temperatures. Climate-resilient agricultural practices, such as drought-tolerant crops, agroforestry, and soil carbon sequestration, will help to safeguard food security and livelihoods while also reducing agricultural emissions and enhancing carbon storage in soils.

These best practices are not exhaustive and should be supplemented with additional strategies tailored to the unique context and needs of the Mopani DM. The success of these efforts hinges on the integration of both mitigation and adaptation principles into all municipal decision-making processes and operations, alongside active community engagement.

The climate change response vision established for the Mopani DM is:

"To become a sustainable, resilient, and low-carbon district municipality that integrates climate change mitigation and adaptation into all aspects of development, prioritizes the protection of natural resources, and collaborates with communities and stakeholders to ensure a prosperous, equitable, and climate-resilient future for all."

This vision emphasizes a dual focus on adapting to the inevitable impacts of climate change and mitigating its drivers by reducing greenhouse gas emissions. The goal is to build a district that is not only resilient to climate risks but also contributes to global climate goals by adopting sustainable, low-carbon solutions.

Achieving this vision requires the development of a comprehensive set of climate actions that address climate risks, promote sustainability, enhance community safety and prosperity, preserve natural resources, and foster innovation and collaboration. These actions will offer co-benefits, such as promoting social equity, ensuring a just transition to a low-carbon economy, and safeguarding the health and resilience of the people, natural resources, and economy of Mopani DM.

7. CLIMATE CHANGE ADAPTATION

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 11). "*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, protecting coastlines from flooding, securing water resources to rely on during periods of drought, and improving crop production for dryland farming, among others.

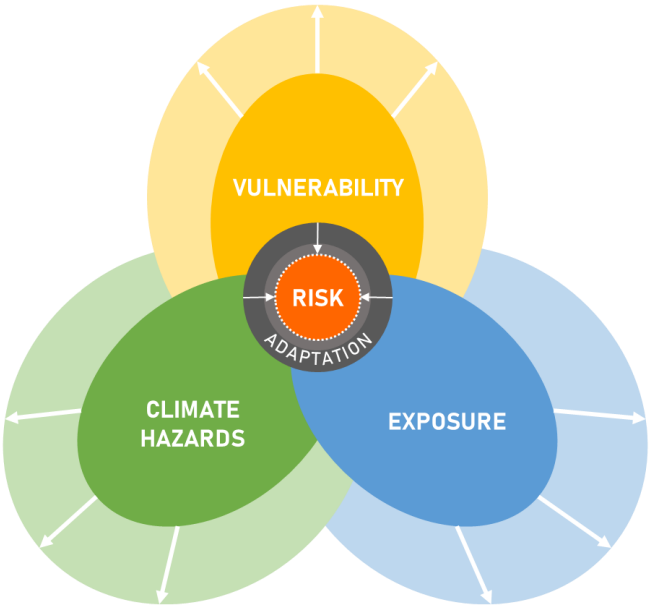

Figure 11: The interaction between the various components of risk, indicating the opportunity to reduce risk through adaptation (based on IPCC, 2014 and IPCC, 2021)

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.

7.1. Adaptation Goals and Priorities

In response to the climate risks and impacts identified in Chapter 2, the following adaptation goals are recommended:

i. **To ensure water security under a changing climate**: Both the quality and quantity of water for human consumption and irrigation are becoming under pressure. Developing comprehensive strategies for water resource management is crucial. These include planning for projected increases in drought cycles, innovative water harvesting, and maintenance, investing in efficient water infrastructure and exploring alternative water sources like groundwater and wastewater reuse.

ii. **To protect biodiversity and improve sustainable use of natural resources**: Protecting and restoring natural ecosystems, such as wetlands and riparian areas, to enhance biodiversity, support water resource management, and provide natural buffers against climate-related hazards such as wildfires.

iii. **To increase the resilience of the agricultural sector to more extreme events such as storms and drought as well as indirect risks such as pests and diseases**: Climate change is reducing crop yields and lowering livestock productivity. Resilience can be increased by implementing sustainable agricultural practices, changing to indigenous

varieties/breeds with higher heat and disease tolerance and identification of new income opportunities to ensure producers' economic viability.

iv. **Increase the adaptive capacity of human settlements to climate change and extreme events:** Ensuring that adaptation efforts prioritize the needs of vulnerable populations, such as low-income communities and informal settlements. This can involve providing access to basic services, improving housing conditions, and implementing early warning systems tailored to these communities.

The process of climate change adaptation and planning is set out in Table 12 . The development of the adaptation approach 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 13: 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 into planning	Integrate adaptation goals, programmes, and actions into existing instruments and processes, particularly those related to development and planning. The aim is to ensure that climate change adaptation and resilience is an integral part of all planning.

7.2. Mopani DM's Key Priority Areas and Strategic Objectives and the linkage to Climate Change Adaptation

Mopani DM identified 6 Key Priority Areas (KPAs) for Development to guide the District Municipality in achieving its vision and mission. Mainstreaming climate action should be considered as a key success factor in achieving these objectives as it can help promote sustainable socio-economic development by protecting the investments being made by the Municipality and supporting livelihood resilience. Table 13 provides an overview of the Municipality's KPAs for Development and indicates potential linkages to climate action.

Table 14: Mopani DM's Development Priorities and Objectives.

Mopani DM's KPAs and Strategic Objectives from the IDP		
Key Priority Area	**Strategic Objective**	**Link to Climate Change**
KPA 1: Municipal Transformation and Organisational Development	To inculcate entrepreneurial and intellectual capabilities.	Municipal Transformation and Organisational Development are closely linked to climate change. For example, strengthening record-keeping and knowledge management can promote the establishment of partnerships with academic institutions and research organisations to ensure ongoing access to the latest research and expertise in the field of climate change. This can help to ensure that the municipality is up-to-date with the latest developments in the field and can leverage the latest knowledge and tools to inform its decision-making and actions.
	To strengthen record keeping and knowledge management.	
KPA 2: Basic Service Delivery	To accelerate sustainable infrastructure and maintenance in all sectors of development.	The District is committed to ensuring effective service delivery. Climate change affects essential services like water supply, waste management, and emergency response. These services need to be reliable and resilient to climate variability and change. Effective service delivery in the face of climate change is integral to maintaining the socio-economic well-being of the District's inhabitants.
	To have integrated infrastructure development.	
	To improve community safety, health and social well-being.	
KPA 3: Local Economic Development	To promote economic sectors in the District.	Local economic development is closely linked to building climate resilience. Enhancing the local economy, through initiatives such as providing active support to facilitate agricultural growth, broadening economic participation and improving active participation of LMs and SMMEs in the renewable energy sector will diversify livelihood opportunities and increase the resilience of the local economy to the impacts of climate change.

Mopani DM's KPAs and Strategic Objectives from the IDP		
Key Priority Area	**Strategic Objective**	**Link to Climate Change**
KPA 4: Spatial Rationale	To have efficient, effective, economic and integrated use of land space.	Spatial rationale is an important KPA in mainstreaming climate change adaptation in the district. Promoting the efficient and effective use of land space provides an opportunity to enhance the resilience of human and natural systems to the impacts of climate change through the promotion of climate resilient spatial planning and sustainable land use practices.
KPA 5: Good Governance and Public Participation	Promoting democracy and sound governance.	Good governance and public participation are critical for addressing the challenges posed by climate change in the municipality. Climate change is a complex and multifaceted challenge that requires coordinated action across all levels of government, as well as the active participation of civil society and other stakeholders. Good governance, including transparent decision-making processes and accountability mechanisms, is essential in ensuring that climate change is prioritised in municipal decision-making and that necessary resources are allocated to address the challenge.
KPA 6: Financial Viability	To increase revenue generation and implement financial control systems.	Adapting to climate change can lead to cost savings in the long run by reducing the risks and costs associated with climate-related damages. Climate change adaptation measures can also attract funding from international climate finance mechanisms, thus enhancing the financial viability of the municipality. Financial management practices can also integrate climate risk into budgeting and procurement processes to ensure that municipal resources are allocated in a way that builds resilience to climate change.

7.3. Adaptation Goals and Programmes

The identification of adaptation actions followed a sequenced approach initiated by the outcomes of the Mopani DM Climate Change Risk profile which informed the development of specific Adaptation Goals. The adaptation goals have been developed to guide a contextually relevant approach to adaptation planning. The goals informed the development of adaptation programmes to support the identification and categorisation of adaptation programmes which was then unpacked to provide a detailed breakdown of the key climate actions and support activities.

