GREENBOOK
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MMSEZ
Musina Makhado Special Economic Zone

Musina-Makhado Special Economic Zone
Adaptation Action Plan

JULY 2024

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List of Acronyms and Abbreviations

CBA	Critical Biodiversity Area
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEMF	District Environmental Management Forum
DFFE	Department of Forestry, Fisheries, and the Environment
DRR	Disaster risk reduction
ESA	Ecological Support Areas
EcVI	Economic Vulnerability
EnVI	Environmental Vulnerability
GCM	General circulation model
GHG	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
LED	Local Economic Development
NGOs	Non-governmental organisations
PVI	Physical Vulnerability Index
SEVI	Socioeconomic Vulnerability
SEZ	Special Economic Zone
SDF	Spatial Development Framework
SMMEs	Small, Micro and Medium-sized Enterprises
SPLUMA	Spatial Planning and Land Use Management Act, 2013 (Act No.16 of 2013)
WSDP	Water Sensitive Design and Planning

Glossary of Terms

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 (CSIR, 2023).
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).
Climate hazards	Climate hazards are a sub-set of natural hazards and a grouping of hydrological, climatological, and meteorological hazards. This includes the spatial extent and frequency of, among others, floods, fires, and extreme weather events such as extreme rainfall and extreme heat. Sometimes referred to as hydrometeorological hazards. The potential occurrence of a climate hazard may cause loss of life, injury, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources (IPCC, 2022). Climate hazards can increase in intensity and frequency with climate change (Pieterse et al., 2023).

Climate risk	Risk implies the potential for adverse consequences resulting from the interaction of vulnerability, exposure, and a hazard. Relevant adverse consequences include those on "lives and livelihoods, health and well-being, economic and sociocultural assets, [as well as] infrastructure and ecosystems" (IPCC, 2022, p. 144). In the IPCC's 6th Assessment Report, it is confirmed that risks may result from "dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system" (IPCC, 2022, p. 132).
Coping capacity	"The ability of people, institutions, organizations and systems, using available skills, values, beliefs, resources and opportunities, to address, manage, and overcome adverse conditions in the short to medium term" (IPCC, 2022, p. 2904).
Disaster risk reduction	"Denotes both a policy goal or objective, as well as the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard or vulnerability; and improving resilience" (IPCC, 2022, p. 2906).
Exposure	Exposure implies the physical exposure of elements to a climate hazard. It is defined as 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 [by climate hazards]" (IPCC, 2022, p. 2908).
Mainstreaming	The process of integrating climate change adaptation strategies and measures into existing planning instruments and processes as opposed to developing dedicated adaptation policies and plans (Pieterse et al., 2021).
Resilience	"The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation" (IPCC, 2022, pp. 2920–2921).
Sensitivity	"The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise)" (IPCC, 2022, p. 2922).
Vulnerability	Vulnerability is defined as 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" (IPCC, 2022, p. 2927). Vulnerability refers to the characteristics or attributes of exposed elements, i.e., elements that are exposed to potential climate-related hazards. Vulnerability is a function of sensitivity and (coping or adaptive) capacity (Pieterse et al., 2023).

1. Introduction

Climate change impacts vary widely from region to region in South Africa, and are reflected by floods, droughts, heatwaves, and coastal erosion, among others. These impacts directly threaten life, economic well-being, property, infrastructure, and ecosystems, as well as the ability of local government to provide public services. It is local government's responsibility and duty to provide leadership in planning and preparing to manage these risks for the sake of the well-being, safety, and security of individuals within their jurisdiction (SABS, 2023). The purpose of this document is to strengthen the capability of local government to prepare for climate change threats and associated risks.

This Climate Change Adaptation Plan and its accompanying Risk Profile report have been specifically drafted for the Musina-Makhado Special Economic Zone (SEZ), with the aim of strengthening its strategic response to climate change. These documents derive their insights from the GreenBook (www.greenbook.co.za), a freely accessible online planning support system. The GreenBook is a unique and invaluable resource, providing quantitative scientific evidence to assist local governments in comprehending their climate risks. It plays a pivotal role in guiding the adaptation of settlements to withstand the impacts of both current and future climate challenges.

Designed as an information-rich tool, the GreenBook caters to South African local governments, offering insights into risks and vulnerabilities associated with population growth, climate change, exposure to hazards, and the vulnerability of critical resources. Moreover, the GreenBook not only diagnoses these challenges but also provides practical adaptation measures. These measures are essential for cities, towns, and settlements, empowering local government to mitigate the impacts of climate hazards on communities, the environment, the economy, and municipal assets and infrastructure, while aligning with broader developmental goals (refer to Green Book l Adapting settlements for the future).

The Climate Risk Profile report and the Climate Change Adaptation Plan serve distinct yet interlinked purposes and strategic objectives. They aim to:

1. Drive and advance the local climate change response agenda.
2. Provide a foundational framework for strategy and planning within the SEZ.
3. Systematically identify and prioritise risks and vulnerabilities.
4. Pinpoint and prioritise targeted interventions and responses.
5. Facilitate the integration of climate change response, particularly adaptation, into mainstream policies and practices.

In essence, these documents are instrumental in equipping the Musina-Makhado SEZ with a comprehensive strategy to navigate the complexities of climate change, reduce vulnerability and exposure, and champion sustainable development.

The Adaptation Plan briefly outlines the policies constituting the framework for adaptation planning and implementation in South Africa. It then goes on to describe generic adaptation principles, approaches, pathways, and various categories of actions. Subsequently, the plan suggests a specific adaptation strategy for the Musina-Makhado SEZ by aligning it with adaptation goals, programmes, and actions designed to address priority risks, as well as an implementation framework, designed to identify appropriate actors and enable the implementation of the strategy. Finally, the document concludes with

recommendations aimed at facilitating the integration of the proposed actions into broader initiatives, ensuring their effective mainstreaming.

2. Policy Framework

South Africa's institutional policy and legislative framework makes provision for climate change adaptation at all levels of government, with local government increasingly identified as the primary driver of climate change adaptation. For instance, there exists various national policy and legislative mechanisms that promote, necessitate, guide and/or regulate climate change adaptation at the local level. These include the Disaster Management Amendment Act, i.e., Act No. 16 of 2015, the Spatial Planning and Land Use Management Act (SPLUMA), i.e., Act No. 16 of 2013, the Climate Change Bill (B9 of 2022), the 2011 National Climate Change Response White Paper, as well as the 2019 National Climate Change Adaptation Strategy.

While the Disaster Management Amendment Act requires each organ of state, as well as provincial and local government to identify measures for, as well as indicate plans to invest in, disaster risk reduction (DRR) and climate change adaptation; SPLUMA identifies the principles of (1) spatial resilience – which involves accommodating "flexibility in spatial plans, policies and land use management systems, to ensure sustainable livelihoods in communities most likely to suffer the impacts of economic and environmental shocks" (Republic of South Africa., 2013, p. 20) – some of which may be induced by the impacts of climate change, and (2) spatial sustainability, which sets out requirements for municipal planning functions such as spatial planning and land use management to be carried out in ways that consider protecting vital ecosystem features such as agricultural land, i.e., from both anthropogenic and natural threats, including the impacts of climate change, as well as in ways that consider current and future costs of providing infrastructure and social services in certain areas (e.g., uninformed municipal investments may lead to an increase in the exposure of people and valuable assets to extreme climate hazards) amongst the key principles intended to guide municipal planning and development. The Climate Change Bill (DEA, 2018) sets out requirements for every District Intergovernmental Forum to serve as a Municipal Forum on climate change that coordinates climate response actions and activities in its respective municipality, while also requiring every municipality to report on their climate change response needs and draft resultant climate risk assessments, as well as climate change response and -implementation plans.

Moreover, the National Climate Change Response White Paper identifies local governments as critical role players that can contribute towards effective climate change adaptation through their various functions, including human settlement planning; urban development; municipal infrastructure and services provision; water and energy demand management; and local disaster response, amongst others. The National Climate Change Adaptation Strategy (DEA, 2019) outlines several actions that are applicable at local government level, including the development and implementation of adaptation strategies and vulnerability reduction programmes for communities and individuals that are most at risk to the impacts of climate change; the development of municipal early warning systems; as well as the integration of climate change adaptation into municipal development plans and relevant sector plans.

In response to the national call to advance spatial transformation and consolidation in human settlement development, the National Department of Human Settlements (DHS) has identified and gazetted a total of 136 Priority Human Settlements and Housing Development Areas (PHSHDAs). The PHSHDAs were declared to ensure that housing delivery is used to restructure and revitalise towns and cities, strengthen the livelihood prospects of households, and overcome apartheid spatial patterns by fostering integrated

urban forms (DHS, 2020). PHSHDAs were designated using national criteria which includes an area or settlement's potential to support sustainable environmental management (which plays a critical role in mitigating the negative impacts of climate change, particularly through nature-based adaptation solutions), as well as its potential to accommodate the integration of land uses and amenities, i.e., in addition to other criteria.

