GREENBOOK
adapting settlements for the future

Tsantsabane Local Municipality Adaptation Action Plan

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List of Acronyms and Abbreviations

CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFFE	Department of Forestry, Fisheries and the Environment
DHS	Department of Human Settlements
DRR	Disaster risk reduction
HDA	Housing Development Agency
IPCC	Intergovernmental Panel on Climate Change
LRT	Let's Respond Toolkit
PHDA	Priority Housing Development Area
PHS	Priority Human Settlement
PHSHDA	Priority Human Settlement and Housing Development Area
SPLUMA	Spatial Planning and Land Use Management Act, 2013 (Act No.16 of 2013)
TLM	Tsantsabane Local Municipality

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, 2019).
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, 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, organisations 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.

The Climate Change Adaptation Plan and its accompanying Risk Profile report have been specifically drafted for the Tsantsabane Local Municipality (TLM) 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 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 Local Municipality, with a specific focus on Priority Human Settlements or Priority Housing Development Areas (PHSDAs).
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 Tsantsabane Local Municipality with a comprehensive strategy to navigate the complexities of climate change, reduce vulnerability and exposure, and champion sustainable development.

The Adaptation Action Plan briefly outlines the policies constituting the framework for adaptation 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 Tsantsabane LM by aligning it with adaptation goals, programmes, and actions designed to address priority risks. 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 governments increasingly identified as the primary drivers of climate change adaptation. For instance, there exists various national policy and legislative mechanisms that promote, necessitate, guide and/or regulate climate change adaptation at the local level. These include the Disaster Management Amendment Act of 2015, the Spatial Planning and Land Use Management Act, i.e., Act No. 16 of 2013 (SPLUMA), 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 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 (See Figure 2).

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; C40, 2020).

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.

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.

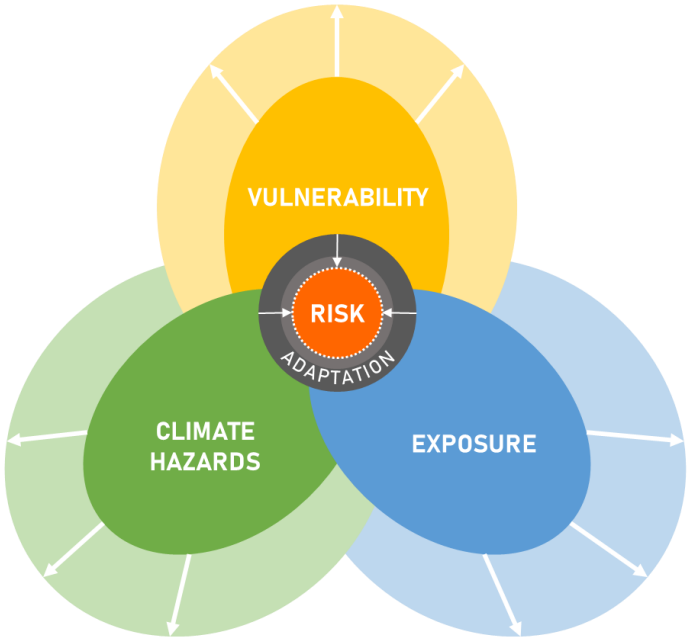

Figure 1 – The interplay between climate hazards, vulnerability and exposure that determines risk (based on IPCC, 2014 and IPCC, 2021)

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 adapt 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, 2019).

A spectrum of adaptation actions is at the disposal of local 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, 2019).

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 team, designed to complement this Plan. The comprehensive Climate Risk Profile serves as an essential resource for understanding the risks associated with climate change in Tsantsabane Local Municipality. Presented to representatives of the Municipality during a series of nationwide stakeholder engagements in late 2023, these workshops served as forums to not only validate the risks outlined in the report but also to confirm the adaptation goals proposed.

This section of the Plan summarises the climate risk profile for Tsantsabane Local Municipality, drawing from the GreenBook Risk Profile Tool at https://riskprofiles.greenbook.co.za/. Consult the accompanying Climate Risk Profile Report for more detailed information.

4.1. Climate projections, vulnerabilities and impacts

The main climate projections for the Tsantsabane LM points to hotter and wetter conditions for the LM. Future projections show increases in temperature up to 3.6 °C. Rainfall predictions show future change in annual rainfall expected to range between -6.81 mm to 81.26 mm. This indicates that rainfall could either decrease by 6.81mm or increase to 81.26mm in future. Future predictions show an increase in the number of very hot days between 22.48 days to 76.72 days per year, as well as an increase in heatwave days of between 25 to 28 days. In terms of economic vulnerability, the LM is ranked 18th out of 26 municipalities in the Northern Cape. The settlements of Postmasburg and Postdene are projected to experience extreme growth pressure in future. It is anticipated that the population will almost triple in size between 2011 and 2050. These two settlements are the growth centres where most economic activities in the LM are based. The Postmasburg PHSHDA's water supply vulnerability is expected to increase into the future due to

reduced rainfall and runoff generation, as well as population growth. The climate change risks as indicated were validated by the stakeholders in the Tsantsabane LM.