The adaptation goals for Mopani DM are as follows:

1. **To ensure water security under a changing climate**: Both the quality and quantity of water for human consumption and irrigation are becoming under pressure. Developing comprehensive strategies for water resource management is crucial. These include planning for projected increases in drought cycles, innovative water harvesting, maintenance, investing in efficient water infrastructure and exploring alternative water sources like groundwater and wastewater reuse.
2. **To protect biodiversity and improve sustainable use of natural resources**: Protecting and restoring natural ecosystems, such as wetlands and riparian areas, to enhance biodiversity, support water resource management, and provide natural buffers against climate-related hazards such as wildfires.
3. **To increase the resilience of the agricultural sector to more extreme events such as storms and drought as well as indirect risks such as pests and diseases**: Climate change is reducing crop yields and lowering livestock productivity. Resilience can be increased by implementing sustainable agricultural practices, changing to indigenous varieties/breeds with higher heat and disease tolerance and identification of new income opportunities to ensure producers' economic viability.
4. **Increase the adaptive capacity of human settlements to climate change and extreme events:** Ensuring that adaptation efforts prioritize the needs of vulnerable populations, such as low-income communities and informal settlements. This can involve providing access to basic services, improving housing conditions, and implementing early warning systems tailored to these communities.

Mopani DM Climate Change Programmes are listed below:

1. ***Programme 1:*** Adopt an integrated approach to water augmentation, water use and water management.
2. ***Programme 2:*** Protect and conserve water through monitoring mechanisms and water conservation through water conservation and water demand management (WCWDM).
3. ***Programme 3:*** Enhanced water conservation and awareness and education for sustainable water management in response to climate change.
4. ***Programme 4:*** Assessing the feasibility and sustainability of alternative water sources for climate change adaptation.
5. ***Programme 5:*** Implementing sustainable groundwater use and development.

6. ***Programme 6:*** Integrate critical biodiversity areas and ecological support areas into the SDF.
7. ***Programme 7:*** Conserve, protect and restore natural open spaces, ecosystems and natural resources.
8. ***Programme 8:*** Enhanced natural resource management and use of ecosystem services.
9. ***Programme 9:*** Enhanced resilience of agricultural production and distribution systems from climate change.
10. ***Programme 10:*** Climate resilient agricultural communities.
11. ***Programme 11:*** Identify and prioritise climate change risks and develop response measures for settlements.
12. ***Programme 12:*** Implement community-based adaptation in communities most at risk of climate-related hazards.
13. ***Programme 13:*** Climate-smart spatial planning for climate-resilient growth and development.

7.4. Climate Change Goal 1: To Ensure Water Security Under a Changing Climate

Goal:	To implement measures to secure water availability for all users and uses, while reducing water demand, use, pollution and waste, in response to the impacts of climate change on the water cycle
Outcome:	A secure and efficient water supply for all, with reduced demand, waste, and pollution.
Linkage to Mopani DM Development Priorities	KPA 2: Basic Service Delivery

7.4.1. Rationale/Context

With the projected increase in temperature and drought risk, water security is a top adaptation priority for the municipality. Mopani DM is a Water Services Authority (WSA) and all its Local Municipalities have Water Service Provision (WSP) in place. Mopani DM lies within and is benefitting from the following catchment areas: Groot Letaba; Olifant and Klein Letaba. In lower-lying regions, such as Greater Giyani and Ba-Phalaborwa, there are insufficient water resources which leads to severe water shortages and ongoing drought conditions. Therefore, the programmes put forward in this section includes exploring alternative water sources such as groundwater and rainwater harvesting, as well as increasing the efficiency of current infrastructure and implementing demand management measures in order to ensure water security.

The impact of climate change on water availability and demand is expected to be particularly challenging for agriculture, which is an important economic sector. Reduced water availability, may result in reduced productivity leading to reduced employment and income. Furthermore, water scarcity can lead to conflicts and tensions between different sectors and communities. The uncertainty in rainfall patterns poses a significant risk to the municipality's water supply. Rainfall uncertainty means that the municipality may experience prolonged periods of low rainfall, making it difficult to predict water availability, and increasing the likelihood of water shortages. Additionally, heatwaves and extremely hot days will increase water demand, as people will consume more water to stay hydrated. This increased demand could lead to water shortages, especially during peak usage periods, such as the hot summer months.

The municipality's focus on water as a top strategic priority is an important step towards ensuring that it can cope with the impacts of climate change and maintain a sustainable water supply for its residents and businesses.

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

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

This programme seeks to address the water resource limitations in MDM. The programme aims to create a comprehensive strategy to manage these resources efficiently, improve water use, and ensure long-term sustainability amid climate change.

- The first component of the programme is **water sensitive urban design (WSUD)**. This strategy integrates the water cycle into urban landscapes to increase water availability and improve its quality.
- Addressing **human resources constraints for effective water management** is another critical step. This action involves identifying workforce gaps, training existing staff, and recruiting additional personnel as necessary.
- **Reviewing the bulk water master plan** is also integral to the programme. Regularly updating this strategic document is critical, especially given the dynamic nature of water resources within the district, the changing climate, and shifts in water demand projections.
- Finally, **the development of a Water Safety Plan (WSP)** is necessary to ensure safe drinking water from the source to the tap and implementing a comprehensive WSP can safeguard public health, meet regulatory requirements, and boost consumer confidence in the water supply.

In summary, the proposed programme aspires to cultivate a holistic approach to water management, considering all aspects of the water cycle, from supply to disposal. It focuses on enhancing the resilience and sustainability of the district's water resources amidst changing climate conditions, a growing population, and an ageing infrastructure.

Table 15: 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:** Assess feasibility of capturing and re-use of 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.

Programme 1: Integrated Approach to Water Augmentation, Use, and Management.	
ACTIONS	**KEY ACTIVITIES**
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 and 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.

Programme 1: Integrated Approach to Water Augmentation, Use, and Management.	
ACTIONS	**KEY ACTIVITIES**
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.

7.4.3. Programme 2: Water Conservation and Demand Management

The protection and conservation of water resources are crucial for the Mopani DM to adapt to climate change impacts. One approach to achieving this is to implement monitoring mechanisms and protect water sources by reducing pollution. This activity can involve identifying potential sources of pollution in the municipality's water supply, implementing water quality monitoring programmes, and regularly assessing the effectiveness of pollution control measures. Additionally, protecting water sources can involve measures such as setting up buffer zones around water bodies, land-use zoning to prevent pollution, and enforcing laws and regulations on pollution control.

It must be noted that some catchment areas fall outside Mopani DM’s boundaries. Therefore, the goal should be to collaborate with all stakeholders to determine an equitable contribution from all to ensure the catchment management area. Alien invasive species clearing in catchment areas can be a key activity to implement to protect water sources, as invasive species can significantly alter the natural ecosystem of a catchment area, leading to reduced water quality and quantity.

Table 16: 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 co-ordinating 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**: 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.

Programme 2: Protect and Conserve Water Through Monitoring Mechanisms and Water Conservation through Water Conservation and Water Demand Management (WCWDM).	
ACTIONS	**KEY ACTIVITIES**
	• **Continue Water Metering and Billing**: Persist with the installation of water meters and implement billing systems that charge consumers based on the amount of water used, as a means to encourage water conservation. Water-efficient infrastructure: The municipality can install water-efficient fixtures and appliances, such as low-flow showerheads, faucets, and toilets and in municipal buildings. • **Greywater recycling**: Promote the use of greywater for irrigation and other non-potable uses to reduce demand on the municipal water supply. • **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.