The DHS has identified two key objectives for PHSHDAs, including (1) targeting and prioritising areas for integrated housing and human settlements development to ensure the delivery of housing for a diverse range of income groups within an integrated mixed-use development, as well as (2) transforming spatial patterns which have historically exacerbated social inequality and economic inefficiency (PLM, 2021). As part of the second objective, this initiative aims to develop post-apartheid cities and city patterns that ensure urban access, as well as achieve a balance between spatial equity, economic competitiveness and environment sustainability (PLM, 2021). As the impacts of climate change become more severe, the latter outcome (i.e., ensuring and maintaining environmental sustainability) will become increasingly important. Furthermore, as part of the implementation approach for housing and human settlement development in PHSHDAs, the DHS has identified the provision and maintenance of ecological infrastructure to support development in priority areas as a key avenue for integrating climate considerations and mainstreaming climate responses, including climate change adaptation.

3. Adaptation Principles, Approach, Programmes & Actions

Climate change mitigation and adaptation refer to the two primary strategies aimed at addressing the adverse effects of climate change, i.e., by either delaying, reducing, redistributing, or avoiding the impacts. Although disaster risk reduction and climate change mitigation form part of the overall climate change response agenda, the focus of this plan is on adaptation.

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, 2022, p. 2898) that may derive from unavoidable impacts of climate change such as extreme hazards. The climate change adaptation agenda is concerned with adapting species, people, places, assets, and systems, to the impacts of actual or anticipated climate-related risks and implements various measures or actions to achieve this (Behsudi, 2021).

This section of the report outlines adaptation principles, drawing from the recommendations by the South African Bureau of Standards. It also presents a structured approach to selecting adaptation options, categorises adaptation actions, and explains the concept of an adaptation pathway.

3.1. Adaptation principles

The Bureau for Standards recently proposed the following principles that apply to local government when adapting to climate change (SABS, 2023):

i. Accountability: Local governments not only acknowledge but also assume responsibility for their climate change adaptation efforts. They willingly subject themselves to appropriate scrutiny and accept the duty to respond to this scrutiny.

ii. Continual learning and improvement: Recognising the uncertainties in knowledge and the dynamic nature of drivers of change, available knowledge and evidence, and the contextual factors, continual learning and improvement are essential for effective climate change adaptation.
iii. Mainstreaming and embedding: The effectiveness of climate change adaptation is maximised when integrated into local government operations, encompassing policies, plans, procedures, risk management, and implementation strategies.
iv. Flexibility: Embrace a flexible approach that considers technical, social, administrative, political, legal, environmental, and economic circumstances. This allows for the accommodation of a diverse range of data availabilities and technical and institutional capacities to meet goals and objectives.
v. Practicality: Set practical and achievable goals and objectives. Impractical targets may hinder the successful realisation of climate change adaptation benefits. Focus on easily measurable indicators/metrics with available underlying data and compare them across scales to avoid imposing additional burdens.
vi. Prioritisation: During the identification of adaptation plans and measures, prioritise areas based on the relative characteristics of climate change impacts (magnitude, likelihood, and urgency). Consider the capacities of stakeholders and the local government and community's ability to act.
vii. Proportionality: Undertake actions that are most effective under the current circumstances, including economic, social, cultural, and political contexts, capabilities, knowledge, and evidence base. Aspire for continual improvement in identifying and assessing adaptation measures.
viii. Relevance: Facilitate assessments that provide decision-makers and practitioners with meaningful information for adaptation planning, considering appropriate spatial scales and relevant time durations.
ix. Transparency: Ensure that reports and communications on climate change adaptation are openly, comprehensively, and understandably presented, providing accessible information for all interested parties (SABS, 2023).

These principles should be considered when formulating adaptation goals, programmes, and measures (also referred to as 'actions').

3.2. Adaptation approach

The approach that was followed to develop this adaptation plan revolves around comprehending the climate-related risks and implementing adaptive measures in response to these risks. Climate-related risk encompasses the potential for adverse consequences arising from the interplay of vulnerability, exposure, and the occurrence of climate hazards (IPCC, 2022). The components of risk are dynamic, with the occurrence of climate hazards influenced by both natural climate variability and anthropogenic climate change. The exposure of individuals, the built environment, and the natural surroundings to climate hazards is driven by both planned and unplanned development and growth. Vulnerability is the inherent characteristics that make systems sensitive to the effects and impacts of climate hazards.

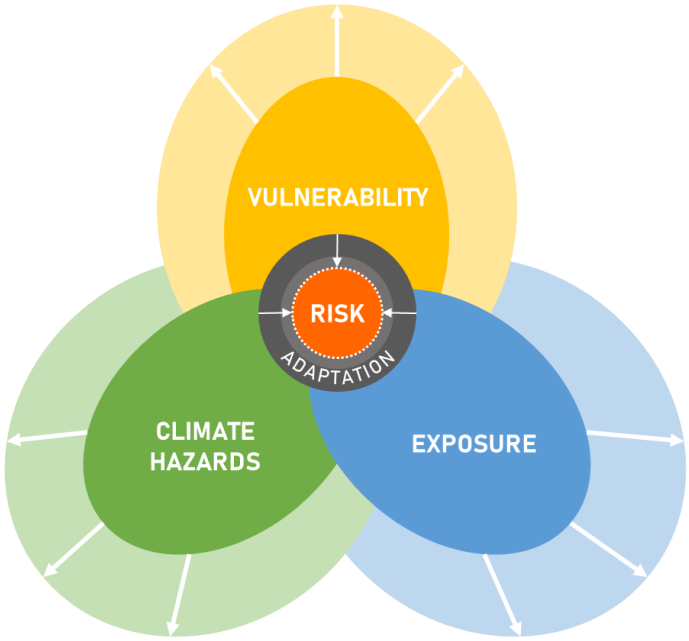

Figure 1: The interplay between hazards, vulnerability and exposure that determines risk (based in IPCC, 2014 and IPCC, 2021)

The inherent uncertainty in future climate trends underscores the necessity for a flexible response and the formulation of adaptable, medium to long-term adaptation strategies.

The approach followed in this plan involves the following steps:

i. Gain an understanding of climate risk in a specific geographic area.
ii. Identify priority climate hazards/zones based on the risk profile.
iii. Establish adaptation goals to mitigate the risk associated with priority hazards/zones.
iv. Develop adaptation programmes with measures/actions to achieve these goals.
v. Integrate climate considerations into other sector plans/instruments/strategies.

Refer to Table 1 for a more detailed description of this approach.

Table 1: The adaptation approach

Understand climate risk for a specific geographic area	A climate risk profile assesses risk by determining – in a specific geographic area and at a specific scale – the likelihood of a hazard to occur, the inherent vulnerability of various systems, and exposure of these systems to specific climate hazards. To be able to develop an appropriate adaptation plan, it is important to understand what contributes to risk and vulnerability.
Identify priority climate-related risks/zones	Identify the climate hazards and impacts that pose the greatest risk at present and in the future within a geographic area. If possible, also identify climate risk zones that need to be prioritised for intervention.

Establish adaptation goals	Identify adaptation goals to address priority risks/zones that speak to policy goals.
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 hazard/vulnerability/exposure. • Suggest a target or an indicator to measure progress. • Be assignable to a primary implementer. • Consider co-benefits and other possible implications. • Include mitigation as far as it builds resilience or reduces exposure and vulnerability.
Mainstream climate considerations into planning	Integrate evidence of climate risk, adaptation goals, programmes, and actions into existing instruments and processes. The aim is to ensure that climate change considerations are an integral part of all that local government is doing.

The primary aim of an adaptation plan is to address both current and anticipated future risks and vulnerabilities while also leveraging opportunities for long-term transformation and sustainable development.

3.3. Adaptation programmes and actions

An adaptation programme is a structured and systematic set of actions, initiatives, and interventions aimed at local governments to adapt their localities to the impacts of climate change. It involves the practical implementation of specific goals identified in the plan.

Broadly, adaptation actions include anticipatory and reactive measures. Anticipatory adaptation involves proactive measures taken in preparation for anticipated climate change impacts, while reactive adaptation entails responding to climate change effects as they are experienced. Furthermore, it facilitates the integration and prioritisation of climate change adaptation and resilience measures into various planning mechanisms and processes (CSIR, 2023).

A spectrum of adaptation actions is at the disposal of municipalities to enhance resilience and mitigate risks posed by changing climatic patterns and extreme weather events. Some of the categories of actions include:

- Infrastructure development, encompassing the construction of, for example, seawalls, levees, and storm surge barriers to protect against rising sea levels and extreme weather events. These engineered solutions provide immediate protection and buy time for longer-term adaptation efforts but are mostly very expensive to build.
- Green infrastructure initiatives offer sustainable and nature-based solutions. Municipalities can implement urban green spaces, green roofs, and permeable pavements to absorb excess water, reduce flooding, and mitigate the urban heat island effect. Such approaches not only enhance climate resilience but also contribute to improved air quality and overall urban liveability.