4.2. Priority climate-related hazards

For Postmasburg PHSHDA the biggest risks are increases in temperature with the risk of heat extremes increasing by as much as 28 days by 2050. Severe and persistent heat can place significant stress on the ecology and livestock and have implications for both human comfort and health. Warmer temperatures can disrupt growing seasons and affect crop yields. Some crops may fail to grow, while others may see reduced productivity. This can lead to food security issues and higher food prices. Higher temperatures can increase the risk of wildfires, threatening forests, homes, and infrastructure. The PHSHDA's populous areas, rely on a combination of surface water and groundwater. For the settlements that are dependent on groundwater, either entirely or partially, the combination of decreasing groundwater recharge potential and increasing population growth pressure will affect settlement water supply as water supplies decrease and demand increases. Municipal officials from Tsantsabane LM highlighted that they have experienced an increase in wildfires in the LM in recent years. Although not indicated by our wildfire risk maps an increase in wildfire is a secondary climate related impact. The higher temperatures predicted for the LM can increase the risk of wildfires, threating homes and infrastructure. Increasing wildfire risk has thus been included in the adaptation plans for the LM.

5. Adaptation Goals, Programmes and Actions

The section outlines the adaptation plan using goals and measures designed to help Tsantsabane LM to adapt to the impacts of climate change. Based on the assessment of the potential risks and vulnerabilities posed by climate change, this plan was developed as a proactive strategy to mitigate these risks and enhance resilience. All settlements in the LM are expected to experience extreme population growth pressure in the future, which means an increase in the exposure of people to heat stress. High population growth pressure will also lead to increased competition for resources – which affects the adaptive capacity of the LM and its inhabitants, thus making it more difficult for people to adapt to, respond to and recover from climate hazards and impacts.

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 Tsantsabane LM were identified, prioritising those risks with the highest potential impact. These goals were validated by stakeholders during the nationwide engagements:

- Goal 1: To prioritise the health and safety of communities in the face of a changing climate.
- Goal 2: To ensure water security in the face of climate change.
- Goal 3: To reduce the exposure and vulnerability of human and natural systems to climate change and extreme weather events.
- Goal 4: To support resilient commercial, small-scale and subsistence farming systems.
- Goal 5: To develop climate-resilient, low-carbon, diverse and inclusive rural economies that are socially responsible, environmentally sustainable and that provide job opportunities for unskilled, semi-skilled and skilled local residences.

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. Adaptation programme: Goal 1

Goal 1: To prioritise the health and safety of communities in the face of a changing climate.

Programme 1.1: Heatwave Preparedness and Response

The programme aims to enhance community resilience to extreme heat events by implementing a range of proactive measures. This programme focuses on identifying vulnerable populations, raising public awareness, providing refuge during heatwaves, and mitigating heat through urban greening.

Actions:

i. Conduct heat vulnerability assessments to identify high-risk areas and vulnerable populations, such as the elderly, children, and outdoor workers.
ii. Develop heatwave early warning systems and public awareness campaigns to educate residents on heat-related risks and protective measures.
iii. Establish cooling centres in community facilities, such as libraries and recreation centres, to provide refuge during heatwaves.
iv. Train healthcare workers, emergency responders, and community volunteers on heat illness prevention, recognition, and treatment.
v. Implement urban greening initiatives, such as planting trees and creating green spaces, to mitigate the urban heat island effect and provide natural cooling.

Programme 1.2: Population Health and Well-being Promotion

This programme aims to enhance the overall health and well-being of the community by addressing the direct and indirect health impacts of climate change. By improving access to healthcare, building local capacity, and promoting healthy lifestyles, the programme seeks to create a more resilient and supportive community environment.

Actions:

i. Provide access to affordable healthcare services and preventive care programs to address climate-related health impacts, such as heat-related illnesses, respiratory diseases, and vector-borne diseases.
ii. Establish community emergency response teams and train residents in first aid, disaster preparedness, evacuation procedures, and health promotion to build local capacity and resilience in the face of climate-related hazards.
iii. Develop mental health and psychosocial support programs to address the psychological impacts of climate change, such as anxiety, stress, and trauma.
iv. Strengthen social support networks and community resilience through peer support groups, neighbourhood associations, and faith-based organisations.
v. Promote healthy lifestyle behaviours, such as physical activity, nutrition, and stress management, through community-based education and outreach initiatives.
vi. Enhance access to clean water, sanitation, and hygiene facilities to prevent waterborne diseases and ensure basic hygiene practices during extreme weather events.

Programme 1.3: Infrastructure Resilience and Emergency Preparedness
This programme focuses on assessing and enhancing the resilience of critical infrastructure to withstand climate-related hazards and extreme weather events. By retrofitting existing structures and leveraging local resources, the programme aims to ensure the safety and functionality of essential services.

Actions:

i. Assess the vulnerability of critical infrastructure, such as healthcare facilities, schools, and water supply systems, to climate-related hazards and extreme weather events.
ii. Identify opportunities to enhance the resilience of existing infrastructure using low-cost, resource-efficient measures, such as retrofitting buildings with locally sourced materials, improving drainage systems using community labour, and repurposing underutilised spaces for emergency shelters.
iii. Seek partnerships with local businesses, NGOs, and community groups to leverage additional resources and expertise for infrastructure upgrades.

5.3. Adaptation programme: Goal 2

Goal 2: To ensure water security in the face of climate change.

Programme 2.1: Groundwater Management and Protection
This programme aims to sustainably manage and protect groundwater resources by conducting comprehensive assessments, implementing monitoring networks, and developing recharge projects. By regulating extraction and establishing protection zones, the programme seeks to ensure the long-term viability and quality of groundwater supplies for the municipality.

Actions:

i. Conduct hydrogeological assessments to understand groundwater recharge potential and identify sustainable yield limits for aquifers in the municipality.
ii. Develop groundwater monitoring networks using low-cost monitoring wells and community-based water quality testing kits to assess groundwater levels and quality.
iii. Implement aquifer recharge projects, such as managed aquifer recharge and infiltration basins, to enhance groundwater replenishment during periods of low rainfall.
iv. Regulate groundwater extraction through permit systems and licensing schemes to prevent overexploitation of aquifers and ensure equitable distribution of groundwater resources.
v. Establish groundwater protection zones around critical recharge areas and vulnerable aquifers, implementing land use regulations to prevent contamination and pollution.