Programme 2: Protect and Conserve Water Through Monitoring Mechanisms and Water Conservation through Water Conservation and Water Demand Management (WCWDM).	
ACTIONS	**KEY ACTIVITIES**
Alien invasive species clearing initiatives in catchment areas.	• **Stakeholder collaboration and equitable contribution**: Recognising that catchment areas fall outside the DM boundaries and that various water users utilise the it is essential to collaborate with all stakeholders to determine an equitable contribution from all parties to manage catchments. • **Identifying and mapping invasive species**: A comprehensive survey of invasive species within the catchment areas can be conducted in partnership with relevant stakeholders to identify and map the areas affected by invasive species. • **Removal and control of invasive species:** This involves the collaborative removal and control of invasive species using various techniques such as mechanical, chemical, and biological control methods, with contributions from all stakeholders. • **Rehabilitation of cleared areas:** After the removal of invasive species, the cleared areas need to be rehabilitated. This can be done through the restoration of indigenous vegetation and the implementation of erosion control measures, with support from all involved stakeholders. • **Education and awareness:** Education and awareness campaigns can be implemented in coordination with stakeholders to increase the understanding of the negative impacts of invasive species on catchment areas, and to promote responsible behaviour in preventing the spread of invasive species. • **Monitoring and evaluation:** The effectiveness of invasive species control measures can be monitored and evaluated in partnership with stakeholders to ensure the long-term sustainability of the project, and to assess the contributions and impact of each stakeholder.
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.

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

7.4.4. Programme 3: Enhancing Water Conservation Awareness and Education for Sustainable Water Management in Response to Climate Change

The Mopani DM is vulnerable to the impacts of climate change, including changes in water availability and quality. Enhancing public awareness and education on water conservation is a crucial action in addressing climate change by reducing water demand, saving energy, and reducing greenhouse gas emissions. This programme aims to enhance water conservation awareness and education to promote sustainable water management in response to climate change. Enhancing water conservation awareness and education is a vital aspect of sustainable water management in response to climate change. The programme can help to foster a culture of conservation, encourage personal responsibility, and reduce pressure on water resources, leading to more sustainable and resilient water management.

Table 17: Programme 3 - Enhancing water 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 programmes.	• **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 organising 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 organisations**: This involves collaborating with community-based organisations, such as schools, churches, and community centres, to disseminate educational materials and raise awareness of water conservation. • **Evaluating the effectiveness of the programme**: This involves collecting data to measure the impact of the education programme on knowledge, attitudes, and behaviours related to water conservation. This data can be used to refine the programme 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. • **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

Programme 3: Enhancing Water Conservation Awareness and Education for Sustainable Water Management in Response to Climate Change.	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
	deliver water directly to plants' roots. This can reduce the amount of water needed to maintain a garden or lawn. • **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	• Conducting water audits to identify areas where water savings can be made. • 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. • Conducting outreach and education programmes to raise awareness among businesses about the importance of water conservation and the benefits of implementing water-saving measures. • 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 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. • Analysing the economic, social, and environmental impacts of water conservation initiatives, to help decision-makers prioritise and implement effective conservation strategies. • Evaluating the effectiveness of existing water conservation programmes, and identifying opportunities for improvement. • Collaborating with other stakeholders, such as government agencies, academic institutions, and non-governmental organisations, 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 organisations to take action to conserve water. • Monitoring and evaluating the implementation and impact of water conservation programmes, to ensure that they are achieving their intended goals and objectives.

7.4.5. Programme 4: Assessing Alternative Water Sources

The programme seeks to address the impacts of climate change on the water supply of the Mopani DM by exploring the feasibility and sustainability of alternative water sources such as water reuse, groundwater, aquifer recharge and rainwater harvesting.

The feasibility and sustainability of these alternative water sources will be evaluated through detailed assessments, considering factors such as energy consumption, water quality, and cost-effectiveness. The programme also involves investment in alternative water sources to ensure a diversified water mix that is resilient to changes in climate. Furthermore, the programme seeks to promote water conservation through the installation of dual, greywater, and water-efficient systems in new developments, reducing water consumption and ensuring sustainable water use.

The programme emphasizes the need for a comprehensive approach to water management, as climate change poses significant challenges to the water supply of the District. The programme's success will be determined by its ability to ensure a continued supply of safe and reliable water, which is essential for the social, economic, and environmental well-being of the region.

Table 18: 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

Programme 4: Assessing the Feasibility and Sustainability of Alternative Water Sources for Climate Change Adaptation	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
Investigating alternative water sources.	• **Feasibility studies**: Conducting feasibility studies to identify and assess the viability of various alternative water sources, such as rainwater harvesting, groundwater extraction, and stormwater capture. • **Hydrological assessments:** Undertaking hydrological assessments to determine the water availability and potential yield of alternative water sources, such as aquifers and rivers. • **Cost-benefit analysis**: Conducting cost-benefit analysis of alternative water sources to determine the economic and environmental costs and benefits of investing in them. • **Water quality assessments**: Conducting water quality assessments to determine the suitability of alternative water sources for various uses, such as drinking water, irrigation, and industrial processes. • **Stakeholder engagement:** Engaging with stakeholders, including communities, businesses, and other water users, to identify 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.	• Researching and evaluating potential alternative water sources: This may involve identifying and assessing the feasibility of various water sources, such as 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

Programme 4: Assessing the Feasibility and Sustainability of Alternative Water Sources for Climate Change Adaptation	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
	support and participation in the development and implementation of these projects.
Develop and Implement a Treated Effluent Reuse Strategy For Sustainable Water Management.	• Assessing the feasibility and potential benefits of a treated effluent reuse strategy for the DM. • Identifying and prioritising potential sites for treated effluent reuse, including public spaces, industrial sites, and agriculture. • Developing a comprehensive treated effluent reuse plan, including infrastructure and system requirements, stakeholder engagement, and potential risks and mitigation strategies. • Conducting a cost-benefit analysis of the treated effluent reuse plan and identifying potential funding sources. • Building and implementing the treated effluent reuse infrastructure, including treatment facilities and distribution systems. • Conducting monitoring and evaluation activities to assess the effectiveness of the treated effluent reuse strategy and identify opportunities for improvement.

7.4.6. Programme 5: Groundwater Management

Groundwater is a critical water resource for the DM and is increasingly vulnerable to the impacts of climate change. Implementing a sustainable groundwater use and development strategy is essential for adapting to climate change impacts, ensuring groundwater sustainability, and securing the continued supply of safe water.

The programme entails conducting groundwater resource assessments to assess the availability of groundwater, to establish sustainable groundwater use policies and guidelines to promote efficient and effective use of groundwater, to implement groundwater monitoring programmes, as well as to develop groundwater recharge and artificial recharge strategies to replenish the aquifer. Additionally, this programme also puts forward an activity to target the implementation of land use planning and zoning regulations to protect groundwater resources from pollution and overuse can also involve managing land use, and the development of an information management system to ensure that there is accurate, accessible data on groundwater is crucial for informed decision-making.

The combination of these actions under the "Groundwater Management" programme presents a comprehensive approach to ensure water security under a changing climate. By addressing issues like infrastructural complications, groundwater dependency, and legal requirements, this programme supports the broader strategic priority of ensuring water security in the MDM.

Table 19: 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 DM Area.	• ***Desk-based research***: Conduct a review of existing literature, data, and reports to gain an understanding of the historical and current state of groundwater resources in the area, as well as any previous studies that have been conducted. • ***Field investigations***: Collect and analyse data from monitoring wells, boreholes, and other sources to determine the quantity and quality of groundwater in the area. This may involve drilling new boreholes or installing monitoring wells to collect data on groundwater levels, water quality, and other relevant parameters. • ***Hydrogeological modelling:*** Develop and use computer models to simulate the behaviour of groundwater resources in the area, including the movement of water through the aquifers and the interaction between surface water and groundwater. • ***Stakeholder engagement:*** Engage with local communities, water users, and other stakeholders to understand their needs and concerns related to groundwater resources in the area. • ***Developing a groundwater management plan***: Use the data collected and the models developed to develop a plan for the sustainable management and use of groundwater resources in the DM 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	• 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.

Programme 5: Implementing Sustainable Groundwater Use and Development Strategy	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
Levels, Water Quality, and Potential Pollution Sources, Enabling Early Detection Of Potential Problems and Timely Intervention.	• 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.