- Environmental protection such as restoring ecosystems like mangroves, dunes, and wetlands, not only provides natural buffers but also supports biodiversity.
- Integrated urban planning is essential to create climate-resilient municipalities. Land-use regulations should be adapted to consider climate risks, prioritising construction practices that enhance resilience. Elevating structures above projected flood- and sea levels and using climate-resilient materials in building design can minimise the impacts of flooding and storm damage.
- Early warning systems and emergency preparedness plans are critical tools to ensure swift responses to extreme weather events, minimising the impact on vulnerable communities.
- Innovative water management strategies are essential for municipalities facing changing precipitation patterns and increasing water scarcity. Diversifying water sources, implementing water efficiency measures, and investing in advanced stormwater management systems contribute to water security and sustainable resource use.
- Engagement and education are pivotal components of successful adaptation strategies. Empowering officials, and residents, to understand and respond to climate risks through awareness campaigns, education programmes, and participatory planning initiatives can enhance local adaptive capacity (CSIR, 2023).

Local governments must embrace a combination of structural, natural, and community-based approaches to build resilience and adaptive capacity, protect vulnerable communities, while ensuring long-term sustainability in the face of evolving climate challenges.

4. Summary of Climate Risk Profile

A Climate Risk Profile report was prepared by the project team, designed to complement this Plan. The Climate Risk Profile report serves as an essential resource for understanding the risks associated with climate change in Musina and Makhado local municipalities, as well as the Musina-Makhado SEZ..

This section of the Plan summarises the Climate Risk Profile for Musina and Makhado local municipalities, as well as Musina-Makhado Special Economic Zone (SEZ) in particular, drawing from the GreenBook Risk Profile Tool (available at: https://riskprofiles.greenbook.co.za/). Please consult the accompanying Climate Risk Profile report for more detailed information.

4.1. Climate projections, vulnerabilities, and impacts

At the baseline (current), large parts of Musina Local Municipality experience average temperatures of between 22 and 24 °C, while Makhado Local Municipality also experiences average annual temperatures of between 20 and 24°C, with higher temperatures prevalent in the western parts of the latter local municipality. The projections show average annual temperature increases of between 2.09 and 2.67°C in the Local Municipality of Musina and increases of between 2.35 and 2.69 °C in Makhado Local Municipality by 2050, under an RCP 8.5 “business as usual” emissions scenario. The Musina-Makhado SEZ (PHSHDA) experiences average annual temperatures of between 22 and 24 °C; this is expected to increase by 2.5 °C, by the year 2050, assuming an RCP 8.5 low emissions scenario.

Musina Local Municipality experiences current GCM derived average annual rainfall of between 400 and 800 mm, with higher averages found in the eastern parts of the local municipality. Makhado Local Municipality experiences current GCM derived average annual rainfall of between 400 and 1600 mm, with

higher averages also prevalent in the eastern parts of the municipality. The projections show changes in average annual rainfall of between 49.77 mm less and 113.29 mm more for Musina Local Municipality, as well as 28.28 mm less and 51.40 mm more for Makhado Local Municipality, by 2050, under an RCP 8.5 "business as usual" emissions scenario. The Musina-Makhado SEZ currently experiences average annual rainfall of 400 mm, with increases of between 0 and 100 mm per annum projected for the area, by 2050.

Musina Local Municipality's socio-economic vulnerability (SEVI) has decreased (improved) between 1996 and 2011, and is well below the national average. Therefore, when compared to the national average, the local municipality houses a considerably low amount of socioeconomically vulnerable households. The municipality's economic vulnerability (EcVI), however, worsened in the same period, and peaked to a score that is noticeably higher than the national average (7.19). Musina Local Municipality's economy is therefore highly susceptible to the negative impacts of external shocks, including climate hazards. Musina Local Municipality also has very high physical vulnerability (PVI), as well as the third highest environmental vulnerability (EnVI) score in the province. While the remoteness of the settlements in the municipality contributes to the high physical vulnerability score, the high environmental vulnerability (EnVI) score alludes to the large presence of ecological assets in the area, and the impact of development and urbanisation on those assets.

Makhado Local Municipality's socio-economic vulnerability also decreased (improved) between 1996 and 2011, while the economic vulnerability increased in the same period. The local municipality's high unemployment rate of 36,7% contributed to this score. While the municipality has an average environmental vulnerability score, its physical vulnerability is considerably high, the fifth highest in the province, out of a total of 22 local municipalities. This alludes to the high structural vulnerabilities present in the municipality, as well as the remoteness of the settlements found in the municipal area.

In 2011, Musina Local Municipality recorded a population of 104 654, with 104 034 people residing in settlements. The settlement-based population increased by 47.63% between 2001 and 2011, and is expected to increase by 106.12% between 2011 and 2030. In 2016, the local municipality recorded a total population of 132 009, about 9.47% of the total population in Vhembe District (Musina Local Municipality, 2023). Makhado Local Municipality had a settlement-based population of 401 524 in 2011, which increased by 6.72% between 2001 and 2011, and is expected to increase by 15.66% between 2011 and 2030. In 2019, the local municipality had a total population of 416 728 (Makhado Local Municipality, 2022).

4.2. Priority climate-related hazards

The greatest risks faced across the Musina-Makhado SEZ / PHSHDA are increased temperatures, heat extremes and drought. The area may also face a high risk of wildfire on the wildland-urban interface once development intensifies. The water supply vulnerability in both local municipalities is expected to increase into a climate-changed future. Moreover, the planned high-density settlement and expansion of industrial development in the area, may further exacerbate this. Therefore, to protect the area from water shortage and insecurity, there may be a need to diversify portable water supply and conserve available water.

Both Musina and Makhado Local Municipalities have highly vulnerable economies (EcVI), settlement fabrics (PVI) – in term of remoteness and structural vulnerabilities – and natural environments (EnVI), which undermine their ability (as well as that of the SEZ in its current state) to recover from external shocks, including climate hazards, if not addressed. The high unemployment rate and undiversified

economy are key contributors to the high economic vulnerability. It is, therefore, essential to manage these factors by diversifying the local economy with sectors that can absorb the existing labour force, while having a minimal impact on climate change. The SEZ's existing and envisaged mining beneficiation (industrial development), ecotourism and agri-tourism sectors, emerge as catalytic sectors with the potential to grow the economy and create jobs, while having a minimal impact on the climate and the environment, although climate-sensitive design principles will have to be applied when developing and expanding the industrial sector. There is therefore value in adapting these sectors to the impacts of climate change. The development of (climate proof) infrastructure, and provision of services and adequate housing in close proximity to areas of employment, as well as the conservation of ecological assets (some of which play a critical role in buffering the impacts of climate change), will also reduce some of the other vulnerabilities present in both municipal areas and the SEZ in particular.

5. Adaptation Goals, Programmes and Actions

The section outlines the adaptation plan using goals and actions designed to help the Musina-Makhado SEZ to adapt to the impacts of climate change. Based on the assessment of the potential risks and vulnerabilities posed and/or exacerbated by climate change, this plan was developed as a proactive strategy to mitigate these risks and enhance resilience.

5.1. Adaptation goals

Drawing upon the assessment of the current and projected climate-related risks and vulnerabilities outlined in the preceding section, the following adaptation goals for the Musina-Makhado SEZ were identified, prioritising those risks with the highest potential impact. These goals were validated by stakeholders during the first engagement with the local municipalities:

- Goal 1: To ensure water security in the face of climate change.
- Goal 2: To reduce the exposure and vulnerability of human and natural systems to climate
- change and extreme weather events.
- Goal 3: To develop a climate-resilient, low-carbon, diverse and inclusive rural economy that is socially responsible, environmentally sustainable and that provides job opportunities for unskilled, semi-skilled and skilled local residents.

5.2. Adaptation programmes and actions

The adaptation programmes below identify the overarching programmes and their actions, necessary to achieve each one of the goals. Specific timeframes and responsibilities are allocated in the subsequent implementation framework.

5.2.1. Goal 1: To ensure water security in the face of climate change

Given the water scarcity challenges in the country, as well as the effects that the projected increase in temperatures (which increase evaporation and reduce runoff, thus reducing the amount of water captured and stored for future consumption), drought tendencies and population growth will have on both local municipalities' (and by default the SEZ's) future water supply – developing comprehensive strategies for water resource management is crucial. As part of these strategies, both local municipalities, and the relevant stakeholders of the Musina-Makhado SEZ, could therefore prioritize water infrastructure maintenance; invest in efficient water supply infrastructure to meet future demand; promote water

conservation practices by implementing strategies such as public awareness campaigns, leak detection and repairs, water metering and billing; as well as explore measures to secure alternative water sources such as rainwater (harvesting), groundwater (recharge and extraction) and wastewater (reuse).