Programme 2.2: Sustainable Water Management and Conservation
This programme focuses on promoting water conservation through education, the distribution of water-saving devices, and community-based initiatives. By reducing water losses and enhancing water use efficiency, the programme aims to ensure sustainable water consumption and availability for all users.

Actions:

i. Implement water conservation education campaigns targeting residents, schools, and businesses to raise awareness about the importance of water conservation practices.

ii. Provide low-cost water-saving devices, such as faucet aerators and low-flow showerheads, to households and businesses to reduce water consumption.
iii. Develop community-based rainwater harvesting initiatives to capture and store rainwater for non-potable uses, such as irrigation and toilet flushing.
iv. Conduct leak detection surveys and repair programs to minimise water losses in distribution networks, prioritising areas with high leakage rates.
v. Conduct regular leak detection surveys and repair activities to minimise water losses in distribution networks.
vi. Establish water metering and monitoring systems to track water usage and identify opportunities for efficiency improvements.

Programme 2.3: Integrated Water Resource Management
This programme seeks to integrate various water management strategies to optimise the use and distribution of both surface water and groundwater resources. By promoting collaborative governance, upgrading infrastructure, and engaging the community, the programme aims to enhance water supply reliability and resilience to climate change.

Actions:
i. Conduct integrated water resource assessments to evaluate the availability and demand for surface water and groundwater resources in the municipality.
ii. Develop water allocation plans that prioritise sustainable water use practices and equitable distribution of water resources among different sectors and users.
iii. Promote multi-stakeholder partnerships and collaborative governance approaches to facilitate coordinated decision-making and collective action for water management.
iv. Invest in water infrastructure upgrades and resilience measures, such as storage reservoirs, and distribution networks, to enhance water supply reliability and resilience to climate change impacts.
v. Facilitate community engagement and participation in water governance processes through public consultations, stakeholder workshops, and citizen science initiatives.

5.4. Adaptation programme: Goal 3

Goal 3: To reduce the exposure and vulnerability of human and natural systems to climate change and extreme weather events.

Programme 3.1: Climate Resilient Infrastructure and Urban Planning
This programme aims to enhance the resilience of critical infrastructure and urban areas to climate-related hazards. By conducting vulnerability assessments, implementing low-cost retrofitting measures, updating urban planning processes, and establishing community-based early warning systems, the programme seeks to mitigate risks and improve the ability of urban areas to withstand extreme weather events.

Actions:
i. Conduct low-cost vulnerability assessments of critical infrastructure using existing data and community input to identify areas at risk from extreme weather events and climate-related hazards such as wildfires and floods.

ii. Implement simple retrofitting and resilience measures for existing infrastructure, such as clearing drainage systems, reinforcing buildings with locally sourced materials, and promoting green spaces to mitigate heat island effects.
iii. Incorporate climate resilience considerations into existing urban planning processes by updating zoning regulations and building codes with minimal cost adjustments.
iv. Establish community-based early warning systems and emergency response protocols for extreme weather events, utilising local networks and volunteers to disseminate information and coordinate responses.

Programme 3.2: Sustainable Land Use and Natural Resource Management

Actions:

i. Promote community-led reforestation and soil conservation projects using volunteer labour and locally available resources to enhance ecosystem resilience and reduce erosion.
ii. Implementing wildfire risk management in catchments: This involves conducting prescribed burns, vegetation management, and erosion control measures in critical catchments to reduce wildfire risks and protect water quality. Early warning systems should be established for wildfires to ensure timely response.
iii. Advocate for the protection of natural habitats and green spaces through community-driven conservation efforts and awareness campaigns, leveraging existing volunteer networks and partnerships.
iv. Establish community-managed conservation areas and urban green spaces to preserve biodiversity and ecosystem services, utilising vacant lots and public lands for community gardening and recreation.

Programme 3.3: Community Engagement and Capacity Building

This programme aims to empower communities to build resilience and adapt to climate change. By facilitating participatory risk assessments, developing community resilience plans, providing capacity-building workshops, and fostering partnerships, the programme seeks to enhance local adaptive capacity, improve disaster preparedness, and leverage resources for effective climate adaptation initiatives.

Actions:

i. Facilitate participatory risk assessments and vulnerability mapping exercises with community members and local organisations to identify priority areas for adaptation and resilience-building.
ii. Develop community resilience plans and adaptation strategies in collaboration with local stakeholders, including residents, community organisations, and indigenous groups, to address specific climate risks and enhance adaptive capacity.
iii. Provide capacity-building workshops and training sessions for residents, community leaders, and government officials on climate change adaptation, disaster preparedness, and emergency response, to empower communities to take proactive measures to reduce vulnerability and build resilience.
iv. Foster partnerships and collaboration between government agencies, non-profit organisations, academic institutions, and private sector actors to leverage resources, expertise, and networks for climate adaptation initiatives at the local level.

5.5. Adaptation programme: Goal 4

Goal 4: To support resilient commercial, small-scale and subsistence farming systems.

Programme 4.1: Climate-Resilient Farming Practice

This programme aims to enhance the resilience of farming communities to climate change by conducting comprehensive climate risk assessments and developing localised adaptation plans. These actions are designed to identify vulnerabilities and guide farmers in adopting practices that mitigate risks posed by increased temperatures and changes in rainfall patterns, thereby ensuring sustainable agricultural productivity.