Programme 5: Implementing Sustainable Groundwater Use and Development Strategy	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
Implementing Land-Use Planning and Zoning Regulations to Protect Groundwater Resources from Pollution and Overuse.	• Conduct a groundwater vulnerability assessment to identify areas where groundwater resources are most at risk from pollution and overuse. • Develop and enforce land-use planning and zoning regulations that limit activities that may threaten groundwater quality, such as restricting the construction of hazardous waste facilities near groundwater sources. • Establish setback requirements that limit the distance between certain land uses and groundwater sources. • Develop best management practices for land uses that have the potential to impact groundwater quality, such as agriculture, mining, and construction. • Encourage the adoption of sustainable development practices that reduce the demand for groundwater, such as green roofs, rainwater harvesting, and greywater recycling. • Establish monitoring programmes to track changes in groundwater quality and quantity over time, and to detect and respond to potential threats to groundwater resources. • Providing education and outreach to stakeholders, including landowners, developers, and the public, about the importance of protecting groundwater resources and the regulations and guidelines in place to do so.
Develop a 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 DM 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.

Programme 5: Implementing Sustainable Groundwater Use and Development Strategy	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
	• Conduct regular reviews and updates of the groundwater information management system to ensure that it remains current, relevant, and effective.

7.5. Climate Change Goal 2: To protect biodiversity and improve sustainable use of natural resources:

Goal:	To conserve and sustainably manage natural resources, maintain healthy ecosystems, and enhance their ability to mitigate the impacts of climate change.
Outcome:	A sustainable and climate-resilient natural environment with improved protected natural resources, promoting ecological well-being for the community.
Linkage to Mopani DM Development Priorities	KPA 3: Local Economic Development KPA 4: Spatial Rationale

7.5.1. Context

Protection of biodiversity and improvement In the sustainable use of natural resources is a critical component of climate change adaptation. In the context of the Mopani DM, the priority risks identified such as temperature increase, flooding, and increase in heatwaves, highlight the importance of planning for environmental management and conservation to mitigate the impact of climate change.

Biodiversity conservation is particularly important as it plays a significant role in the adaptation and resilience of ecosystems to climate change. Climate change threatens biodiversity by changing habitats and disrupting the food chain, ultimately leading to the loss of species. By focusing on biodiversity conservation, Mopani DM can protect its ecosystems and ensure the survival of native species, which in turn provides numerous benefits such as pollination, water filtration, and soil fertility, among others.

The aim of the goal is to contribute to the sustainability of the environment, safeguarding the health of the population, and promoting the resilience of the natural systems.

7.5.2. Programme 6: Integrate Critical Biodiversity Areas and Ecological Support Areas into the SDF

The integration of these areas into the spatial framework will enable the municipality to identify and map natural open spaces, ecosystems, and natural resources. Furthermore, it will allow for the incorporation of these inventories into the Spatial Development Framework, the Open Space Framework, and other relevant plans. This strategic inclusion of these critical and endangered ecosystems will facilitate their protection and management, contributing to the overall resilience of the municipality to climate change impacts.

Assessing the value of open spaces and ecosystems is also an important activity associated with this programme. This involves conducting assessments to determine the economic, social, and ecological value of open spaces and ecosystems. By understanding the value of these areas, the municipality can develop plans that ensure their protection and conservation, as well as the implementation of measures that improve their ecological functionality and resilience.

Table 20: Programme 6 - Integrate critical biodiversity areas and ecological support areas into the spatial framework.

Programme 6: Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Framework.	
ACTIONS	**KEY ACTIVITIES**
Ensuring critical biodiversity and ecological support areas are integrated into municipal spatial plans at all scales.	• 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.

Programme 6: Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Framework.	
ACTIONS	**KEY ACTIVITIES**
	• 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 the Spatial Development Framework 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 the Spatial Development Framework, open space framework, and other relevant plans, to guide future development and land-use decisions. • Updating the mapping and inventory information regularly to ensure it remains accurate and up-to-date with any changes in the natural environment.
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.

Programme 6: Integrate Critical Biodiversity Areas and Ecological Support Areas into the Spatial Framework.	
ACTIONS	**KEY ACTIVITIES**
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.

7.5.3. Programme 7: Conserve, Protect and Restore Natural Open Spaces, Ecosystems with Climate Change Adaptation Benefits

The programme involves several activities to ensure the protection and restoration of natural resources. The first activity involves assessing natural resources in the municipality and developing strategies to conserve and protect them. This can include identifying and mapping natural open spaces, ecosystems, and resources and identifying undeveloped open spaces that can potentially be used for green infrastructure.

Open spaces such as wetlands can be harnessed to absorb and filter stormwater runoff, which reduces the risk of flooding and erosion. Restoration of degraded ecosystems and natural resources is another important aspect of the programme, which includes planting trees, restoring natural habitats for endangered or protected species, and increasing the resilience of the ecosystem and the services it can provide.

Valuations of ecosystem services can be conducted to assess the value of natural resources and open spaces. These valuations highlight the importance of natural resources and open spaces to the local economy and encourage greater investment in their conservation and protection. Overall, this programme aims to safeguard the natural resources and open spaces in the DM to ensure a sustainable future for its residents, and by implementing these key activities, the municipality can enhance its resilience to climate change impacts while also providing a range of other benefits, such as improved water quality, enhanced biodiversity, and increased recreational opportunities.

Table 21: Programme 7 - Conserve, protect and restore natural open spaces, ecosystems and natural resources.

Programme 7: 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.	• Conduct a comprehensive inventory of natural resources, including land, water, and biological resources, to identify areas of high conservation value and areas of concern. • Assess the current state of natural open spaces, ecosystems, and resources to determine their condition and any threats or vulnerabilities they may face due to climate change. • Develop conservation plans and management strategies for high conservation value areas, ensuring that they are integrated into municipal spatial plans and protected through legislation, policy and land use management. • Implement measures to restore degraded natural open spaces and ecosystems, such as wetlands and riparian areas, to improve their function and resilience in the face of climate change. • Establish protected areas and ensure that they are managed effectively to ensure the conservation of natural resources and ecosystems.
Harnessing the potential of open spaces to absorb and mitigate the impacts of climate change.	• 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.

Programme 7: Conserve, Protect and Restore Natural Open Spaces, Ecosystems and Natural Resources.	
ACTIONS	**KEY ACTIVITIES**
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.

7.5.4. Programme 8: Enhanced Natural Resource Management

This programme comprises a series of activities designed to monitor and improve the quality of natural resources and reduce their pollution levels.

The first key action is to monitor and improve water quality. The municipality can participate in a comprehensive water quality monitoring programme to track the pollution levels in its water resources, including rivers and wetlands. This programme can identify sources of degradation and implement measures to reduce them, such as promoting best management practices for agriculture and industry and enforcing regulations to prevent sewage and industrial discharges into the waterways. Additionally, the municipality can invest in water treatment technologies to improve the quality of drinking water and wastewater discharge.

A key issue in terms of environmental degradation is soil erosion resulting from the removal of natural vegetation and changing rainfall patters. The municipality can implement measures to prevent soil erosion and preserve natural vegetation, such as the implementation of sustainable

land-use practices, tree planting, and soil conservation measures. This program can also promote sustainable forestry practices and agroforestry to reduce deforestation and land degradation.

In conclusion, the programme to enhance natural resources by improving the quality of air, soil, and water resources is a critical climate change response programme for the DM. It can help reduce the impact of climate change on natural resources, improve the health of ecosystems and communities, and support sustainable economic development.

Table 22: Programme 8 - Enhanced natural resource management and use of ecosystem services.

Programme 8: Enhanced Natural Resource Management and Use of Ecosystem Services	
ACTIONS	**ACTIVITIES**
Ensuring the quality of water resources.	• 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. • By implementing these key activities, Mopani DM can improve the quality of its water resources, protecting the environment and promoting sustainable socio-economic development.

Programme 8: Enhanced Natural Resource Management and Use of Ecosystem Services	
ACTIONS	**ACTIVITIES**
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.	• 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	• 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

Programme 8: Enhanced Natural Resource Management and Use of Ecosystem Services	
ACTIONS	**ACTIVITIES**
Use the District Environmental Management Forum (DEMF) to enhance collaboration and coordination between Sectoral Departments, Conversation Organisation and agencies related to natural resource management.	• 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.

7.6. Climate Change Goal 3: Increase the resilience of the agricultural sector to more extreme events such as storms and drought as well as indirect risks as pets and diseases.