Programme 1.1: Integrated Water Supply Management

The programme aims to ensure a reliable and sustainable water supply by identifying, developing, and utilizing alternative sources of water. This programme's rationale is grounded in the belief that reducing reliance on a single water source and diversifying the water supply portfolio can increase resilience to climate change impacts such as drought, increasing temperatures and heat extremes – which result in increased evaporation and reduce the amount of water stored in dams. The adaptation actions under this programme are outlined below:

i. Address human resources constraints for effective water management: Training and capacity building in water management, water conservation, and climate change could enhance municipal ability to adapt.
ii. Undertake water resource management planning: This action involves a comprehensive analysis of the water resources in the local municipality, determining the current and future demand, and assessing how this demand can be met through a mix of traditional and alternative water sources.
iii. Diversify water supply and investigate alternative water sources: Explore alternatives to freshwater resources (such as greywater re-use) to bolster resilience to climate change.
iv. Review, or develop, and implement a treated wastewater reuse strategy: Water reuse strategy should promote at-source greywater reuse, as well as the large-scale reuse of treated wastewater (effluent), for the purposes of conserving and augmenting available potable water resources, while meeting demand.
v. Review, or develop, and implement a groundwater management strategy: implementing a sustainable groundwater use and management strategy is essential for adapting the resource to climate change impacts, ensuring groundwater sustainability, and securing the continued supply of safe water in the municipality.
vi. Review, or develop, and implement a stormwater management strategy: Stormwater management strategy should promote the sustainable collection, storage, and use of stormwater (from household to catchment level), for the purposes of conserving and augmenting available potable water resources, while meeting demand.
vii. Review the bulk water master plan: This review should consider (i) the expected increase in water demand due to urbanisation, economic development, and population growth, (ii) the projected changes in climate conditions and climate change impacts, as well as (iii) the need to ensure water security.
viii. Implement monitoring mechanisms and protect water sources by reducing pollution: Monitoring mechanisms provide regular and reliable data on water quality, allowing for timely interventions.

Programme 1.2: Integrated Water Demand Management

The programme aims to promote efficient water use and decrease wastage to ensure long-term water security in the Musina-Makhado SEZ (as well as the Vhembe District Municipality as a whole). This approach is crucial given the ageing infrastructure, discrepancies in water access, the effects of climate change, and regulatory compliance demands in the municipality. The adaptation actions under this programme are outlined below.

i. Implement water conservation measures: Implementing water conservation measures can range from promoting water-efficient technologies and practices and enhancing public awareness about the importance of saving water, to implementing strict regulations on water use during periods of drought.
ii. Implement alien invasive species clearing initiatives in catchment areas: Alien invasive species, particularly those encroaching into river systems, often consume more water than native species, thus compromising water security. Their presence can lead to the degradation of water catchment areas. Therefore, enhancing water security should involve implementing the strategic clearing of these invasive species from catchment areas, which in turn protects these vital water sources.
iii. Adopt a Water Sensitive Design and Planning (WSDP) approach for brownfield and greenfield developments: A WSDP approach is intended to simultaneously promote development, as well as the sustainable use of resources, particularly water resources.

Programme 1.3: Education and Awareness Raising around Climate Change and Sustainable Water Use

As the climate projections suggest more frequent periods of water stress due to increased temperatures and drought tendencies, it is therefore of paramount importance that Musina and Makhado local municipalities, as well as the Musina-Makhado SEZ enhances water conservation awareness and education. This programme is aimed at improving the community's understanding of climate change impacts, particularly the importance of sustainable water management and its role in mitigating these impacts. This programme is grounded in the belief that an informed and engaged community is crucial to achieving long-term water security in the face of climate change. The adaptation actions identified under this programme are outlined below.

i. Develop water conservation education programmes: Workshops, community outreach, and public awareness campaigns can be used to disseminate information about the benefits of water conservation, water-saving techniques, and the long-term impact of these actions on water availability and quality.
ii. Promote water conservation in households: This can involve providing households with practical guidance and tools to reduce water consumption. For example, educational materials can be distributed to homeowners about water-efficient appliances and fixtures such as low-flow showerheads and dual-flush toilets, rainwater harvesting systems, and greywater reuse techniques.
iii. Encourage businesses to implement water-saving measures: This might involve hosting workshops for businesses on water-efficient practices, providing recognition or incentives for businesses that achieve significant water reductions, and promoting the use of water-efficient technologies in industrial processes.
iv. Conduct research on water conservation: This can involve investigating the impact of existing conservation measures, identifying barriers that prevent or hinder water conservation, and exploring innovative approaches and technologies for water conservation.
v. Engage community leaders and stakeholders: Engaging community leaders and stakeholders in promoting water conservation can help to build momentum, secure buy-in, and thus increase participation in water conservation efforts.

5.2.2. Goal 2: To To reduce the exposure and vulnerability of human and natural systems to climate change impacts and extreme weather events

To minimise the damage and loss stemming from the unavoidable impacts of climate change, it is essential to reduce the exposure and vulnerability of elements found in both human and natural systems present in the Musina-Makhado SEZ / PHSHDA, to climate-related hazards and extreme events. Reducing exposure and vulnerability will involve a combination of infrastructural, behavioural, and institutional changes. For human systems, this might involve building climate-resilient infrastructure, providing climate-proof housing, developing or improving existing disaster risk reduction strategies, and enhancing social safety nets for the most vulnerable. For natural systems, this can involve protecting and restoring ecosystems and ecological assets that provide natural buffers against climate impacts, such as wetlands that absorb flood waters and natural fire breaks (e.g., creeks, bluffs).

Programme 2.1: Identification and prioritisation of climate change risks, and the consequent development of appropriate response measures for human settlements

Identifying and prioritising climate change risks and developing appropriate response measures for human settlements is crucial to ensure the long-term resilience of communities to the impacts of climate change. Informal settlements, rural households and other vulnerable communities are likely to face exacerbated challenges in terms of access to quality housing, health, and livelihoods due to climate change. To address these challenges, the local municipality could consider the implementation of this programme, which is 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 those risks. The programme could include conducting a risk and vulnerability assessment to identify populations and locations most at risk to climate change impacts, establishing early warning systems, building local capacity for climate change adaptation and resilience through partnerships with other relevant stakeholders, as well as 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. The adaptation actions identified under this programme are outlined below.

i. Conduct a risk and vulnerability assessment to identify the populations and locations most at risk to climate change impacts: Helps in establishing priority areas for interventions and formulating effective, targeted climate change adaptation strategies.
ii. Develop and implement early warning systems to help communities prepare for, and respond to, climate change risks: Having robust early warning systems is crucial to prepare communities for impending hazards, and to facilitate timely responses to minimise the impact.
iii. Establish partnerships with local stakeholders, such as community groups and NGO: These partnerships foster local capacity-building, making communities more skilled at handling climate change-related challenges, a critical need in a region frequently exposed to various environmental threats.
iv. Develop and implement land use planning and zoning regulations that take into account the potential impacts of climate change: Integrate climate change considerations into land use planning and zoning regulations (land use management) and adopt planning practices that consider potential climate impacts.

Programme 2.2: Climate resilient spatial planning

This programme is fundamental in the municipality's endeavour to mitigate and adapt to the impacts of climate change. It acknowledges that traditional approaches to spatial planning may not be adequate in the face of climate change, which presents new and evolving challenges. The programme seeks to integrate climate change considerations into spatial planning, fostering resilience and ensuring the municipality's urban, peri-urban and rural spaces are better prepared for future climate conditions. The adaptation actions under this programme are outlined below.

i. Ensure that spatial planning frameworks consider a long-term view of climate hazards, while incorporating green infrastructure: Integrate an understanding of future climate hazards into spatial planning and recognises the crucial role of green infrastructure in climate adaptation, such as wetlands, swales, rain gardens, as well as retention and detention ponds for flood regulation.
ii. Develop local-level climate-resilient planning instruments – precinct plans: At the local level, these plans will guide development that's designed to withstand climate impacts and ensure the longevity and sustainability of the City's communities.
iii. Ensure collaborative strategic planning that incorporates input from all relevant municipal functions: Collaboration should occur from the strategic planning phase to the project implementation phase
iv. Create mechanisms to strengthen public participation in planning and decision-making processes: Public involvement ensures plans reflect local needs and knowledge, thus improving the effectiveness and acceptance of climate-resilient plans (i.e., securing buy-in
v. Develop and design urban, rural and townships to be more resilient: This involves designing the municipality's urban, rural and township areas with climate resilience in mind, such as designing urban green spaces to mitigate heatwaves and floods.
vi. Identify climate risk zones and hotspots that affect vulnerable municipal infrastructure and assets: Helps to prioritise where resilience needs to be built most urgently, and where infrastructure upgrades or changes may be necessary.