Actions:

i. Conduct comprehensive climate risk assessments to identify vulnerabilities and risks posed by increased temperatures and changes in rainfall patterns.
ii. Develop localised adaptation plans based on assessment findings to guide farming communities in adopting climate-resilient practices.

Programme 4.2: Promotion of Agroecological Farming Techniques

This programme focuses on educating farmers about sustainable agricultural practices through training programs. By promoting agroforestry, crop rotation, and integrated pest management (IPM), and facilitating the adoption of soil conservation methods, the programme aims to improve soil health, enhance resilience to climate extremes, and support sustainable farming practices that preserve the environment.

Actions:

i. Implement training programmes to educate farmers on sustainable agricultural practices such as agroforestry, crop rotation, and integrated pest management (IPM).
ii. Facilitate the adoption of soil conservation methods to improve soil health and resilience to climate extremes.

Programme 4.3: Water-Efficient Irrigation Systems

This programme aims to address water scarcity and improve water use efficiency in farming. By introducing water-efficient irrigation technologies such as drip irrigation and rainwater harvesting systems, and providing training and technical support to farmers, the programme seeks to optimise water usage, mitigate water scarcity risks, and ensure the sustainability of agricultural practices in the face of climate change.

Actions:

i. Introduce and promote the use of water-efficient irrigation technologies such as drip irrigation and rainwater harvesting systems.
ii. Provide training and technical support for farmers to optimise water use efficiency and mitigate water scarcity risks.

5.6. Adaptation programme: Goal 5

Goal 5: To develop climate-resilient, low-carbon, diverse and inclusive rural economies that are socially responsible, environmentally sustainable and that provide job opportunities for unskilled, semi-skilled and skilled local residences.

Programme 5.1: Rural Economic Diversification and Innovation

This programme aims to stimulate rural economies by promoting innovation and entrepreneurship in green industries. By establishing rural innovation hubs, supporting local businesses, organising community forums, and facilitating market access, the programme seeks to create sustainable economic opportunities, reduce dependency on traditional livelihoods, and enhance resilience through diversification.

Actions:

iii. Establish rural innovation hubs or incubators to support the development of local businesses and startups focused on renewable energy, sustainable agriculture, eco-tourism, and other green industries.
iv. Use existing community resources and volunteer networks to establish low-cost innovation hubs or entrepreneurship centres in community spaces.
v. Organise community forums, pitch competitions, and local markets to showcase and support grassroots entrepreneurship and small-scale enterprises.
vi. Facilitate knowledge-sharing and skills development through peer-to-peer learning, mentorship programs, and online training platforms.
vii. Facilitate access to markets, networks, and supply chains for rural producers and entrepreneurs through partnerships with wholesalers, retailers, and online platforms.

Programme 5.2: Capacity Building and Skills Development

This programme focuses on enhancing the skills and capacities of rural residents to adapt to changing economic and environmental conditions. Through collaboration with NGOs, vocational training centres, and local industries, the programme offers cost-effective training in sustainable practices and technologies, creates job placement opportunities, and leverages digital platforms to provide accessible learning, thereby empowering individuals and improving livelihoods.

Actions:

i. Collaborate with local NGOs, community colleges, and vocational training centres to offer cost-effective training programmes and workshops on sustainable farming practices, renewable energy technologies and green building techniques that are tailored to the needs of rural residents.
ii. Leverage digital technology and mobile learning platforms to provide accessible and affordable training opportunities to reach a broader audience.
iii. Partner with local industries and employers to create job placement programmes, apprenticeships, and internship opportunities for youth and unemployed individuals seeking entry into the workforce.

Programme 5.3: Infrastructure Development and Access to Services

This programme aims to improve rural infrastructure and access to essential services using low-cost, labour-intensive methods. By implementing community-driven infrastructure projects, exploring

innovative financing mechanisms, and partnering with various stakeholders, the programme seeks to enhance the quality of life in rural areas, support economic activities, and build resilience to climate impacts.

Actions:

i. Implement low-cost infrastructure improvements, such as road repairs, community waterpoints, and renewable energy installations, using labour-intensive methods and locally available materials.
ii. Explore innovative financing mechanisms, including crowd-funding campaigns, community savings groups, and microfinance initiatives, to fund infrastructure projects and service upgrades.
iii. Seek partnerships with government agencies, development organisations, and private sector stakeholders to leverage resources and reduce financial burdens.

Programme 5.4: Natural Resource Management and Environmental Conservation

This programme promotes sustainable management of natural resources and environmental conservation. By engaging local schools, youth groups, and community organisations in environmental education and hands-on conservation activities, and providing technical assistance to farmers, the programme aims to preserve biodiversity, improve ecosystem services, and encourage sustainable agricultural practices, contributing to long-term environmental resilience.

Actions:

i. Foster partnerships with local schools, youth groups, and environmental organisations to promote environmental education, awareness, and stewardship within the community.
ii. Engage local volunteers and community groups in hands-on conservation activities, such as tree planting, habitat restoration, and waste management initiatives, leveraging community labour and resources.
iii. Provide technical assistance, training, and incentives for farmers to adopt sustainable agricultural practices, such as agroforestry, organic farming, soil conservation, and water-efficient irrigation methods.