Goal:	To enhance the resilience and well-being of Mopani DM'S agricultural communities and the agricultural sector by enhancing the resilience of agricultural production and distribution systems and communities to the impacts of climate change.
Outcome:	Improved resilience of the agricultural sector and communities to the impacts of climate change, such as storms and drought, and increased protection of food security.
Linkage to Mopani DM Development Priorities	KPA 1: Municipal Transformation and Organisational Development KPA 3: Local Economic Development KPA 5: Good Governance and Public Participation

7.6.1. Programme 9: Enhanced Resilience of Agricultural Production and Distribution Systems from Climate Change

Given the importance of agricultural production to Mopani DM's economy and the susceptibility of the sector to the impacts of climate change, this programme has been developed to enhance the resilience of agricultural production and distribution systems from climate change. Given that Mopani DM is at risk of increased temperatures and drought conditions, it is particularly important

for the agricultural sector to adapt to the impacts of climate change, in order to protect livelihoods and food security.

This programme aims to develop a knowledge base on the vulnerability of agriculture to the impacts of climate change through conducting a district-level vulnerability and risk assessment for the agriculture sector as well as the promotion of climate-resilient crop and livestock production systems and technologies in the commercial sector. It is also vital to foster partnerships as well as to align relevant plans in order to contribute to the enhanced resilience of the agricultural sector.

Table 23: Programme 9 - enhanced resilience of agricultural production and distribution systems from climate change.

Programme 9: Enhanced Resilience of Agricultural Production and Distribution Systems from Climate Change.	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
Develop a knowledge base on the vulnerability of agriculture to the impacts of climate change.	• Conduct a district-level vulnerability and risk assessment for the agricultural sector. • Promote climate-resilient crop and livestock production systems and technologies in the commercial sector. • Establish partnerships with institutions for targeted research and dissemination of results. • Establish a platform for collating weather data and analysis in the context of climate change and develop channels for communicating weather information to farmers across the district. • Align Climate Change Response Plans, Disaster Management Plans, Spatial Development Framework, Rural Development/ Growth and Development/ Local Development Strategies.
Align Climate Change Response Plans, Disaster Management Plans, Spatial Development Framework, Rural Development/ Growth and Development/ Local Development Strategies.	• Management/ rehabilitation of land owned by the DM to address the concern regarding the loss of agriculturally productive land and natural resources. • Develop a subsistence farming irrigation policy to facilitate the responsible use of water for irrigation.

7.6.2. Programme 10: Climate Resilient Agricultural Communities

In line with Programme 9, '**enhanced resilience of agricultural production and distribution systems from climate change'**, this Programme aims to respond to the risk that climate change poses on the agricultural sector, such as increased temperatures and increased drought conditions, and to enable farming communities to respond and adapt to the impacts of climate change, in order to protect livelihoods and food security.

This Programme considers enhancing the capacity for climate change adaptation in farming communities and industry through supporting subsistence farmers in accessing extension services, support of knowledge sharing and well as the development and implementation of community gardens that can be utilised for agriculture and food production. Additionally, this Programme promotes enhanced social protection for farming communities, which considers supporting farmer organisations in accessing financing and insurance products as well as documenting and assessing indigenous knowledge and coping strategies.

In conclusion, this programme aims to leverage innovation, and training to help the agricultural sector within the MDM adapt to and mitigate the impacts of climate change. This in turn will protect and enhance local livelihoods, contribute to food security, and promote sustainable and resilient community development.

Table 24: Programme 10 - Climate resilient agricultural communities

Programme 10: Climate Resilient Agricultural Communities	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
Enhanced Capacity for Climate Change Adaptation in farming communities and industry	• Support subsistence farmers in accessing extension services. • Host farmer field schools to support knowledge sharing on climate-resilient practices. • Implementation and utilisation of community gardens for agriculture and food production.
Enhanced social protection for farming communities.	• Support farmer organisations in accessing financing and insurance products. • Implementation and utilisation of community gardens for agriculture and food production. • Document and assess indigenous knowledge and coping strategies.

7.7. Climate Change Goal 4: Increase the adaptive capacity of human settlements to climate change and extreme events

Goal:	To enhance the resilience and well-being of Mopani DM communities by reducing their vulnerability to the impacts of climate change and extreme weather events through inclusive, community-led risk reduction strategies and improved access to resources and services.
Outcome:	Improved quality of life for all members of the Mopani DM community, with reduced risks from the impacts of climate change and extreme weather events, and enhanced opportunities for sustainable livelihoods, social inclusion, and overall well-being.
Linkage to Mopani DM Development Priorities	KPA 1: Municipal Transformation and Organisational Development KPA2 Basic Service Delivery KPA 3: Local Economic Development KPA 4 Spatial Rationale KPA 5: Good Governance and Public Participation KPA 6 Financial Viability

7.7.1. Context

The adverse effects of rising temperatures, heat waves, and uncertain rainfall patterns require the identification and prioritisation of climate change risks, along with the development of effective response measures for settlements.

Incorporating youth and gender considerations into adaptation actions is important to ensure that the actions taken are not only effective but also equitable. By actively engaging youth in these initiatives, we can harness their energy, creativity, and unique perspective while also ensuring inter-generational equity. This could be achieved by promoting youth leadership in climate change response activities. The incorporation of gender perspectives is also crucial, as climate change can disproportionately affect women and girls, particularly in vulnerable communities. Gender-responsive strategies could include ensuring women's participation in decision-making processes, addressing gender-specific climate change risks in health and safety plans, and promoting gender equity in access to resources and opportunities related to climate resilience.

Promoting public health and safety in the face of extreme weather events is essential to address the risks of illness and injury that may arise from such occurrences. Furthermore, ensuring food security by promoting local food production is a crucial element of this strategic priority. This will guarantee access to adequate and nutritious food even during climate change-induced disruptions to food supply chains. Community-based adaptation in high-risk communities is another essential aspect that aims to provide targeted support to the most vulnerable communities and individuals to cope with the impacts of climate change. Public awareness campaigns that involve communities, provide climate change training, and raise awareness are necessary to

equip the community with the necessary knowledge and skills to respond to climate change impacts.

7.7.2. Programme 11: Identify and Prioritise Climate Change Risks and Develop Response Measures for Settlements.

Identifying and prioritising climate change risks and developing response measures for settlements is crucial to ensure the long-term resilience of communities to climate change impacts. Informal settlements and vulnerable communities are likely to face exacerbated challenges related to housing, health, and livelihoods due to climate change. to address these challenges, Mopani DM should consider a programme aimed at achieving resilience and adaptation to climate change by assessing and identifying the risks and impacts of climate change and then developing suitable measures to reduce these risks.

This programme includes actions relating to conducting a vulnerability assessment to identify populations and locations most at risk of climate change impacts, establishing an early warning system, building local capacity for climate change adaptation and resilience through partnerships with stakeholders, and developing and implementing land use planning and zoning regulations that account for climate change impacts. These activities aim to enhance community resilience and ensure the long-term sustainability of settlements in the face of climate change.

Overall, this programme would help to ensure that local communities are not only able to withstand the impacts of climate change but also thrive in the face of these challenges. By empowering communities to take a leading role in adaptation efforts, this programme could also help to ensure that the benefits of these efforts are felt at the local level, supporting the well-being of the most vulnerable populations.

Table 25: Programme 11 - Identify and prioritise climate change risks and develop response measures for settlements.

Programme 11: 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 climate change. • 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 groups and NGOs, to build local capacity for climate change adaptation and resilience.	• Building partnerships with community groups to identify local needs and priorities for adaptation and resilience measures. • Providing capacity-building training to community members on disaster preparedness and response. • Collaborating with local NGOs to implement small-scale adaptation measures, such as rainwater harvesting and urban agriculture.
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.

7.7.3. Programme 12: Community-Based Adaptation in Communities Most at Risk of Climate-Related Hazards

Community-based adaptation (CBA) is an effective approach to addressing climate change risks in vulnerable communities. Implementing a CBA programme can enhance community resilience to climate change impacts. This can involve identifying community-based adaptation measures such as rainwater harvesting, greywater recycling, and community gardens to improve water security, reduce erosion and soil degradation, and improve food security.

Developing and implementing climate adaptation plans and policies can address the root causes of climate change risks and enhance the capacity of communities to manage and adapt to climate-related hazards. Other potential activities could include providing training and education programmes on climate change and its impacts and promoting traditional knowledge and practices that help communities adapt to changing environmental conditions.

Establishing partnerships and collaborations with relevant stakeholders such as local community-based organisations, NGOs, and government agencies can also be beneficial for the successful implementation of community-based adaptation measures.