Programme 2.3: Integrated fire management for climate resilience

This programme is pivotal for Musina-Makhado SEZ, given its present conditions and forecasted wildfire risk. The programme seeks to systematically mitigate the risk and consequences of wildfires through a series of focused activities. The adaptation actions identified as part of this programme are outlined below.

i. Conduct a comprehensive evaluation of fire hazards: Examine fire ecotypes, the likelihood and severity of wildfire occurrences, and their socioeconomic repercussions.
ii. Chart a strategic fire deterrence roadmap: The "strategic fire deterrence roadmap" should define preventative steps and actions to alleviate wildfire risk, such as maintaining firebreaks, controlling flammable vegetation, and applying safe land-use practices.
iii. Engage communities and educate them on fire safety: Raising awareness about fire risks, preventative measures, and actions to take during a wildfire.
iv. Invest in advanced fire detection and monitoring infrastructure: Establish advanced fire detection and monitoring infrastructure to keep track of wildfires, potentially employing remote sensing technologies and early warning systems.
v. Develop an Emergency Preparedness and Response Strategy: Ensure prompt and effective containment and rescue operations.

vi. Conduct post-fire restoration and ecosystem rehabilitation: This action could involve efforts to restore the ecosystem and rehabilitate affected regions.
vii. Undertake fire management policy and by-law development: This would involve establishing regulations to bolster wildfire management and climate resilience
viii. Promote and support innovation in fire management techniques: This could stimulate studies into improved wildfire management strategies.
ix. Encourage inter-organisational collaboration and form strategic partnerships: Promote collaboration and enable the exchange of knowledge, resources, and support.
x. Strengthen fire management capacities and ensure effective use of resources: Boost the competencies of wildfire management personnel, and thus ensure the efficient use of resources, and improve infrastructure where necessary.

Programme 2.4: Community-based adaptation in communities most at risk to climate-related hazards

This programme is crucial for building resilience and mitigating the impacts of climate change in the Musina-Makhado SEZ. It's built around the understanding that local communities, often the first to feel the impacts of climate change, need tailored, place-based adaptation solutions. The programme emphasises empowering local communities and leveraging their knowledge in creating and implementing climate adaptation strategies. The adaptation actions identified under this programme are outlined below.

i. Conduct detailed risk and vulnerability assessments in communities to identify drivers of risk: By identifying these risks at a granular level, the municipality can develop adaptation measures that are specific, targeted, and effective.
ii. Develop and implement community-based adaptation measures to reduce risks and build resilience: Promote climate-smart agricultural practices, ensuring food security, and building community resilience.
iii. Provide training and education to build community capacity and promote sustainability: Equip community members with the knowledge and skills needed to adapt to climate change.
iv. Conduct comprehensive community engagements and raise public awareness initiatives on climate change: Ensure that awareness campaigns are inclusive, accessible, and relevant to all members of the community.

Programme 2.5: Conservation, protection and restoration of Musina-Makhado SEZ's natural open spaces and ecosystems, with the aim of exploiting climate change adaptation benefits

In light of the evolving climate dynamics in the Musina-Makhado SEZ, this programme emerges as an essential strategy for a resilient future. It addresses the significant risks posed by climatic variations, such as drought, increasing temperature, heat extremes, wildfires, and flooding, on the local municipality's natural resources, ecosystems, and open spaces, and prioritizes their conservation, protection, and restoration. This is geared towards leveraging these spaces' inherent ability to provide ecosystems services such as absorbing greenhouse gases, acting as buffers against severe weather events, and providing vital habitats for a wide range of species. The adaptation actions under this programme are outlined below.

i. Assess natural resources and ensure that natural open spaces, ecosystems, and resources are conserved, protected, and restored: This adaptation action involves regular monitoring and scientific analysis of the condition and health of natural spaces and resources.
ii. Implement nature-based solutions to mitigate/buffer against the impacts of climate change and severe weather, particularly in climate-risk zones: For example, in areas susceptible to wildfires,

measures might include managing vegetation to reduce fuel loads, creating firebreaks, and conducting controlled burns. In flood-prone zones, restoring wetlands and implementing sustainable land use and management practices to reduce runoff could be key actions.

Programme 2.6: Enhancement of Musina-Makhado SEZ's Natural Resource Management

Considering the rapidly changing climate within the Musina-Makhado SEZ, this programme represents an integral strategy for building the local municipality's resilience and ensuring sustainable development. It addresses the pressing need for careful stewardship of the municipality's natural resources, such as water and soil, and seeks to strengthen institutional and community capacity to manage these resources sustainably in the face of climate change. The adaptation actions associated with this programme are outlined below.

i. Monitor and prevent soil erosion to ensure the long-term health and productivity of natural ecosystems, as well as maintain the quality of water resources: This includes regular monitoring of erosion hotspots, land-use planning that factor in erosion risk, as well as the implementation of soil conservation measures, such as sustainable agricultural practices.
ii. Provide training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines: The training can help to build capacity and knowledge of these regulations, ensuring that those involved in natural resource management have the skills and understanding needed to comply with the regulations and guidelines effectively.
iii. Establish a District Municipal Environmental Management Forum (DEMF): Such a forum could serve as a platform to enhance collaboration and coordination between sectoral departments, conversation organisations, and agencies related to natural resource management. Attach Key Performance Indicators (KPIs) for various sectoral departments to the attendance of the forum.

Programme 2.7: Integrate Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) into the Spatial Development Framework (SDF)

This programme underscores the vital importance of acknowledging the intrinsic and instrumental value of natural spaces and ecosystems in the planning and development agenda of the Musina-Makhado SEZ. The local municipality's climate change projections further demonstrate the necessity of this initiative. The adaptation actions under this programme are outlined below.

i. Ensure critical biodiversity and ecological support areas are integrated into Musina and Makhado's municipal spatial plans at all scales: The municipality's ecologically vital areas should be incorporated into the municipal spatial planning process to guarantee their preservation and sustainable use.
ii. Identify and map natural open spaces, ecosystems, and natural resources, and integrate them into the Spatial Development Framework and the Open Space Framework.
iii. Identify undeveloped open spaces with potential for green infrastructure: Such spaces can provide vital climate adaptation benefits, such as heat mitigation, increased stormwater management, as well as the provision of habitats for biodiversity, therefore contributing to the overall resilience of the municipality.
iv. Assess the value of open spaces and ecosystem services: Quantify and appreciate the ecological, economic, and socio-cultural value offered by the local municipality's open spaces and the services its ecosystems provide.

5.2.3. Goal 3: To develop a climate-resilient, low-carbon, diverse and inclusive rural economy that is socially responsible, environmentally sustainable and that provides job opportunities for unskilled, semi-skilled and skilled local residents

A climate-resilient rural economy would be one that can absorb and recover from climate shocks; that also contributes minimally to climate change. This might involve promoting sustainable agricultural practices that are adaptive to changing climate conditions, investing in renewable energy sources, and encouraging diversification of the rural economy into sectors that are less climate-sensitive (e.g., ecotourism). Furthermore, efforts to create more inclusive economies, that also provide job opportunities at all skill levels, may involve training programs for local residents, policies to support small, micro and medium enterprises, as well as the implementation of measures designed to ensure that economic opportunities and the benefits of economic activities are equitably distributed (e.g., rural development and services provision).

Programme 3.1: Low-carbon rural economic transformation

The low-carbon rural economic transformation programme in the Musina-Makhado SEZ is a strategic initiative aimed at transitioning the local rural economy towards more sustainable, low-carbon practices. The local municipality is home to a range of industries, including agriculture, government, tourism, as well as the beneficiation industries of the some of the municipality's leading primary sectors, some of which rely heavily on carbon-intensive practices. This programme aims to address these challenges and promote environmental sustainability while also supporting economic growth and job creation. The adaptation and mitigation actions under this programme are outlined below.

i. Promote the use of renewable energy technologies in agricultural, mining, as well as beneficiation industries to reduce carbon emissions: This involves advocating for and facilitating the adoption of renewable energy technologies such as solar power, wind power, and bioenergy across key sectors.
ii. Establish incentives for businesses in the local municipality to switch to low-carbon, adaptive operations: Promote the use of incentives like subsidies or tax reductions to encourage businesses to adopt green technologies and reduce their carbon footprints and contribute to adaptation.

Programme 3.2: Inclusive and diverse economic development

The *inclusive and diverse economic development* programme for the Musina-Makhado SEZ aims to foster an economy that provides opportunities for all citizens, irrespective of their skill level, and reduce dependence on a single sector by promoting economic diversity. The actions identified under this programme are outlined below.

i. Implement skills training programmes aimed at individuals with different skills levels to facilitate diverse job creation: Equip the residents of the Musina-Makhado SEZ with skills that are relevant to various sectors including agriculture (beneficiation), mining (beneficiation), tourism, and others.
ii. Develop policies to support the growth of Small, Micro and Medium-sized Enterprises (SMMEs): Policies could be designed to provide financial, technical, and logistical support to SMMEs in key sectors such as agricultural and mining beneficiation, as well as tourism.

iii. Introduce economic diversification initiatives that can create new industries: Identify and foster growth in potential new industries, such as eco-tourism, agro-processing, renewable energy, organic farming and mining beneficiation.