6. Implementation Framework

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

6.1. Implementation framework: Goal 1

Goal 1: To prioritise the health and safety of communities in the face of a changing climate

Adaptation programme 1.1: Heatwave Preparedness and Response				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Conduct heat vulnerability assessments. In this action heat vulnerability assessments to identify high-risk areas and vulnerable populations, such as the elderly, children, and outdoor workers will be conducted.	Temperature increases Increased heat stress Increase in heatwaves	Environmental Department and Community Services Department in collaboration with local community	Short term (< 5 years)	High
ii. Develop heatwave early warning systems and public awareness campaigns. In this action heatwave early warning systems and public awareness campaigns to educate residents on heat-related risks and protective measures will be developed.	Temperature increases Increased heat stress Increase in heatwaves	ZF Mgcawu disaster management department in collaboration with local community	Short term (< 5 years)	High
iii. Establish cooling centres in community facilities. In this action cooling centres will be established in community facilities, such as libraries and recreation centres, to provide refuge during heatwaves.	Temperature increases Increased heat stress Increase in heatwaves	Community Services Department	Short term (< 5 years)	Medium
iv. Train healthcare workers, emergency responders, and community volunteers. In this action healthcare workers, emergency responders, and community	Temperature increases Increased heat stress Increase in heatwaves	Department of Health in collaboration with ZF Mgcawu District Disaster Management Department	Short term (< 5 years)	High

volunteers will be trained on heat illness prevention, recognition, and treatment.				
iv. Implement urban greening initiatives. In this action urban greening initiatives, such as planting trees and creating green spaces, to mitigate the urban heat island effect and provide natural cooling will be implemented.	Temperature increases Increased heat stress Increase in heatwaves	Development and Town Planning Department	Medium term (5-10 years)	Medium

Adaptation programme 1.2: Population Health and Well-being Promotion				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Provide access to affordable healthcare services and preventive care programmes. In this action access to affordable healthcare services and preventive care programmes to address climate-related health impacts, such as heat-related illnesses, respiratory diseases, and vector-borne diseases will be provided.	Temperature increases Increased heat stress Increase in heat related illnesses	ZF Mgcawu District Environmental Health Department in collaboration with local health clinics and community organisations	Short term (< 5 years)	High
ii. Establish community emergency response teams and train residents. In this action community emergency response teams will be established, and residents will be trained in first aid, disaster preparedness, evacuation procedures, and health promotion to build local capacity and resilience in the face of climate-related hazards such as wildfire and floods.	Increased heat stress Temperature increases Remoteness, access to available services	ZF Mgcawu District Disaster Management Department in collaboration with local community leaders and organisations	Short term (< 5 years)	High
iii. Develop mental health and psychosocial support programs.	Temperature increases Increased heat stress Increase in heat related illnesses	ZF Mgcawu District Environmental Health Department in collaboration with local	Medium term (5-10 years)	High

In this action mental health and psychosocial support programmes will be developed to address the psychological impacts of climate change, such as anxiety, stress, and trauma.		health clinics and community organisations		
iv. Strengthen social support networks and community resilience. In this action social support networks and community resilience will be strengthened through peer support groups, neighbourhood associations, and faith-based organisations.	Temperature increases Increased heat stress Increase in heat related illnesses	Development and Town Planning in collaboration with NGOs	Medium term (5-10 years)	Medium
v. Promote healthy lifestyle behaviours. In this action healthy lifestyle behaviours, such as physical activity, nutrition, and stress management, through community-based education and outreach initiatives will be promoted.	Temperature increases Increased heat stress Increase in heat related illnesses	Community Services Department in collaboration with local health clinics and community organisations	Short term (< 5 years)	High
vi. Enhance access to clean water, sanitation and hygiene facilities. In this action access to clean water, sanitation, and hygiene facilities to prevent waterborne diseases and ensure basic hygiene practices during extreme weather events will be enhanced.	Temperature increases Increased heat stress Increase in heat related illnesses	Technical Services Department and development and town planning	Short term (< 5 years)	High

Adaptation programme 1.3: Infrastructure Resilience and Emergency Preparedness				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Assess the vulnerability of critical infrastructure. In this action the vulnerability of critical infrastructure, such as healthcare facilities,	Temperature increases	Technical Services Department	Short term (< 5 years)	High

schools, and water supply systems, to climate-related hazards and extreme weather events will be assessed.				
ii. Enhance the resilience of existing municipal infrastructure. In this action opportunities to enhance the resilience of existing infrastructure using low-cost, resource-efficient measures, such as retrofitting buildings with locally sourced materials, improving drainage systems using community labour, and repurposing underutilised spaces for emergency shelters will be identified.	Increased heat stress Temperature increases	Technical Services Department in collaboration with local businesses, NGOs and community groups	Medium term (5-10 years)	High
iii. Develop partnerships. In this action efforts will be made to seek partnerships with local businesses, NGOs, and community groups to leverage additional resources and expertise for infrastructure upgrades.	Temperature increases	Municipal Manager and Technical Services Department and development and town planning department		

6.2. Implementation framework: Goal 2

Goal 2: To ensure water security in the face of climate change.

Adaptation programme 2.1: Groundwater Management and Protection				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Conduct hydrogeological assessments. In this action a hydrogeological assessment will be conducted to understand groundwater recharge potential and identify sustainable yield limits for aquifers in the municipality.	Water supply vulnerability Water security	Technical Services in collaboration with	Short term (< 5 years)	High

ii. Develop groundwater monitoring networks. In this action groundwater monitoring networks using low-cost monitoring wells and community-based water quality testing kits to assess groundwater levels and quality will be developed.	Water supply vulnerability Water security	Technical Services in collaboration with community	Short term (< 5 years)	High
iii. Implement aquifer recharge projects. In this action aquifer recharge projects, such as managed aquifer recharge and infiltration basins, to enhance groundwater replenishment during periods of low rainfall will be implemented.	Water supply vulnerability Water security	Technical Services	Medium term (5-10 years)	Medium
iv. Regulate groundwater extraction. Groundwater extraction will be regulated through permit systems and licensing schemes to prevent overexploitation of aquifers and ensure equitable distribution of groundwater resources.	Water supply vulnerability Water security	Technical Services	Short term (< 5 years)	High
v. Establish groundwater protection zones. In this action groundwater protection zones will be established around critical recharge areas and vulnerable aquifers, implementing land use regulations to prevent contamination and pollution.	Water supply vulnerability Water security	Technical Services	Medium term (5-10 years)	High