Table 26: Programme 12 - Community-based adaptation in communities most at risk of climate-related hazards.

Programme 12: 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 stakeholders (such as the 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	• Organize community events and distribute educational materials (both physical and digital) to raise awareness.

Programme 12: Community-Based Adaptation in Communities Most at Risk Of Climate-Related Hazards.	
ACTIONS	**KEY ACTIVITIES**
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.***	• Implement training programs, workshops, and seminars for community members. • Hold public meetings to gather input and feedback on climate change issues. • Partner with local organizations and community groups to ensure the campaign's accessibility and relevance. • Develop a tailored public awareness campaign that addresses the needs of diverse and vulnerable populations. • Conduct outreach activities to educate the community on mitigation and adaptation strategies. • Provide capacity-building sessions for local leaders on sustainable practices. • Utilize multiple media channels, including social media, radio, and print, to share climate change messages. • Collaborate with educational institutions and stakeholders to expand the campaign's reach. • Establish feedback mechanisms to evaluate the campaign's effectiveness and adapt accordingly. • Build a network of community ambassadors to promote sustainable behaviors. • Develop partnerships with industry, research institutions, and government agencies to support the implementation of climate change solutions.

7.7.4. Programme 13. Climate Resilient Spatial Planning

Spatial planning is one of the key entry points for building climate resilience on a local level. Adaptation action involves creating long-term spatial plans to guide development to withstand the impacts of climate change while ensuring growth and development within the municipality. The activities that the programme could entail include ensuring that the spatial planning frameworks consider a long-term view of climate hazards and incorporate ecological infrastructure. The programme could also involve developing local-level climate-resilient planning mechanisms, such as precinct plans that are designed to be adaptable to the impacts of climate change. The municipality should also ensure collaborative strategic planning that incorporates all relevant departments in both strategic planning and project implementation.

Overall, the programme aims to ensure that the MDM is prepared for the impacts of climate change and that its development is sustainable and resilient. It represents a comprehensive,

integrated approach to spatial planning that recognizes the reality of climate change and the importance of building resilience at the community level.

Table 27: Programme 13 - Climate-smart spatial planning for climate-resilient growth and development.

Programme 13: Climate-Smart Spatial Planning For Climate-Resilient Growth and Development.	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
Ensure that spatial planning frameworks consider a long-term view of climate hazards and incorporate natural infrastructure.	• Conduct a review of current spatial planning frameworks, • Identify climate hazards and vulnerable areas in the municipality, • 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.

Programme 13: Climate-Smart Spatial Planning For Climate-Resilient Growth and Development.	
ACTIONS	**POSSIBLE KEY ACTIVITIES**
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 Municipal Spatial Development Framework (MSDF) 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.	• 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.

8. CLIMATE CHANGE MITIGATION

The Limpopo Climate Change Response Strategy highlights the importance of reducing Mopani's energy-related emissions in order to contribute to the province's overall GHG reduction targets (LEDET, 2022). Mitigation efforts in Mopani should prioritize transitioning to renewable energy sources, enhancing energy efficiency in industries and households, and promoting sustainable transportation (IPCC, 2022a). Furthermore, improving land-use practices, such as increasing soil carbon sequestration and reducing deforestation, will further support emission reductions

This approach, combined with robust adaptation measures, ensures that Mopani's climate action plan is comprehensive and aligned with local policy frameworks, addressing both current and future climate risks and vulnerabilities. By integrating climate mitigation and adaptation strategies, the Municipality can create a sustainable and resilient future for its communities, while contributing to national and provincial climate goals (UNEP, 2022).

The water sector is crucial in both climate change adaptation and mitigation. As a Water Service Authority (WSA), the Municipality must address climate change through mitigation strategies for long-term sustainability. Water-related processes, including extraction, treatment, distribution, and wastewater management, are energy-intensive and contribute to GHG emissions. Therefore, implementing mitigation strategies in the water sector is essential for reducing Mopani's carbon footprint while ensuring reliable water services for communities.

Mopani District Municipality, like many regions globally, faces significant climate challenges due to its GHG emissions, particularly in sectors such as energy, agriculture, transport, and waste. Implementing targeted mitigation strategies across these key sectors is vital for reducing the district's carbon footprint and contributing to global climate goals. Below are the climate change mitigation strategies for Mopani, covering water, biodiversity, agriculture, energy, ecosystems, livelihoods, transport, and waste management.

8.1. Water Sector

The water sector is both a contributor to and a victim of climate change. Energy-intensive water extraction, treatment, distribution, and wastewater management processes contribute significantly to GHG emissions.

Mitigation Strategies:

- ***Energy Efficiency in Water Treatment and Distribution****:* Improve energy efficiency in water treatment plants by integrating energy-efficient technologies such as advanced membrane filtration, energy recovery systems, and optimized pump systems. Reducing water losses through improved leak detection, repair, and automation can also lower energy consumption and GHG emissions.
- ***Renewable Energy for Water Treatment****:* Harness solar energy, given Mopani's abundant sunlight, to power water treatment plants. This would reduce reliance on fossil fuels for water treatment processes, thereby lowering emissions.

- ***Water Recycling and Reuse**:* Promote greywater recycling in residential and commercial buildings, and encourage industries to adopt water reuse systems, reducing both water extraction and energy consumption. Stormwater harvesting can also alleviate pressure on conventional water sources.
- ***Water-Saving Technologies**:* Encourage the adoption of water-saving technologies in agriculture (drip irrigation) and households (low-flow appliances). Public education campaigns on water conservation can also help reduce water demand and associated energy usage

8.2. Biodiversity

Biodiversity in Mopani plays a critical role in carbon sequestration and ecosystem health. However, climate change and human activity pose significant risks to the region's biodiversity. Mitigation Strategies:

- ***Conservation and Restoration of Natural Habitats**:* Implement conservation projects and restore degraded ecosystems through afforestation, reforestation, and sustainable land-use practices. These activities can increase carbon sequestration and preserve biodiversity.
- ***Incentivizing Sustainable Land-Use Practices**:* Promote biodiversity-friendly farming and forestry practices, ensuring the protection of critical habitats while enhancing carbon storage.
- ***Protected Areas and Corridors**:* Create and expand protected areas and ecological corridors to maintain biodiversity, allowing species to migrate and adapt to changing climate conditions.

8.3. Agriculture

Agriculture is a significant source of GHG emissions in Mopani, especially from land-use change, livestock, and crop production. In addition to this, it holds potential for mitigation through sustainable practices.

Mitigation Strategies:

- ***Sustainable Agricultural Practices**:* Promote agroecological methods such as conservation tillage, agroforestry, crop rotation, and organic farming. These practices reduce emissions from fertilizers, improve soil health, and enhance carbon sequestration.
- ***Climate-Smart Agriculture (CSA)**:* Encourage CSA practices that increase productivity and resilience to climate change while lowering emissions. This includes precision agriculture techniques, the use of cover crops, and efficient water management.
- ***Livestock Emissions Reduction**:* Implement strategies to reduce methane emissions from livestock, such as improved feeding practices and livestock manure management systems.
- ***Soil Carbon Sequestration**:* Promote the use of soil conservation practices, including no-till farming and the incorporation of organic materials into the soil to sequester carbon.

8.4. Energy

The energy sector is a major contributor to GHG emissions in the Muncipality, primarily through electricity sales, use of other energy sources. Transitioning to renewable energy sources is essential for reducing emissions.

Mitigation Strategies:

- ***Renewable Energy Transition****:* Increase the share of renewable energy sources such as solar and biomass. Mopani's solar potential is vast, and investments in solar energy systems for both residential and industrial sectors can reduce dependence on coal.
- ***Energy Efficiency****:* Encourage energy-efficient building codes and industrial practices to reduce energy demand. The use of energy-efficient technologies in both public and private sectors, such as LED lighting and high-efficiency appliances, can lower energy consumption and emissions.
- ***Industrial Energy Efficiency****:* Promote energy efficiency in food processing, non-metallic minerals, and non-ferrous metal industries through energy audits, modern equipment, and waste heat recovery technologies.

8.5. Ecosystems

Ecosystems provide essential services, including carbon sequestration, water filtration, and soil stabilization, all of which are vital in mitigating climate change.