Programme 3.3: Social responsibility and environmental stewardship

Within the context of the Musina-Makhado SEZ, the *social responsibility and environmental stewardship* programme aims to foster a culture of care and respect for the environment among local communities, businesses, and other stakeholders. It seeks to safeguard the natural resources, biodiversity, and ecosystems in the local municipality by promoting responsible practices and mitigating environmental degradation. The adaptation actions identified under this programme are outlined below.

i. Develop and implement environmental protection regulations: In line with local municipality's commitment to environmental stewardship, new regulations may be established to protect the region's natural resources, biodiversity, and ecosystems.
ii. Launch community awareness campaigns: Raising awareness about the importance of environmental sustainability and responsible practices is crucial for instilling a culture of environmental stewardship in the municipality.
iii. Establish partnerships with local communities, businesses, and NGOs: Partnerships enable collaborative work on socially responsible initiatives such reforestation projects, cleanup drives, and the promotion of community-based tourism that respects local cultures and environments.

Programme 3.4: Climate-resilient agricultural communities

This programme aims to respond to the risks that climate change impacts (including impacts such as increased temperatures, heat extremes and increased drought conditions) pose on the agricultural sector and farming communities, and aims to enable those communities to respond and adapt to the impacts of climate change, in order to protect livelihoods and food security. The adaptation actions under this programme are outlined below.

i. Enhance capacity for climate change adaptation in farming communities and industry: Support subsistence farmers in accessing extension services, fostering knowledge sharing between relevant stakeholders, and through the development of community gardens that can be utilised for agriculture and food production.
ii. Enhance social protection for farming communities: Support farmer organisations in accessing financing and securing insurance, as well as documenting, assessing and (where applicable) applying indigenous knowledge and coping strategies.

Programme 3.5: Climate-smart transport strategy for resilience and efficiency

This programme aims to improve accessibility, affordability, and resilience of transport infrastructure and services in the Musina-Makhado SEZ, while mitigating their environmental impact. The programme takes into consideration the unique challenges faced by the region including poor road conditions, the inability of the transport system to meet basic accessibility needs, unaffordability of transport services for vulnerable populations, lack of flexibility in response to customer demands, and inadequate infrastructure development. The adaptation and mitigation actions under this programme are outlined below.

i. stablish an evidence-base and assess vulnerability of the transport and mobility sector: Developing an understanding the current state of the transport system in the City, including the

number of taxis, condition of roads, accessibility of the transport system, and affordability of services.

ii. Develop and implement a low-carbon, inclusive transport plan: Designing an integrated transport system that addresses the region's specific challenges through a low-carbon framework, promoting the use of energy-efficient vehicles, optimizing routes for fuel efficiency, and encouraging public transit, walking and cycling, where feasible, to reduce carbon emissions.

iii. Enhance the resilience of the local transport infrastructure to climate shocks: Strengthening transport infrastructure such as roads and taxi stands, to withstand the impacts of climate change, including more frequent or intense floods, storms, and heatwaves.

iv. Monitor, evaluate, and continually improve the transport plan and infrastructure resilience: This will involve tracking the performance of the new transport plan, assessing how well the improved infrastructure is withstanding climate shocks, and making necessary adjustments.

6. Implementation Framework

The implementation framework summarises the adaptation plan and indicates responsibilities, timeframes, and priorities.

6.1. Goal 1: To ensure water security in the face of climate change

Adaptation programme 1.1: Integrated Water Supply Management				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Address human resources constraints for effective water management	Temperature increases Increased Water Demand Drought Heat extremes Environmental Vulnerability: Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Human Resources function	Medium term (5 – 10 years)	High priority
ii. Undertake water resource management planning	Temperature increases Increased Water Demand Drought Heat extremes Environmental Vulnerability: Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Technical Services	Long term (>10 years) Continuous	High priority
iii. Diversify water supply	Temperature increases Increased Water Demand Drought Heat extremes Environmental Vulnerability: Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Technical Services function	Long term (>10 years)	High priority
iv. Review, or develop, and implement a treated effluent (wastewater) reuse strategy	Temperature increases Increased Water Demand Drought Heat extremes Environmental Vulnerability: Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Technical Services function	Medium to Long term (5 – >10 years)	Medium priority
v. Review, or develop, and implement a groundwater management strategy	Temperature increases Increased Water Demand Drought	Vhembe District, as well as Musina and Makhado Local Municipalities:	Medium to Long term (5 – 10 years)	High priority

		Heat extremes Environmental Vulnerability: Water Quality	Water and Sanitation function and Technical Services function		
vi.	Review, or develop, and implement a stormwater management strategy	Temperature increases Increased Water Demand Drought Heat extremes Flooding Environmental Vulnerability: Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function; Roads and Stormwater function; Environmental Management function and Technical Services function	Medium to Long term (5 to >10 years)	High priority
vii.	Review bulk water master plan	Temperature increases Increased Water Demand Drought Heat extremes Flooding Environmental Vulnerability: Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Technical Services function	Medium term (5 – 10 years)	High priority
viii.	Implement monitoring mechanisms and protect water sources by reducing pollution	Temperature increases Increased Water Demand Drought Heat extremes Flooding Environmental Vulnerability: Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function, Environmental Management and Technical Services function	Medium to Long term (5 to >10 years)	High priority

Adaptation programme 1.2: Integrated Water Demand Management				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Implement water conservation measures	Temperature increases Drought Heat extremes Increased Water Demand	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Community Services function	Short term (< 5 years)	High priority

ii.	Implement alien invasive species clearing initiatives in catchment areas	Temperature increases Drought Heat extremes Increased Water Demand Environmental Vulnerability: Water Availability and Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Environmental Management function	Short term (< 5 years)	High priority
iii.	Adopt a Water Sensitive Design and Planning (WSDP) approach for brownfield and greenfield developments	Temperature increases Increased Water Demand Drought Heat extremes Flooding Environmental Vulnerability: Water Quality Population growth pressure Urbanisation	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation, Environmental Management, Spatial Planning and Land Use Management, Integrated Development Planning, Technical Services and Building Regulations, as well as Parks and Recreation functions	Long term (> 10 years)	High priority

Adaptation programme 1.3: Education and Awareness Raising around Climate Change and Sustainable Water Use					
Adaptation Actions		Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i.	Develop water conservation education programmes	Temperature increases Drought Heat extremes Increased Water Demand	National and Provincial departments of Water and Sanitation (*Water Wise*) DFFE *Working for Water* Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Community Services function	Short term (<5 years)	High priority
ii.	Promote water conservation in households	Temperature increases Drought Heat extremes	Vhembe District, as well as Musina and Makhado Local Municipalities:	Short term (5> years)	High priority

		Increased Water Demand	Water and Sanitation function and Community Services function		
iii.	Encourage businesses to implement water-saving measures	Temperature increases Drought Heat extremes Increased Water Demand	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation, LED, and Community Services functions	Short to Medium term (<5 to years)	High priority
iv.	Conduct research on water conservation	Temperature increases Drought Heat extremes Increased Water Demand	Research and Tertiary institutions National and Provincial departments of Water and Sanitation Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Corporate Services department	Short term (<5 years) Continuous	High priority

6.2. Goal 2: To reduce the exposure and vulnerability of human and natural systems to climate change impacts and extreme weather events

Adaptation programme 2.1: Identification and prioritisation of climate change risks and development of appropriate response measures for settlements				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Conduct a vulnerability assessment to identify the populations and locations most at risk to climate change impacts	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, Spatial Planning, and Integrated Development Planning functions	Short term (<5 years)	High Priority

		Socioeconomic vulnerability Physical vulnerability			
ii.	Develop and implement early warning systems to help communities prepare for, and respond to, climate change risks	Temperature Increases Drought Heat extremes Wildfire Flooding	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management function and Disaster Management function	Short term (<5 years)	High Priority
iii.	Establish partnerships with local stakeholders, such as community groups and NGOs, to build local capacity for climate change adaptation and resilience	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, and Community Services functions; as well as the District and Local Municipal Cooperate Services departments	Medium term (5 – 10 years)	High priority
iv.	Develop and implement land use planning and zoning regulations that take into account the potential impacts of climate change	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Spatial Planning and Land Use Management, Environmental Management, Disaster Management, and Water and Sanitation Services functions	Short term (<5 years)	High priority

Adaptation programme 2.2: Climate resilient spatial planning				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Ensure that spatial planning frameworks consider a long-term	Temperature Increases Drought	Vhembe District, as well as Musina and Makhado	Medium term (5 – 10 years)	High priority

	view of climate hazards, while incorporating natural infrastructure	Heat extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic vulnerability Physical vulnerability	Local Municipalities: Spatial Planning and Land Use Management, Environmental Management, Disaster Management, and Water and Sanitation functions		
ii.	Develop local-level climate-resilient planning instruments - precinct plans	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Spatial Planning and Land Use Management, Building Regulations, Environmental Management, Disaster Management, and Water and Sanitation functions	Medium term (5 – 10 years)	Medium priority
iii.	Ensure collaborative strategic planning that incorporates input from all relevant departments (from the strategic planning phase to the project implementation phase)	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, and Integrated Development Planning functions *Vhembe Intergovernmental Forum	Short term (<5 years)	High priority
iv.	Create mechanisms to strengthen public participation in planning and decision-making processes	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, Spatial Planning,	Short term (5> years)	High priority