Adaptation programme 2.2: Sustainable Water Management and Conservation.				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Implement water conservation education campaigns.	Water security Water supply vulnerability	Community Services Department in collaboration with community	Short term (< 5 years)	High

In this action water conservation education campaigns targeting residents, schools, and businesses to raise awareness about the importance of water conservation practices will be implemented.				
ii. Provide low-cost water saving devices. In this action low-cost water-saving devices, such as faucet aerators and low-flow showerheads will be provided to households and businesses to reduce water consumption. The municipality can partner with local hardware stores or suppliers to offer aerators and low flow showerheads at subsidised prices.	Water supply vulnerability Water security	Technical Services in collaboration with local hardware stores and suppliers	Short term (< 5 years)	High
iii. Develop community-based rainwater harvesting initiatives. In this action community-based rainwater harvesting initiatives will be developed to capture and store rainwater for non-potable uses, such as irrigation and toilet flushing.	Water supply vulnerability Water security	Community Services Department and technical services in collaboration with community	Short term (< 5 years)	High
iv. Conduct leak detection surveys and repair programs. In this action leak detection surveys and repair programs will be conducted to minimise water losses in distribution networks, prioritising areas with high leakage rates.	Water supply vulnerability Water security	Technical Services Department	Short term (< 5 years)	High
v. Establish water metering and monitoring systems. In this action water metering and monitoring systems will be established to track water usage and identify opportunities for efficiency improvements.	Water supply vulnerability Water security	Technical services	Short term (< 5 years)	High

Adaptation programme 2.3: Integrate Water Resource Management				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Conduct integrated water resource assessments. In this action integrated water resource assessments will be conducted to evaluate the availability and demand for surface water and groundwater resources in the municipality.	Water security Water supply vulnerability	Technical Services Department	Short term (< 5 years)	High
ii. Develop water allocation plans. In this action water allocation plans will be developed that prioritise sustainable water use practices and equitable distribution of water resources among different sectors and users.	Water supply vulnerability Water security	Technical Services and Development and Town Planning Department	Short term (< 5 years)	High
iii. Promote multi-stakeholder partnerships. In this action stakeholder partnerships among various stakeholders involved in water resource management, including government agencies, local authorities, community groups, NGOs, private sector, and research institutions will be formed to engage stakeholders in joint problem solving to develop and implement water management strategies.	Water supply vulnerability Water security	Technical Services Department and Municipal manager in collaboration with NGO's, community groups, private sector, and research institutions	Short term (< 5 years)	High
iv. Invest in water infrastructure upgrades. In this action the municipality should invest in water infrastructure upgrades and resilience measures, such as storage reservoirs, and distribution networks, to enhance water supply reliability and resilience to climate change impacts.	Water supply vulnerability Water security	Technical Services Department	Medium term (5-10 years)	Medium

v. Facilitate community engagement. In this action the municipality will facilitate community engagement and participation in water governance processes (i.e. implementation of policies related to the use and management of water resources) through public consultations, stakeholder workshops, and citizen science initiatives.	Water supply vulnerability Water security	Technical services	Short term (< 5 years)	High

6.3. Implementation framework: Goal 3

Goal 3: To reduce the exposure and vulnerability of human and natural systems to climate change and extreme weather events.

Adaptation programme 3.1: Climate Resilient Infrastructure and Urban Planning				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Conduct vulnerability assessments. In this action the municipality will conduct low-cost vulnerability assessments of critical infrastructure using existing data and community input to identify areas at risk from extreme weather events and climate-related hazards such as wildfires and floods.	Fire Flood Increase in temperature.	Technical Services Department	Short term (< 5 years)	High
ii. Implement retrofitting measures. In this action the municipality will implement simple retrofitting and resilience measures for existing infrastructure, such as clearing drainage systems, reinforcing buildings with locally sourced materials, and promoting green spaces to mitigate heat island effects.	Increased temperature Fire risk	Municipal Works Department	Short term (< 5 years)	Medium
iii. Updating zoning regulations.	Increase in heatwaves. Wildfire risk	Development and Town Planning Department	Medium	High

In this action the municipality will incorporate climate resilience considerations into existing urban planning processes by updating zoning regulations and building codes with minimal cost adjustments.				
iv. Establish early warning systems. In this action community-based early warning systems and emergency response protocols will be established for wildfire fire and flood events, utilising local networks and volunteers to disseminate information and coordinate responses.	Increased heat stress Wildfire risk	ZF Mgcawu District Disaster Management Department in collaboration with community	Short	High