Mitigation Strategies:

- ***Ecosystem Restoration****:* Invest in the restoration of degraded ecosystems such as wetlands, forests, and grasslands. These ecosystems can enhance carbon storage and resilience to climate change.
- ***Agroforestry****:* Promote agroforestry systems that integrate trees with agricultural production. These systems not only store carbon but also enhance biodiversity, improve water retention, and reduce soil erosion.
- ***Sustainable Water Management****:* Implement Integrated Water Resource Management (IWRM) to protect watershed areas, reduce water over-extraction, and ensure sustainable water use that supports both agriculture and ecosystems.

8.6. Livelihoods

The livelihoods of the people of Mopani are closely linked to the sectors of agriculture, energy, and biodiversity. Enhancing climate resilience while reducing emissions in these sectors will protect and create sustainable livelihoods.

Mitigation Strategies:

- ***Green Jobs****:* Create green jobs in the renewable energy, energy efficiency, waste management, and sustainable agriculture sectors. Training and upskilling workers in climate-resilient practices will also help improve livelihoods while reducing emissions.

- ***Diversified Livelihoods**:* Support communities in diversifying their income sources by investing in sustainable practices such as eco-tourism, sustainable agriculture, and the use of renewable energy technologies.

8.7. Transport

The transport sector is another significant contributor to GHG emissions in the Municipality, particularly due to the reliance on fossil fuels.

Mitigation Strategies:

- ***Public Transport Systems**:* Develop and promote efficient public transportation options such as buses, trains, and shared mobility services. This will reduce the dependence on private vehicles, lowering transport-related emissions.
- ***Electric Vehicles (EVs)**:* Promote the use of electric vehicles (EVs) by providing incentives for EV purchases and investing in EV charging infrastructure. This will help reduce emissions from the transport sector and lower local air pollution.
- ***Non-Motorized Transport (NMT)**:* Encourage walking and cycling by developing pedestrian-friendly infrastructure and cycling lanes. This reduces the need for short car trips, further decreasing emissions.

8.8. Waste Management

Waste management, including both solid waste and wastewater, contributes significantly to GHG emissions, particularly methane from landfills and untreated wastewater.

Mitigation Strategies:

- ***Waste-to-Energy (WtE)**:* Develop waste-to-energy facilities to reduce the amount of waste sent to landfills while generating clean energy.
- ***Recycling and Composting**:* Encourage waste segregation and expand recycling and composting infrastructure. Reducing organic waste in landfills will minimize methane emissions, while composting organic waste can produce nutrient-rich soil for agriculture.
- ***Circular Economy**:* Promote a circular economy by reducing, reusing, and recycling materials. This will not only reduce waste but also decrease emissions from waste processing and disposal.
- ***Wastewater Treatment**:* Improve wastewater treatment processes to reduce methane emissions from untreated or partially treated wastewater. Encouraging the reuse of treated wastewater in agriculture and industry can also reduce the overall environmental footprint.

8.9. Human Settlements

Mitigation Strategies

- ***Promote sustainable urban planning and resilient infrastructure**:* This ensures that new developments are designed to be resilient to climate impacts, such as flooding, heatwaves,

and extreme weather events. Sustainable urban planning promotes the efficient use of resources and ensures community safety.

- ***Improve building codes to integrate climate-resilient designs****:* This helps mitigate risks from climate change by ensuring buildings are designed to withstand extreme weather conditions, reduce energy use, and improve the overall resilience of settlements.
- ***Upgrade informal settlements with resilient infrastructure****:* This aims to improve the living conditions of vulnerable communities by providing better infrastructure, reducing the risk of flooding, and improving access to essential services, while enhancing resilience to climate impacts.

Specific activities for climate change mitigation in the various sectors are presented in Table 28 below:

Table 28: Climate change mitigation strategies for Mopani District Municipality.

Sector	Specific Activities
Water	• Improve energy efficiency in water treatment plants. • Integrate renewable energy (solar) in water systems. • Promote water-saving technologies and recycling.
Biodiversity	• Implement conservation and restoration projects. • Promote sustainable land-use and agroforestry.
Agriculture	• Promote climate-smart agriculture and sustainable land-use practices. • Enhance soil carbon sequestration. • Improve livestock management practices.
Energy	• Increase use of renewable energy (solar, wind, biomass). • Implement energy efficiency programs in industries and households. • Promote energy audits.
Transport	• Develop public transport systems. • Promote electric vehicles (EVs) and alternative fuels. • Improve cycling and walking infrastructure.
Waste	• Promote waste-to-energy technologies. • Expand recycling and composting infrastructure. • Improve wastewater treatment processes.
Ecosystems	• Restore and protect wetlands, forests, and grasslands. • Promote agroforestry. • Implement Integrated Water Resource Management (IWRM).
Livelihoods	• Develop green jobs in renewable energy, sustainable agriculture, and waste management. • Diversify income sources with eco-tourism and sustainable industries.

9. IMPLEMENTATION

9.1. Implementation Framework & Action Plan

An Implementation Framework & Action Plan has been developed and forms as an attachment to this Climate Change Response Strategy.

The Plan is a vital resource for putting into action the climate change response strategies outlined in this Strategy. It provides detailed actions and projects aimed at mitigating and adapting to climate change effects and should be considered in conjunction with this strategy.

By adopting a proactive and practical approach, the plan makes use of local resources and expertise to promote a sustainable and resilient future. It prioritizes integrated planning, collaboration with stakeholders, and capacity building to address climate risks, adapt to inevitable changes, and support the achievement of global climate goals.

9.2. Enabling Mechanisms for Implementation

9.2.1. Institutional Arrangements

The establishment of a Climate Change Response Strategy is a significant step towards adapting to and mitigating the impacts of climate change. However, to effectively implement this strategy, it is essential to optimise the institutional arrangements within Mopani DM for implementing and mainstreaming climate change.

It is also crucial for the District Municipality to align the Climate Change Response Strategy with the various plans and policies of each department. This alignment will ensure that climate change goals are integrated into all aspects of municipal operations, and KPIs are linked to each department's responsibilities. For instance, the IDP, Spatial Development Framework, and Local Economic Development Strategy of the Planning and Economic Development department can incorporate targets and actions related to climate change. Furthermore, having District and Municipal forums/ platforms that discuss and engage on climate change-related issues is an important step in mainstreaming climate change. This provides an opportunity to engage cross-departmentally, across different levels of government and across various stakeholder groups in order to foster knowledge-sharing and collaborative decision-making.

The municipality should consider assigning the lead responsibility for each climate action to a department that has the necessary expertise, resources, and capacity. It is equally crucial for the municipality to determine which departments can support the lead department in implementing the climate action. Each department's complementary expertise, resources, and capacity should be taken into account when assigning supporting roles. The heads of each department should be consulted to ensure that they agree with the proposed lead and supporting roles. This consultation

process will help to identify potential challenges and provide insights on how the action can be effectively implemented. The municipality should document the departmental roles and responsibilities for each climate action in the Climate Change Response Strategy. This documentation will ensure that all stakeholders understand their responsibilities and can work together to achieve the goals of the strategy. Regular check-ins and progress reports should be made to ensure that the strategy is being implemented effectively, and any issues can be addressed in a timely manner.

In conclusion, optimising institutional arrangements for addressing climate change in Mopani DM requires assigning clear responsibilities for each department and aligning the Climate Change Response Strategy with each department's plans and policies. This alignment will help to integrate climate change goals into all aspects of municipal operations and ensure that progress towards the goals is tracked and reported. By working collaboratively and leveraging the expertise, resources, and capacity of each department, the municipality can effectively address the impacts of climate change in the area.

9.2.2. Governance Considerations

It is recommended that the Mopani DM ensures that each department has clear responsibilities for addressing climate change and that those responsibilities are linked to key performance indicators (KPIs) to track progress towards climate goals. This can be achieved by aligning existing plans and policies with climate change goals and tracking progress towards those goals through specific KPIs. The Planning and Economic Development department can align its plans, such as the Integrated Development Plan (IDP), Spatial Development Framework, and Local Economic Development Strategy, with climate change goals.

The department can also develop KPIs, such as the number of local businesses that have adopted sustainable practices or the amount of renewable energy generated in the municipality, to track progress towards climate goals. The municipality should prepare to respond to natural disasters, such as floods and wildfires, which are expected to increase in frequency and severity due to climate change. By aligning climate change goals with existing plans and policies and tracking progress through KPIs, municipalities can ensure that climate change is integrated into all aspects of municipal operations. This will help to ensure that the municipality is making progress towards a more sustainable future and is prepared to deal with the impacts of climate change.