		Economic Vulnerability Socioeconomic vulnerability Physical vulnerability	Integrated Development Planning, and Community Services functions		
v.	Promote resilient urban and township design and development to minimise the risk and impact of climate change on urban areas	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Spatial Planning and Land Use Management, Building Regulations and Engineering Services, Water and Sanitation, and Environmental Management functions	Short term (<5 years)	High priority
vi.	Identify climate risk zones and hotspots that affect vulnerable municipal infrastructure and assets	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Spatial Planning and Land Use Management, Environmental Management, Disaster Management, Water and Sanitation function, and Technical Services functions	Short term (<5 years)	High priority

Adaptation programme 2.3: Integrated fire management for climate resilience				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Conduct a comprehensive evaluation of fire hazards	Temperature Increases Wildfire Environmental Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Fire and/or Emergency Services and/or Public Services and/or	Short term (5> years)	High priority

			Community Services functions		
ii.	Chart a strategic fire deterrence roadmap	Temperature Increases Wildfire Environmental Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Fire and/or Emergency Services and/or Public Services and/or Community Services functions	Short term (5> years)	High priority
iii.	Engage communities and educate them on fire safety	Temperature Increases Wildfire Environmental Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Fire and/or Emergency Services and/or Public Services and/or Community Services functions	Short term (continuous)	High priority
iv.	Invest in advanced fire detection and monitoring infrastructure	Temperature Increases Wildfire Environmental Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Fire and/or Emergency Services and/or Public Services functions	Medium term (5 – 10 years)	High priority
v.	Develop a Fire Emergency Preparedness and Response Strategy	Temperature Increases Wildfire Environmental Vulnerability Socioeconomic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Fire and/or Emergency Services and/or Public Services and/or Community Services functions	Short term <5 years)	High priority

vi.	Conduct post-fire restoration and ecosystem rehabilitation	Temperature Increases Wildfire Environmental Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Environmental Management, Fire and/or Emergency Services and/or Public Services and/or Community Services functions	Short to Medium term (<5 to 10 years)	Medium priority
vii.	Undertake policy and by-law development	Temperature Increases Wildfire Environmental Vulnerability Socio-economic vulnerability Physical vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Environmental Management, Fire and/or Emergency Services and/or Public Services and/or Community Services functions	Short term (<5 years)	High priority
viii.	Promote and support innovation in fire management techniques	Temperature Increases Wildfire Environmental Vulnerability Economic Vulnerability Socio-economic Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Environmental Management, Water and Sanitation, Fire and/or Emergency Services and/or Public Services and/or Community Services functions	Medium to Long term (5 to >10 years)	High priority
ix.	Encourage inter-organisational collaboration and form strategic partnerships	Temperature Increases Wildfire Environmental Vulnerability Economic Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Environmental	Short term (<5 years) Continuous	High priority

	Socio-economic Vulnerability Physical Vulnerability	Management, Water and Sanitation, Fire and/or Emergency Services and/or Public Services and/or Community Services functions; as well as the Local and District Municipal Corporate Services departments		
x. Strengthen fire management capacities and ensure effective use of resources	Temperature Increases Wildfire Environmental Vulnerability Economic Vulnerability Socio-economic Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Disaster Management, Fire and/or Emergency Services and/or Public Services and/or Community Services functions	Short to Medium term (5> to 10 years)	High priority

Adaptation programme 2.4: Community-based adaptation in areas most at risk to climate-related hazards				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Conduct detailed risk and vulnerability assessments in communities to identify drivers of risk and develop appropriate adaptation measures	Temperature Increases Drought Heat Extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, Planning, and Community Services functions	Short term (5> years)	High priority
ii. Develop and implement community-based adaptation measures to reduce risks and build resilience	Temperature Increases Drought Heat Extremes Wildfire	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental	Medium term (5 – 10 years)	High priority

		Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic Vulnerability Physical Vulnerability	Management, Disaster Management, Planning, and Community services functions		
iii.	Provide training and education to build community capacity and promote sustainability	Temperature Increases Drought Heat Extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, and Community services functions	Short to Medium term (5> years to 10 years)	High priority
iv.	Conduct comprehensive community engagements and raise public awareness initiatives on climate change	Temperature Increases Drought Heat Extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, and Community services functions	Short term (5> years)	High priority

Adaptation programme 2.5: Conservation, protection and restoration of Musina-Makhado SEZ's natural open spaces and ecosystems, with the aim of exploiting climate change adaptation benefits					
Adaptation Actions		Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i.	Assess natural resources and ensure that natural open spaces, ecosystems, and resources are conserved, protected, and restored	Temperature increases Drought Wildfires Heat extremes	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental	Medium to Long term (5 – >10 years)	High Priority

	Flooding Environmental vulnerability: Encroachment Relatively high population growth pressure	Management, Water and Sanitation, Engineering and Technical Services, and Land Use Management functions		
ii. Implement nature-based solutions to mitigate/buffer against the impacts of climate change and severe weather events, particularly in climate-risk zones	Temperature increases Drought Wildfires Heat extremes Flooding	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Parks and Recreation, Water and Sanitation, Engineering and Technical Services, as well as Disaster Management functions	Medium to Long term (5 to >10 years)	High priority

Adaptation programme 2.6: Enhancement of Musina-Makhado SEZ's Natural Resource Management				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Monitor and prevent soil erosion to ensure the long-term health and productivity of natural ecosystems, as well as maintain the quality of water resources	Temperatures increases Heat extremes Increased Water Demand Flooding Environmental vulnerability: Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Water and Sanitation function and Environmental Management function	Medium term (5 – 10 years)	High priority
ii. Provide training to municipal staff and stakeholders on biodiversity and natural resource management regulations and guidelines	Temperatures increases Drought Heat extremes Increased Water Demand Flooding Wildfire Environmental vulnerability: Water Quality and Encroachment	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management function	Short term (<5 years)	High priority
iii. Establish a District Municipal Environmental Management Forum	Temperatures increases Drought	Vhembe District, as well as Musina and Makhado	Short term (<5 years)	High priority

	(DEMF) to enhance collaboration and coordination between sectoral departments, conversation organisations and agencies related to natural resource management	Heat extremes Increased Water Demand Flooding Wildfire Environmental vulnerability: Water Quality and Encroachment	Local Municipalities: Environmental Management function		

Adaptation programme 2.7: Integrate Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) into the Spatial Development Framework					
Adaptation Actions		Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i.	Ensure that critical biodiversity and ecological support areas are integrated into Musina and Makhado's municipal spatial plans at all scales	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability: Encroachment and Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Spatial Planning and Land Use Management function and Environmental Management function	Short term (<5 years)	High priority
ii.	Identify and map natural open spaces, ecosystems, and natural resources, and integrate into the Spatial Development Framework and the Open Space Framework	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability: Encroachment and Water Quality	Vhembe District, as well as Musina and Makhado Local Municipalities: Spatial Planning and Land Use Management functions, as well as Environmental Management, and Water and Sanitation functions	Short term (<5 years)	High priority
iii.	Identify undeveloped open spaces with potential for green infrastructure	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability:	Vhembe District, as well as Musina and Makhado Local Municipalities: Spatial Planning and Land Use Management, Environmental Management, and Parks	Medium term (5 – 10 years)	Medium priority

	Encroachment and Water Quality	and Recreation functions		
iv. Assess the value of open spaces and ecosystem services	Temperature Increases Drought Heat extremes Wildfire Flooding Environmental Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management function and Parks and Recreation function	Short term (<5 years)	Medium priority

6.3. Goal 3: To develop climate-resilient, low-carbon, diverse and inclusive rural economy that is socially responsible, environmentally sustainable, and that provides job opportunities for unskilled, semi-skilled and skilled local residents