Adaptation programme 3.2: Sustainable Land Use and Natural Resource Management				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Promote soil conservation projects. In this action the municipality will promote community-led soil conservation and reforestation projects using volunteer labour and locally available resources to enhance ecosystem resilience and reduce erosion.	Wildfire risk	Community Development Department in collaboration with community	Short term (< 5 years)	High
ii. Implement wildfire risk management in catchments. In this action prescribed burns, vegetation management and erosion control measures are conducted in critical catchments to reduce wildfire risk and protect water quality. Early warning systems for wildfires should be established to ensure timely response.	Increase in temperature Increase in wildfire risk	Municipality in collaboration with agricultural extension services, community organisations, educational institutions and local farmers	Short term (< 5 years)	High

iii. Advocate for habitat protection. In this action the municipality will advocate for the protection of natural habitats and green spaces through community-driven conservation efforts and awareness campaigns, leveraging existing volunteer networks and partnerships.	Increase in temperature. Wildfire risk	Environmental Health and Emergency Services: Fire unit in collaboration with Fire Protection Association (FPA)	Short term (< 5 years)	High
iv. Establish community-managed green spaces. In this action community-managed conservation areas and urban green spaces will be established to preserve biodiversity and ecosystem services, utilising vacant lots and public lands for community gardening and recreation.	Increase in temperature. Wildfire risk	Development and Town planning in collaboration with community	Medium term (5-10 years)	Medium

Adaptation programme 3.3: Community Engagement and Capacity Building				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Facilitate Risk Assessments In this action participatory risk assessments and vulnerability mapping exercises with community members and local organisations will be facilitated to identify priority areas for adaptation and resilience-building.	Wildfire risk Increase in temperature. Increase in heat stress	Community Development Department in collaboration with community	Short term (< 5 years)	High
ii. Develop resilience plans. In this action community resilience plans and adaptation strategies will be developed in collaboration with local stakeholders, including residents, community organisations, and indigenous groups, to	Increase in temperature. Reduced crop yield Food security Wildfire risk	Municipality in collaboration with community	Short term (< 5 years)	High

address specific climate risks and enhance adaptive capacity.				
iii. Provide capacity building workshops. In this action capacity-building workshops and training sessions will be provided for residents, community leaders, and government officials on climate change adaptation, disaster preparedness, and emergency response, to empower communities to take proactive measures to reduce vulnerability and build resilience.	Increase in temperature. Wildfire risk Increase in heat stress Reduced crop yield Food security		Short term (< 5 years)	High
iv. Foster partnerships. In this action the municipality will foster partnerships and collaboration between government agencies, non-profit organisations, academic institutions, and private sector actors to leverage resources, expertise, and networks for climate adaptation initiatives at the local level.	Increase in temperature. Wildfire risk Increase in heat stress Reduced crop yield Food security	Development and Town planning in collaboration with community	Medium term (5-10 years)	Medium

6.4. Implementation framework: Goal 4

Goal 4: To support resilient commercial, small-scale and subsistence farming systems

Adaptation programme 4.1: Climate-Resilient Farming Practice				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Conduct climate risk assessments. In this action comprehensive climate risk assessments are conducted to identify vulnerabilities and risks posed by increased temperatures and changes in rainfall patterns. The data should be analysed to	Increase in temperature. Wildfire risk Increase in heat stress Reduced crop yield Food security	Department of Agricultural Research and Climate Assessment	Short term (< 5 years)	High

identify vulnerabilities and risks in farming systems.				
ii. Develop localised adaptation plans. In this action localised adaptation plans are developed based on assessment findings to guide farming communities in adopting climate-resilient practices.	Increase in temperature. Wildfire risk Increase in heat stress Reduced crop yield Food security	Department of Agricultural Extension Services	Medium term (5-10 years)	High

Adaptation programme 4.2: Promotion of Agroecological Farming Techniques				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Implement training programs on sustainable agricultural practices. In this action training materials on agroforestry, crop rotation, and IPM are created. Workshops and training sessions should be conducted for farmers. Ongoing support and resources should be provided for farmers to implement practices.	Increase in temperature. Increase in heat stress Reduced crop yield Food security	Department of Agriculture	Short term (<5 years)	High
ii. Facilitate the adoption of soil conservation methods. In this action awareness about the benefits of soil conservation is raised. Demonstration projects on soil conservation techniques should be implemented. Incentives should be provided for farmers to adopt soil conservation methods. Demonstration projects should be implemented on soil conservation techniques.	Increase in temperature. Increase in heat stress Reduced crop yield Food security	Department of Agriculture	Medium-term (5 to 10 years)	High

Adaptation programme 4.3: Water efficient irrigation systems				
Adaptation Actions	Key risk or vulnerability addressed	Responsible entity	Timeframe	Priority level
i. Introduce water efficient irrigation technologies. In this action the use of water-efficient irrigation technologies such as drip irrigation and rainwater harvesting systems are introduced and promoted.	Increase in temperature. Increase in heat stress Reduced crop yield Food security	Department of Agriculture	Short term (< 5 years)	High
ii. Provide training and support. Training and technical support are provided for farmers to optimise water use efficiency and mitigate water scarcity risks.	Increase in temperature. Increase in heat stress Reduced crop yield Food security	Department of Water and Sanitation	Short term (< 5 years)	High

6.5. Implementation framework: Goal 5

Goal 5: To develop climate-resilient, low-carbon, diverse and inclusive rural economies that are socially responsible, environmentally sustainable and that provide job opportunities for unskilled, semi-skilled and skilled local residences.