9.2.3. Information Management

Implementing the Climate Change Response Strategy in Mopani DM effectively necessitates the cultivation of a risk avoidance mindset among all stakeholders. This entails empowering officials, politicians, residents, and other participants through comprehensive education, training, and public awareness campaigns, underpinned by scientific research. By enhancing awareness and understanding of climate change impacts and responses, a sense of responsibility and ownership among stakeholders can be fostered.

To achieve this, Mopani DM can undertake the following actions:

- The Municipality can develop and implement an integrated education and training programme on climate change and its impacts on the District Municipality. This should be targeted at officials, politicians, and residents to ensure a common understanding of climate change and the importance of taking action.
- Mopani DM can use scientific research and data to inform education and training materials and ensure that stakeholders receive accurate and up-to-date information. This can also help identify critical risk areas and areas where action is most urgently needed.
- The municipality can promote public awareness campaigns on climate change and its impacts. This can be done through various channels, such as social media, community workshops, and public events. Such campaigns can help raise public awareness and understanding of climate change and the need for action, as well as provide practical guidance on steps individuals can take to mitigate their impact.
- The district municipality can encourage participation in climate change mitigation and adaptation actions by residents, civil society organisations, and the private sector by providing opportunities for engagement and collaboration. This can include establishing partnerships with relevant stakeholders to develop and implement joint initiatives and providing resources and support to individuals and organisations that are taking action.
- Mopani DM can establish partnerships with academic institutions and research organisations to ensure ongoing access to the latest research and expertise in the field of climate change. This can help to ensure that the municipality is up-to-date with the latest developments in the field and can leverage the latest knowledge and tools to inform its decision-making and actions.
- The Municipality should incorporate indigenous knowledge systems in its climate change response strategies. By recognizing and integrating traditional ecological knowledge, practices, and values that have been passed down through generations, Mopani DM can harness valuable insights into local climate patterns, sustainable land management, and resource use. Engaging communities with indigenous knowledge can complement modern scientific approaches, ensuring more culturally relevant, sustainable, and locally adapted solutions. This approach can also empower indigenous and local communities, honoring their roles in climate resilience while promoting community-driven adaptation strategies.
- The Municipality should identify and maintain records of climate change initiatives, including projects and programs related to monitoring, research, and planning, and ensure these are reported to the National Climate Change Response Database (NCCRD) or any such platforms as prescribed by the national department responsible for Climate Change.

By fostering a culture of risk avoidance and capacitating all role players, Mopani DM can create a conducive environment for the effective implementation of the climate change response plan, ultimately contributing to a more resilient and sustainable district. This will necessitate an enduring commitment and effort, alongside continuous engagement with stakeholders to ensure their needs and viewpoints are incorporated into climate change policies and initiatives.

9.2.4. Funding Mechanisms

Climate change is an increasingly pressing challenge for municipalities in South Africa, and addressing it requires significant funding. Various funding mechanisms are available to support climate change response initiatives, including national and international grants, public-private partnerships, and municipal budgets. However, municipalities may face issues such as insufficient funds, limited capacity to manage funds effectively, and limited access to funding sources.

Table 29 below summarizes the funding mechanisms available to South African municipalities for climate change response.

Table 2929: Funding mechanisms available to municipalities for climate change response

Funding Mechanism	Description	Potential Use for Climate Change Projects	Limitations/Challenges
Municipal Infrastructure Grant (MIG)	Provides funding for the development of basic infrastructure, including water, sanitation, and solid waste management.	Can fund climate change response projects related to basic infrastructure needs, such as water management and sanitation.	Limited in scope, may not cover all necessary climate change projects. Municipalities may struggle to meet all needs with this funding alone.
Green Fund	A national funding mechanism that provides financing for green initiatives, including renewable energy, energy efficiency, and climate change adaptation and mitigation.	Can finance renewable energy, energy efficiency, and climate change mitigation and adaptation projects.	Limited resources and significant competition for funding from other municipalities and organizations.

Funding Mechanism	Description	Potential Use for Climate Change Projects	Limitations/Challenges
Global Environment Facility (GEF)	Provides financing for climate change response programmes in developing countries, focusing on environmental sustainability.	Can finance climate change adaptation and mitigation projects in developing regions.	Stringent eligibility requirements and complex application processes. Accessing funding can be challenging.
Green Climate Fund (GCF)	A global fund that provides financing for climate change mitigation and adaptation in developing countries, focusing on sustainable development.	Can finance large-scale projects related to climate change adaptation, mitigation, and low-carbon development.	Stringent requirements for eligibility and access to funding. Complex processes and competition for limited funds.
Public-Private Partnerships (PPPs)	Involves collaboration between the public and private sectors to finance and implement infrastructure projects, providing mutual benefits for both.	Can be used for financing climate change response programs by leveraging private sector resources, expertise, and investment.	Requires careful management of terms to ensure fairness, with risks of private sector priorities overshadowing public interests. Private sector partner commitment is essential.

There are several issues that municipalities may face when accessing funding for climate change response programmes. These challenges are presented in Table 32 below with potential solutions to each problem.

Table 30: Summary of challenges municipalites may face when accessing funding for climate change response programs.

Issue	Description	Challenges	Potential Solutions
Lack of Technical Expertise	Municipalities may lack the in-house technical capacity to develop and implement detailed project proposals, especially for funding agencies that require specialized knowledge.	• Difficulty in developing detailed, high-quality project proposals. • Limited expertise to meet the technical requirements of funding organizations.	• Build technical capacity in-house through training and hiring of experts. • Form partnerships with technical consultants and academic institutions.
Limited Resources for Climate Change Response	Municipalities are often financially constrained and may prioritize other basic service delivery needs over climate change projects.	• Financial limitations restrict the ability to allocate funds for climate change programs. • Climate change response seen as a lower priority compared to immediate needs.	• Prioritize climate change initiatives as part of broader development planning. • Seek additional funding from external sources (e.g., green bonds, crowdfunding).
Financial Constraints	Many municipalities already face significant budget shortfalls, making it challenging to allocate funds for climate change initiatives.	• Existing financial pressures result in insufficient funds for climate change projects.	• Explore innovative financing mechanisms such as green bonds, crowdfunding, and public-private partnerships (PPPs). • Engage in resource sharing arrangements with neighboring municipalities.

Issue	Description	Challenges	Potential Solutions
Low Priority for Climate Change Projects	Due to competing priorities (such as basic services), climate change projects may not receive the attention or funding they deserve.	• Climate change may be seen as a long-term issue, not immediately urgent. • Basic services such as water and sanitation take precedence.	• Advocate for climate change integration into broader municipal development and planning frameworks. • Raise public awareness to emphasize climate urgency.

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

9.3. Recommendations for mainstreaming

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

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

response. These documents can be revised to include climate evidence and response actions.

Some specific mainstreaming recommendations include:

1. **Key Performance Indicators (KPIs**): Climate responsiveness/sustainability outcomes should be included in the KPIs of all departments, ensuring that progress towards climate goals can be tracked and measured.
2. **Raising Awareness:** Conducting awareness training with groups like the Project Management Unit, Strategic Procurement, Councillors, and other relevant entities can facilitate mainstreaming. By improving their understanding of climate change and the need for adaptation and mitigaion, these groups can better integrate climate considerations into their work.
3. **Policy and Plan Updates:** Existing policies and plans should be updated to reflect the climate risk profile, adaptation actions and mitigation strategies. This could include incorporating climate change considerations into land use plans, infrastructure development strategies, and emergency management plans.
4. **Funding:** MDM should explore existing and new revenue streams to support climate change response efforts. This could include applying for grants from government agencies, engaging in public-private partnerships, and incorporating climate change adaptation and mitigaiton into budget planning processes.
5. **Capacity Building:** There is a need for ongoing training and capacity building of officials in all departments to enhance their understanding of climate change and their ability to incorporate climate considerations into their work.
6. **Establishing Networks or Partnerships:** MDM should consider establishing networks or partnerships with civil society organisations, the private sector, government, and other relevant entities to bolster climate adaptation efforts.

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

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