Adaptation programme 3.1: Low-carbon local economic transformation				
Adaptation Actions	**Key risk or vulnerability addressed**	**Responsible entity**	**Timeframe**	**Priority level**
i. Promote the use of renewable energy technologies in agricultural, mining, tourism and local business industries to reduce carbon emissions	Temperature Increases Drought Heat Extremes Wildfire Flooding Economic Vulnerability Socioeconomic Vulnerability Environmental Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Energy/Electricity Provision and/or Technical Services, and LED functions National and/or Provincial Department of Agriculture Private Sector: Mining Houses, Commercial and Subsistence Farmers, Business Owners and Operators	Long term (>10 years)	High priority

ii.	Establish incentives for businesses in the Musina-Makhado SEZ to switch to low-carbon operations	Temperature Increases Drought Heat Extremes Wildfire Flooding Economic Vulnerability Socioeconomic Vulnerability Environmental Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Energy/Electricity Provision, Technical Services and LED functions	Medium to Long term (5 years to >10 years)	High priority
Adaptation programme 3.2: Inclusive and diverse economic development					
Adaptation Actions		Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i.	Implement skills training programmes aimed at different levels to facilitate diverse job creation	Economic Vulnerability Socioeconomic Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: LED and Community Services and functions **Environmental Management function* Extended Public Works Programmes (EPWP)	Medium term (5 – 10 years)	High priority
ii.	Develop policies to support the growth of Small, Micro and Medium-sized Enterprises (SMMEs)	Economic Vulnerability Socioeconomic Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: LED, Integrated Development Planning and Community Services functions **Environmental Management function*	Short term (<5 years)	High priority
iii.	Introduce economic diversification initiatives that can create new industries	Economic Vulnerability Socioeconomic Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: LED, Integrated Development Planning	Short term (<5 years)	High priority

		and Community Services functions **Environmental Management function*		
Adaptation programme 3.3: Social responsibility and environmental stewardship				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Develop and implement environmental protection regulations	Temperature Increases Drought Heat Extremes Wildfire Flooding Environmental Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, and Water and Services functions	Short term (<5 years)	High priority
ii. Launch community awareness campaigns	Temperature Increases Drought Heat Extremes Wildfire Flooding Environmental Vulnerability Socioeconomic Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, Water and Sanitation, and Community Services functions	Short to Medium term (<5 years to 10 years)	High priority
iii. Establish partnerships with local communities, businesses, and NGOs	Temperature Increases Drought Heat Extremes Wildfire Flooding Environmental Vulnerability Economic Vulnerability Socioeconomic Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, and LED functions, as well as District and Local Municipal Corporate Services departments	Medium to Long term (5 to >10 years)	High priority
Adaptation programme 3.4: Climate-resilient agricultural communities				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level

i.	Enhance capacity for climate change adaptation in farming communities and industry	Temperature Increases Drought Heat Extremes Increased Water Demand Wildfires Economic Vulnerability Environmental Vulnerability Socioeconomic Vulnerability Physical Vulnerability	National and Provincial Department of Agriculture National and Provincial Department of Science, Technology and Innovation Vhembe District, as well as Musina and Makhado Local Municipalities: LED, Environmental Management, Disaster Management, and Water and Sanitation functions Academic and Research Institutions	Long term (>10 years)	High priority
ii.	Enhance social protection for farming communities	Temperature Increases Drought Heat Extremes Increased Water Demand Wildfires Socioeconomic Vulnerability	National and Provincial Department of Agriculture National Department of Social Development Vhembe District, as well as Musina and Makhado Local Municipalities: LED, Environmental Management, Disaster Management, Water and Sanitation, Social Services functions	Long term (>10 years)	Medium priority
Adaptation programme 3.5: Climate-smart transport strategy for resilience and efficiency					
Adaptation Actions		Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i.	Establish an evidence-base and assess vulnerability of the transport and mobility sector	Temperature Increases Drought Heat Extremes Wildfire Flooding Economic Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Planning and Transport functions	Short term (<5 years)	High priority

		Socioeconomic Vulnerability Environmental Vulnerability Physical Vulnerability			
ii.	Develop and implement a low-carbon, inclusive transport plan	Temperature Increases Drought Heat Extremes Wildfire Flooding Economic Vulnerability Socioeconomic Vulnerability Environmental Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, Community Services, and Transport functions	Long term (>10 years)	High priority
iii.	Enhance the resilience of the local transport infrastructure to climate shocks	Temperature Increases Drought Heat Extremes Wildfire Flooding Economic Vulnerability Socioeconomic Vulnerability Environmental Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, Transport, Planning, and Technical and/or Engineering Services functions	Medium term (5 – 10 years)	High priority
iv.	Monitor, evaluate, and continually improve the transport plan and transport infrastructure resilience	Temperature Increases Drought Heat Extremes Wildfire Flooding Economic Vulnerability Socioeconomic Vulnerability Environmental Vulnerability Physical Vulnerability	Vhembe District, as well as Musina and Makhado Local Municipalities: Environmental Management, Disaster Management, Transport, Planning, and Technical and/or Engineering Services functions	Continuous	High priority

7. Implications for the PHSHDA

As highlighted in the Climate Risk Profile report, greatest risks faced across the Musina-Makhado SEZ / PHSHDA are increased temperatures, heat extremes and drought. The area may also face a high risk of wildfire on the wildland-urban interface once development intensifies. The water supply vulnerability in both local municipalities is expected to increase into a climate-changed future. Moreover, the planned high-density settlement and expansion of industrial development in the area, may further exacerbate this. Therefore, to protect the area from water shortage and insecurity, there may be a need to diversify portable water supply and conserve available water.

The Musina-Makhado SEZ already has a predefined urban edge; this will help manage the increasing exposure of people and assets to climate impacts, provided that the local municipalities, as well as other relevant stakeholders of the PHSHDA ensure enforcement by prohibiting development and occupation beyond the boundaries of this development area. To manage the risk of wildfires, the local municipalities, as well as other relevant stakeholders could (in addition to implementing the measures outlined under the integrated fire management programme for climate resilience) (i) identify, protect and maintain buffer zones to reduce the spread of wildfire, especially along the wildland-urban interface; (ii) design permeable settlement layouts to allow for and enable timely evacuation, entries and movement of people, assets and aid during fire incidents; (iii) secure and store water for fire-fighting; as well as (iv) create and maintain firebreaks and maintain fuel loads (as outlined in the plan, under the integrated fire management for climate resilience programme).

To manage the risk of increasing temperatures and heat extremes, the local municipalities could (amongst various other measures) (i) rehabilitate ecosystems and maintain ecological/green infrastructure to ensure that it keeps providing and producing ecosystem services and goods, and (ii) increase vegetation coverage, this will not only provide shading for pedestrians, but also recharge the groundwater table. The municipalities and other relevant stakeholders could also encourage and support residential property owners within the SEZ to (i) install water efficient devices such as low flow faucets and showerheads, as well as dual-flush toilets, while encouraging the use of modern eco-efficient appliances, to further conserve water; (ii) install solar panels which have been proven to be climate-proof, while also reducing reliance on carbon intensive energy sources. Developers could also employ passive design principles when developing new (or upgrading existing) properties, buildings and/or structures within the SEZ to increase comfort levels, and do so in an energy efficient manner, thus resulting in additional co-benefits for the climate change mitigation agenda.

8. Recommendations for Mainstreaming

Mainstreaming is the process of integrating climate change considerations into existing sectoral plans, other instruments and decision-making processes across various sectors and levels of governance. It involves recognising that climate change impacts and risks cut across multiple sectors and require a holistic approach to address effectively. Mainstreaming supports and enables the implementation of climate adaptation measures.

Mainstreaming climate change involves several key elements, and recommendations are made in terms of each of these:

- Policy integration: Embedding evidence of climate change, as well as climate change adaptation and mitigation considerations into sectoral policies and strategies, such as those related to disaster risk management, energy, water resources, transportation, and urban planning. This ensures that climate change is not treated as a standalone issue but is instead integrated into broader development agendas.
- Institutional integration: Incorporating climate change responsibilities and expertise within departments. This may involve establishing a dedicated but decentralised climate change unit, as well as fostering collaboration and coordination among departments and relevant external stakeholders. Incorporating climate response outcomes in the KPIs of all relevant departments, will ensure that progress towards climate goals can be tracked and measured.
- Capacity building: Enhancing the knowledge, skills, and capacities of politicians, decision-makers, and practitioners to understand and address climate change effectively. This includes providing training, technical assistance, and access to relevant information and tools, such as the GreenBook. By improving their understanding of climate change and the need for adaptation, these groups can better integrate climate considerations into their work.
- Budgeting and financing: Allocating resources and funding to support climate change adaptation and mitigation activities within existing budgets and financing mechanisms. This may involve reallocating funds from other priorities, leveraging external sources of finance, or integrating climate considerations into budget planning processes. Various funding mechanisms are available to support climate change response initiatives, including national and international grants, public-private partnerships, and municipal budgets.
- Establishing networks and partnerships: Establishing networks or partnerships with civil society organisations, research councils, the private sector, different spheres of government, and other relevant entities could bolster climate adaptation efforts.
- Monitoring and evaluation: Establishing systems for monitoring and evaluating the effectiveness of mainstreaming efforts and tracking progress towards climate-related goals and targets. This helps ensure accountability and facilitates learning and adaptation over time.

Climate change mainstreaming is essential for building resilience and promoting sustainable development in the face of climate change. By integrating climate considerations into decision-making processes and actions across sectors, mainstreaming helps minimise future risks, maximise opportunities for adaptation and mitigation, and enhance overall resilience to climate change impacts.

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