Adaptation programme 5.1: Rural Economic Diversification and Innovation				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Establish rural innovation hubs. In this action rural innovation hubs or incubators to support the development of local businesses and startups focused on renewable energy, sustainable agriculture, eco-tourism, and other green industries will be established	Economic vulnerability Change in crop production.	Local Economic Development Department in collaboration with local community centres and NGOs	Short term (< 5 years)	Medium
ii. Use community resources for innovation centres. In this action existing community resources and volunteer networks will be used to	Economic vulnerability	Development and town planning in collaboration with local community centres and NGOs	Short term (< 5 years)	High

establish low-cost innovation hubs or entrepreneurship centres in community spaces.				
iii. Organise community forums and markets. In this action the municipality will organise community forums, pitch competitions, and local markets will be organised to showcase and support grassroots entrepreneurship and small-scale enterprises.	Economic vulnerability	Local economic development department in collaboration with local business associations and community leaders	Short term (< 5 years)	High
iv. Facilitate access to markets and networks. In this action the municipality will facilitate access to markets, networks, and supply chains for rural producers and entrepreneurs through partnerships with wholesalers, retailers, and online platforms.	Economic vulnerability	Local economic development department in collaboration with Trade Associations and Online Platforms	Medium term (5-10 years)	High

Adaptation programme 5.2: Capacity Building and Skills Development				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Offer training programs and workshops. In this action municipality will collaborate with local NGOs, community colleges, and vocational training centres to offer cost-effective training programs and workshops on sustainable farming practices, renewable energy technologies and green building techniques that are tailored to the needs of rural residents.	Economic vulnerability Change in crop production. Increased risk to livestock Increase in temperature	Development and town planning department in collaboration with NGOs and vocational training centres	Short term (< 5 years)	High
ii. Leverage digital technology for learning. In this action the municipality will facilitate knowledge-sharing and skills development	Economic vulnerability Socio-economic vulnerability	Local Economic Development department and development and town	Short term (< 5 years)	High

through peer-to-peer learning, mentorship programs, and online training platforms.		planning department in collaboration with IT department and online platforms		
iii. Create job placement programmes. In this action the municipality will partner with local industries and employers to create job placement programmes, apprenticeships, and internship opportunities for youth and unemployed individuals seeking entry into the workforce.	Economic vulnerability Socio-economic vulnerability	Local Economic Development department and Development and town planning department in collaboration with local industries and employers	Medium term (5-10 years)	High

Adaptation programme 5.3: Infrastructure Development and access to services				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Implement low-cost infrastructure improvements. In this action the municipality will implement low-cost infrastructure improvements, such as road repairs, community water points, and renewable energy installations, using labour-intensive methods and locally available materials.	Economic vulnerability Increased isolation of rural communities	Technical services department in collaboration with community development department and NGOs	Medium term (5-10 years)	High
ii. Explore innovative financing mechanisms. In this action the municipality will explore innovative financing mechanisms, including crowd-funding campaigns, community savings groups, and microfinance initiatives, to fund infrastructure projects and service upgrades.	Economic vulnerability	Municipal Finance Department in collaboration with local savings groups and financial institutions	Medium term (5-10 years)	High
iii. Seek partnerships for resource leveraging.	Economic vulnerability	Corporative service in collaboration with Government agencies	Medium term (5-10 years)	High

In this action the municipality will seek partnerships with government agencies, development organisations, and private sector stakeholders to leverage resources and reduce financial burdens.		and private sector stakeholders		

Adaptation programme 5.4: Natural Resource Management and Environmental Conservation				
Adaptation Actions	Key risk or vulnerability addressed	Responsible department	Timeframe	Priority level
i. Promote environmental education and stewardship. In this action the municipality will foster partnerships with local schools, youth groups, and environmental organisations to promote environmental education, awareness, and stewardship within the community.	Economic vulnerability	Development and town planning department, in collaboration with schools, youth groups and NGOs	Medium term (5-10 years)	High
ii. Engage community in conservation activities. In this action the municipality will engage local volunteers and community groups in hands-on conservation activities, such as tree planting, habitat restoration, and waste management initiatives, leveraging community labour and resources.	Economic vulnerability	Development and town planning in collaboration with community groups and NGOs	Medium term (5-10 years)	High
iii. Provide technical assistance for sustainable farming. In this action the municipality will provide technical assistance, training, and incentives for farmers to adopt sustainable agricultural practices, such as agroforestry, organic farming, soil conservation, and water-efficient irrigation methods will be provided.	Economic vulnerability Change in fruit production	Development and town planning department in collaboration with agricultural extension services and NGOs	Medium term (5-10 years)	High

7. Implications for the PHSHDA

Given the vision of the Postmasburg PHSHDA to integrate, and formalise informal settlements to create a sustainable, well-functioning, investable regional mining town (PSHDA, 2022), there are several implications to consider due to projected climate change impacts, water supply vulnerability and projected population growth. In the planning and development of the Postmasburg PHSHDA planners should ensure that new developments promote health and safety by incorporating green spaces, pedestrian-friendly infrastructure, and access to healthcare facilities. Communities should be engaged with, especially those in informal settlements, to ensure their needs and perspectives are included in planning processes. Significant increases in temperature and increases in heatwaves are predicted for the municipality. Measures should be implemented to mitigate the impact of climate change on health, such as heat-resilient design, effective waste management systems, and disease prevention programmes. The projected decrease in rainfall and increase population projections makes the Postmasburg PHSHDA vulnerable to water shortages in future. Water-sensitive urban design principles should be integrated into neighbourhood planning to maximise water efficiency and reduce reliance on centralised water supply systems. Rainwater harvesting, greywater recycling, and sustainable landscaping practices should be promoted to conserve water and enhance resilience to droughts and water shortages. Settlements should be designed to withstand climate-related hazards, such as floods and storms, through resilient infrastructure, floodplain management, and disaster risk reduction measures. Nature-based solutions such as green infrastructure and wetland restoration, to buffer communities from the impacts of extreme weather events and enhance ecosystem services should be incorporated into planning and design. Economic diversification and entrepreneurship should be fostered within the Postmasburg PHSHDA by supporting small-scale businesses, promoting local food systems, and creating job opportunities in renewable energy and green technologies.

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 climate change involves several key elements:

- 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.
- 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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